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FROM PRESERVATION TO PARTICIPATION: DIGITAL APPLICATIONS FOR SUSTAINABLE CULTURAL TOURISM IN TRIPOLI OLD CITY

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Abstract

Valorising the significance of integrating digital technologies at heritage sites leads to collaboration, which could represent the cultural identity and enhance the visitors' perception of authentic cultural knowledge. This contributes directly to forming the Lebanese cultural tourism market toward providing an effective experience. The paper investigates the integrative fundamentals between employing innovative digital technologies and their applications, and providing an edutainment cultural tourism experience in Tripoli Old City (Lebanon). It is a qualitative empirical case study that employs direct observations and assesses thirty semi-structured interviews with the key actors. The methods focus on the integration of digital devices to enhance visitor experiences and sustainable conservative management. The findings suggest a framework from which actors may initiate future advancements of increasing the investment in AR/VR/AI.

Keywords

Cultural Tourism, Cultural Value Perception, Cultural Heritage, Digital Technology, Sustainability, Tripoli Old City

1. Introduction

UNWTO Recommendations on Sustainable Development of Indigenous Tourism (2019) defined cultural tourism (CT) as a tourism activity that not only includes consuming (in)tangible cultural heritage (CH) assets but also the visitors' socio-cultural experience at the heritage sites (HSs) and the meanings they ascribe to it. CT cultivates a deeper perception and appreciation of a city's heritage and nostalgia (Iakovaki et al., 2023). Thereby, it contributes to protecting cultural assets, generating socio-economic resources, raising awareness of the communities and engaging them towards enhancing these outstanding values, respecting socio-cultural diversity, and improving facilities and services, which further upgrades HSs' appeal and accessibility (Wang, 2023). Thus, it gives opportunities for locals to share their socio-cultural legacy with the visitors, cultivating cross-cultural understanding and trade (Li et al., 2022). The integration of advanced digital technologies (DTs) - a term used in this study to describe a group of immersive and interactive DTs such as Augmented Reality (AR), Virtual Reality (VR), Artificial Intelligence (AI), digital signage (DS), and 3D photogrammetry- has immense transformative potential for CT industry of Lebanon.

Integrating advanced DTs into the Lebanese CT market, particularly in Tripoli Old City, presents a multifaceted opportunity to enhance visitor experiences. The application of innovative DTs can facilitate accessibility, improve resource management, and promote CH, thereby attracting various segments. By enabling interactive storytelling, guided digital tours, and personalised navigation of historical locations, such technologies enhance a more accessible and interactive type of tourism. The use of immersive DTs can create interactive experiences that engage visitors more deeply with Tripoli's rich history (Jia et al., 2023). Information and communication technologies can streamline CT planning, ensuring that HSs are effectively managed and marketed (Panagiotopoulou et al., 2020). The adoption of technology in CT may lead to opportunities such as cultural concentration, which could enhance the transmission process of the authenticity of Tripoli's historical narrative. Balancing technological advancements with cultural integrity remains crucial for sustainable tourism development (Azouri et al., 2016).

Tripoli Old City, with its rich historical and socio-cultural legacy, tells the urban-architectural evolution and a story of craftsmanship that has been overlooked and underrepresented. It suffers from a damaged public image. Tripoli is Lebanon's second-largest city and contains more than 600 registered heritage buildings. Yet, it receives less than 5% of the nation's overall tourists. The city is relatively unknown and suffers from some infrastructural issues, which make it lag behind in tourism. Showcasing these elements through digital platforms can finally give the city the recognition it deserves and attract the relevant target segments. DTs are essential in changing this perception by allowing people to virtually explore the city's rich landmarks, historical sites, and cultural assets. It faces noteworthy obstacles such as limited funding, outdated technology, and the need for progressive visitor engagement (El-Barazi, 2009).

Guided by the European cities model, the research seeks to provide visitors with an opportunity to explore Tripoli's architectural and cultural assets in advance. This virtual exposure can encourage more visitors to experience the city first-hand. The integration of advanced technological innovations, such as AR/VR/AI, and digital signage (DS), offers innovative arrangements for solving these or at least lessening conservatively its human-induced impacts, such as cultural dilution or over-commercialisation. While these technologies have been used in international heritage contexts, they are here examined particularly in connection with the Tripoli historic context and CT potential. It also addresses increasing local demand for heritage-based tourism experiences and identifies the recognised necessity of technology development in the management of urban heritage in Lebanon. This study aims to comprehensively examine how these advances are presently used and how they can be further utilised to upgrade Tripoli's CT context.

This paper is divided into four sections. Initially, we review the usage of technological innovations in the CT market, which contributes to creating visitors' experiences. Then, we present the applied qualitative method, its results and the case study, including the cultural significance. Finally, the last section develops a kind of corporate agenda to reflect on the implications for the technological applications.

2. Literature Review - Digital Business Models and Cultural Tourism-based Technological Innovations

In this section, we build our theoretical framework by reviewing multidimensional perspectives of the conservative background of CT market, including the advanced innovative DTs, the digital business models, and the perception of the CH value. Thus, we address the fundamentals of digitising HSs, concerning the urban and cultural landscapes perspective. Attracting various visitors, the Lebanese heritage tourism market was socially and economically investigated in various literature, but there aren't many studies which assess the significance and impact of technological innovation in this market (Azouri et al., 2016; Ghiye, 2020; El-Shami, 2023).

The digital revolution, in CT business models, has changed recognising how cultural experiences are marketed, accessed, and monetised. Online booking and information dissemination platforms have increasingly become indispensable tools in CT. The websites offer convenient access to information about all available cultural sites, events, and activities and simplify the process of booking tours, accommodations, and experiences. DTs could provide the opportunity to promote CT attractions effectively and, at the same time, increase the visibility and attractiveness of these for all potential visitors (Ammirato et al., 2022). Conducive to an improved distribution of resources, online booking convenience can facilitate the management of high demand more gently, thereby improving visitor flow management (Nur et al., 2021). This is a particularly important option for managing highly demanded CT attractions. Thus, the integration of user-generated content or reviews further improves visitors' decision-making on these sites, as it makes real-time feedback from previous visitors accessible (Liu et al., 2022). Once these innovative digital solutions are adopted, inclusiveness, attractiveness, and economic viability will be created in CT landscape for various actors.

Virtual experiences have received the same traction as their physical counterparts, and they form ever-growing part of CT. The COVID-19 pandemic accelerated development in virtual tourism, which now allows cultural institutions to surmount geographical limits and target more successfully. According to UNWTO survey (2021), 70% of respondents expressed a great interest in

virtual tours (VTs) (Afifi, 2021). Therefore, VTs allow off-site visitors to access cultural locations without any degradation. Live streaming and VTs build an interactive shopping atmosphere in which consumers can interact with cultural products in real-time (Liu et al., 2022). Such digital engagement increases not only consumer trust but also the chances of conversion from virtual experiences to actual visits, which drives future tourism (Xu & Li, 2023). Above all, the ability of VR/AR to provide experiences of immersion is what adds to the richness of CT, allowing audiences to connect with CH in completely new ways.

DTs play a crucial role in the marketing and selling of local crafts and goods, making them an integral part of CT experience, partially with the possible use of e-commerce. This creates online marketplaces for local producers and craftsmen, enhancing economic viability by expanding their market access. E-commerce-based applications in tourism sectors directly facilitate the marketing of culturally related objects and significantly boost domestic economies (Chang et al., 2015). Moreover, integrating e-commerce with social media (SM) could potentially enhance visibility and improve engagement by developing responsive knowledge for targeted marketing. Following the argument of Xu and Li (2023), digital platforms, virtual experiences, and e-commerce interact in a full circle to form a facilitating environment that enhances CT. By applying technology, CT actors can develop a journey for visitors right from the research stage to the experience and even further to post-activities (Joo et al., 2020).

Blockchain technology emerges as a strong driving force in CT, most significantly through blockchain-ticketing and Non-Fungible Tokens (NFTs) platforms. NFTs enable virtual experiences or artefacts to be owned digitally, opening up new revenue streams for conservation. Blockchain ticketing and crowdfunding platforms function to allow transparent sources of funding for CH conservation. With such a platform, financial contributions can directly contribute towards environmentally friendly tourism strategies. Blockchain technology has played a significant role in the funding of CH preservation. In tourism, Blockchain can underpin digital ticketing, proof of provenance of artefacts, or preservation funding mechanisms via token-based systems. NFTs present new opportunities for cultural institutions to monetise digital copies of heritage assets, such as virtual tours, 3D modelling, or digital art derived from historic sites, and provide new engagement channels for worldwide audiences. NFT sales of digital copies of historic monuments, such as Notre Dame Cathedral, have raised over $1 million for restoration. Blockchain-based ticket systems enhance security and transparency, reducing ticketing fraud by 90%. Blockchain-enabled crowdfunding for CH initiatives has also been more effective than traditional means, with 60% higher funding success rates (Gregorić, 2022; Prajapat, 2024).

Digital business models in CT also serve purposes beyond mere transnationality. From a people-centred approach, these foster community participation and empowerment because they provide local stakeholders with the enabling tools and resources they require to engage in the tourism economy actively. Empowerment plays a vital role in enabling sustainable tourism development that benefits both visitors and local communities by ensuring the adequate distribution of economic benefits arising from CT. Subsequently, e-commerce serves as a medium for promoting tourism, enabling local communities to showcase their culture to visitors (Wahdiniwaty & Gafarina, 2023).

Technological progressions have essentially changed CT scene. For instance, DS and versatile applications further improve the visitors' experience by giving real-time data and interactive content (Graziano & Privitera, 2020). DS can display dynamic substance, such as historical actualities, multimedia presentations, and interactive maps, upgrading the educational perspective of a visit (Xinyu, 2023). Mobile apps offer comfort by providing guests with access to data on the go, including audio guides, virtual visits, and interactive maps. These DTs can help oversee guest flows and provide insights into visitor behaviour, allowing for effective management of cultural locales (Bordoni, 2011).

Another key technological development in CT is 3D photogrammetry, through which CH can be preserved in a digital format, creating high-quality 3D images of HSs. These images could enable people abroad to visit HSs virtually. 3D photogrammetry involves using a series of photographs to reconstruct highly accurate 3D models of buildings or artefacts, allowing remote access and virtual conservation of heritage sites (Gregorić, 2022; Ma, 2024). Digital archiving saves

locations at risk of degradation and loss, such as in restoration work that recreates ancient cityscapes like Palmyra (Cai et al., 2021).

Then, developing DTs, such as AR/VR/AI, has revolutionised how visitors encounter cultural assets (Hausmann & Schuhbauer, 2021). Extended reality (XR) brings together VR, AR, and Mixed Reality (MR), offering new dimensions in CT. XR refers to a broad category of technology, i.e. AR/VR/MR. AR overlays digital information into the actual world through smartphones or smart glasses; VR fully immerses individuals into digitally created worlds; MR enables real-time interaction between the physical and digital worlds. XR technology enriches visitor experiences by offering immersive, interactive forms of discovering HSs and cultural monuments. These technologies enable immersive storytelling, virtual reconstructions of damaged or lost heritage elements, and greater accessibility for people unable to physically visit sites, thus democratising CH access. VR offers immersive encounters that permit visitors to explore historical sites virtually (Ammirato et al., 2022) with its unique moments in a more engaging way than regular guided tours (Ahmed et al., 2022; Buhalis & Karatay, 2022). Through VR, the visitors can nostalgically experience destinations or be associated with digital reproductions of lost or damaged assets. It also enhances the visitors' memory to explore the intangible heritage expressions by representing cultural occasions and celebrations that they might not be able to attend in person (Katsoni & Spyriadis, 2019).

AR overlays digital data onto the physical world, permitting visitors to interact with historic objects and sites more engagingly, for instance, in Pompeii, Italy (Jiang et al., 2022). For occurrence, AR applications can give additional contexts about a site's history or display recreations of ancient structures, improving the educational value of a visit. AR software overlays virtual information over real locations, enriching narratives and enhancing visitor experiences of cultural places (Abdul-Jabbar & Alwehab, 2023; Judijanto, 2024).

Innovative technology in urban CT faces a series of barriers to effective implementation. Regarding the International Telecommunication Union report (2021), about 37% of the population worldwide continued to lack access to technology, especially in developing countries with poor technological infrastructure. Besides creating a widening technology divide in terms of tourism development, the divide makes it even more difficult to access high-class tourism experiences. Most rural and underdeveloped towns lack strong connectivity. Thus, they can't effectively contribute to the international tourism economy. Cities, including New York and Paris, have included AR capabilities in an attempt to enhance experiences accessible to visitors. VR/AR technology is an expensive barrier to new forms of technological acceptance. High-class VR headsets cost between $300 and $1,000, a price that most economically disadvantaged regions' tour operators can't pay. It costs between $50,000 and $150,000 to produce AR software of high quality - a price that excludes small companies and cultural groups from accessing technology. (Pangrazio et al., 2020)

MR software in museums brings together real and virtual dimensions, offering interactive experiences that stimulate visitor activity and learning (Buhalis, 2019; Buhalis & Karatay, 2022). The "Lingnan Attire" exhibition in the Hong Kong Heritage Discovery Centre could be a good example. Interactive digital narratives heightened visitors' cultural awareness and emotional arousal immensely. 85% of the visitors exhibited a willingness to revisit the exhibit. (Mo et al., 2024).

AI applications, in terms of customisability, bring new ethical concerns about safeguarding information privacy. Mistakes in how history is shown can lead to misinformation and distort heritage stories, which reduces the educational value of these DTs (Fareed & Amer, 2023). CH institutions, historians, and technology developers need to work together to create standard guidelines for representing HSs online (Navarrete, 2019). Despite AI technology storing and processing massive amounts of information to make personalised recommendations and immersive experiences, concerns about safeguarding information haven't yet been addressed (Jie, 2023). The regulatory and legal environment for AI and heritage is underdeveloped, and uncertainty regarding copyright and property claims arises in terms of AI-created heritage assets, such as computer simulations of heritage items. There is also uncertainty regarding whether such assets belong to the AI creator, cultural institution, or community of origin. Unclear laws complicate use in heritage conservation and tourism, and an international agreement must be reached in developing regulations protecting heritage and

intellectual property (Xu, 2023). Consequently, ensuring historical accuracy in AI and VR content is difficult when it comes to preserving heritage and tourism.

AI has made critical commitments to sociocultural tourism. Through natural language processing (NLP), AI-powered frameworks can improve visitors' engagement through personalised proposals and tailored encounters (Stock, 2001). Additionally, AI-powered virtual guides deliver real-time information and cultural interpretations, opening up environments in a historical manner (Praničević, 2021; Ma, 2024). AI algorithms can analyse the visitors' preferences and recommend personalised itineraries or give real-time information about nearby attractions. AI chatbots can help guests with inquiries and provide instant support, improving visitors' involvement (Graziano & Privitera, 2020; Fareed & Amer, 2023).

AI-created cultural representations facilitate the recreation of artwork from extinct items, thereby enriching museums and educational programs by providing access to contextual information that could otherwise be irretrievable (Ahmed et al., 2022; Ma,2024). AI-powered recommendation platforms monitor visitor behaviour and preferences to present personalised tours, heighten visitor engagement, and boost visitor satisfaction (Ma, 2024; Prajapat, 2024). AI virtual guides, e.g. in the Louvre Museum, upgrade visitors' engagement by 40%. This was accomplished by providing them with personalised information about the artwork and exhibit items (Guo et al., 2022). AI-facilitated gamification and individualisation, such as AI-facilitated scavenging in heritage locations, encourage participatory discovery and involve visitors in a new way (Ma, 2024; Omran Group, *n.d.*). AI-powered multilingual narrative tools widen access for non-native speakers, enriching diversity in CT (Abdul-Jabbar & Alwehab, 2023; Ma, 2024). All these improvements make CT vibrant, accessible, and flexible for a range of visitor needs. While these technologies vary in complexity and cost, their strategic application in the CT sector can transform passive sightseeing into interactive, educational, and emotionally resonant heritage experiences.

As a result of that, public-private collaboration is imperative for successful technological innovation in CT. Governments, private entities, and communities have to collaborate in synergistic efforts to invest in smart CT programs, like in Guilin, China, to confirm collaboration's effectiveness in utilising technology for CT development. Nevertheless, collaboration is accompanied by a fair portion of bureaucratic impediments and the harmonisation of conflicting stakeholder interests (Pradana, 2024). Governments and private investors need to work together in funding technological development in CH conservation, such that such technology is accessible and beneficial to all sectors of society. Constrained financial resources can obstruct the usage of technological developments and the advancement of CT activities. Numerous historical cities battle with budget limitations, which can influence their capacity to invest in modern innovations, maintain cultural locales, and advance tourism. Securing financing from governmental sources, private investors, and international organisations is vital for addressing these challenges and guaranteeing the sustainability of CT projects (Gustafsson & Amer, 2023).

3. Case Study: Tripoli Old City: Values and Cultural Significance

Tripoli Old City (fig.1) is considered one of the highly significant historic centres in Lebanon, particularly through its medieval architecture, Ottoman-era monuments, and rich cultural history. Recognising Tripoli as a cultural landscape, it has several layers and associated values (Tab.1) with a strategic geographical location, which effectively influences the city's urban planning. It hosts the Crusader-built Tripoli Citadel, the medieval markets, and several historic mosques and churches that reflect the city's long-standing religious and cultural diversity (Sfeir, 2009). Reviewing the integrity value, Mamluk-era Madrasa al-Shamsiyat reflects the educational and social aspects of Tripoli, while it has a limited direct economic or urban impact. The institutions expose their historical papers by deploying text recognition technology. Also, Khan al-Khayyatin, as a traditional caravanserai (inn for traders), plays a major role in Tripoli's economy. Moreover, Hammam al-Nouri acts as an example of historical/traditional health practices. Scientific researchers conduct stability preservation research and identify proper restorative techniques at controlled temperature settings through AI simulation methods.

Tab. 1: Heritage Values of Tripoli Old City's Components

City Attributes Values	St. Gilles Citadel	Mansouri Great Mosque	Madrasa Al-Shamsiyah	Hammam Al-Nouri	Al-Uwaysiyat Mosque	Khan Al-Khayyatin	Taynal Mosque	Al-Muallaq Mosque
Historic	✓	✓	✓	✓	✓	✓	✓	✓
Aesthetic	✓	✓		✓	✓	✓	✓	✓
Social		✓	✓	✓	✓	✓	✓	✓
Economic						✓		
Architectural	✓	✓	✓	✓	✓	✓	✓	✓
Urban	✓			✓		✓		
Cultural	✓	✓	✓	✓	✓	✓	✓	✓
Spiritual		✓	✓		✓		✓	✓
Geographical	✓					✓		

Fig.1: Tripoli Old City (Abu Ali River in the Foreground and Tripoli Citadel in the background) [©Ar. Mounzer Hamze, 2019]

As a coastal city with historical landmarks and a vibrant cultural scene, Tripoli attracts a considerable number of tourists annually, contributing to the local economy. In recent years, the Lebanese Ministry of Tourism has highlighted Tripoli as CT attraction, especially with its rich blend of ancient traditional craftsmanship and local culinary experiences drawing visitors globally (Taha, 2018). The economic value of CT in Tripoli is notable, as it boosts local businesses, thus sustaining CH. In contrast, Tripoli faces challenges in fully capitalising on its tourism assets due to infrastructural limitations. Nevertheless, with the proper investment in CT infrastructure and heritage preservation, Tripoli could reach a high inflow of visitors, further strengthening its economic standing.

4. Research Methodology

This study advocates qualitatively towards advanced technological accessibility to the Tripoli CT market, seeking to understand the current use of technology in promoting and preserving CH and identify opportunities for further integration of innovative digital tools. Through direct observation and semi-structured interviews with the key stakeholders, it involves an examination of the conservation mandate of Tripoli's historic contexts. The applied interpretive-descriptive analytical approach exhibits inductive and deductive characteristics. The interpretation of qualitative data draws from the narratives and personal experiences of the authors, lending an inductive nature to the research. The descriptive analysis conversely follows deductive reasoning, deriving insights from direct observations and reviews conducted in the historic quarter and its surrounding areas.

4.1. Qualitative Data Collection & Validity

Thirty semi-structured interviews were conducted with the key stakeholders' representatives of Tripoli's CT market: (1) academics from Lebanese University, Lebanese American University (LAU), Beirut Arab University (BAU), Balamand University (BU) – five interviewees; (2) governmental bodies from the Directorate General of Antiquities for North Lebanon (DGA), the Islamic Endowments Administration - North Lebanon (IEA-NL), etc. – six interviewees; (3) non-governmental organisations (NGOs) like the Order of Engineers and Architects (OEA) in Tripoli, United Nations, ICOMOS, Tourist Guides Syndicate – five interviewees; (4) the private sector, including tourism agencies and technology investors – six interviewees; (5) the professional community (e.g. architects, tour guides, etc.) – eight interviewees.

Most of the interviewees are experts and familiar with CT environments and DTs. They are among decision-makers, contributing to the urban policy, or project managers. Local community, or even tourists, weren't among the target segments of the interviews because they are just users, not a

part of the decision-making process. The interview comprised 20 open-ended and close-ended questions encompassing four dimensions, which focus on their experiences with and perspectives toward providing advanced technological accessibility and integrating it in Tripoli CT, and the former, ongoing, and proposed development projects in the future.

The interviews were conducted in Arabic and English due to the limited proficiency in English of some interviewees, ensuring participants could express their perspectives and insights authentically and effectively. The gathered data, from the interview transcripts, were recorded and analysed using a thematic analysis approach, enabling a structured and in-depth examination of recurring themes and patterns. Participants enthusiastically signed the consent forms, reflecting their openness and support for the research's focus.

In every addressed dimension, some questions were directed to all stakeholders, while others were addressed to a specific stakeholder. Interviews were tape-recorded and then manually transcribed for extended qualitative analysis. The interviewer took notes during the interviews to reflect on the ideas being discussed. Interviews lasted from 50 to 60 minutes. The data were then analysed through interpretive-descriptive analysis that departs from efforts to build an understanding of the level of application of the following dimensions associated with the integration level of advanced technology to the Lebanese CT market. The analysis was carried out manually through the process of organising, sorting, grouping, categorising, and interpreting the data. The applied analytical approach has some deductive and inductive characteristics. The descriptive analysis followed deductive reasoning as it was inferred from the theoretical conceptualisation of the four investigated dimensions. However, the interpretation of data was built on the narratives and personal experiences of research participants, which gives an inductive nature to the research. In sum, using the theoretical lens of the four investigated dimensions to frame how stakeholders reasoned about the implemented strategy, this study proposes a more nuanced approach.

Interviews have effectively constructed a narrative that captures the unfolding events. A narrative serves as a principal tool for analysing, illustrating, and organising qualitative methods, rendering them intelligible. To address the issues, bilingual experts familiar with the study's thematic focus were engaged, back-translation techniques were used to verify accuracy, and findings were triangulated with contextual observations to enhance data reliability. By documenting the translation process transparently, the approach acknowledges both the strengths and limitations of the methodology.

4.2. Coding Process & Results

The interview is segmented into four dimensions:

D.1. Technological Awareness explores the level of awareness towards the significance of integrating advanced DTs. It indicates the current statement and projects that were implemented to enhance innovatively Tripoli's CH assets.

Result: Maintaining human interaction with the cityscape is crucial and remains the preferred approach. The direct sensory connection to CH holds irreplaceable emotional and historical significance, and preserves the human essence and embedded cultural values. Within certain limitations, DTs are essential for developing and enhancing conservation methodologies, like digital documentation and environmental monitoring, visitor experience, and cultural engagement (e.g. interactive exhibits or storytelling) in Tripoli CT landmarks. Tripoli faces very tough socio-cultural and security conditions, making it crucial to focus on sustainability and safeguarding against vandalism in case of any unforeseen events. DTs are vital tools for preserving local urban heritage, allowing us to showcase the treasures without compromising their authenticity and visual integrity. It engages the youth more deeply with the historical context they live in and the cultural identity (CI) they belong to, and aligns with their requirements and new trends.

Int.11: *Intangible heritage is deeply human and requires direct experience to truly appreciate; it engages all the senses, which technology alone can't fully replicate.*

On the other hand, the visitors visually draw their experiences. Via DTs, they can connect with CT landmarks, local culture and social practices in a meaningful way, exploring and visualising the sites that no longer exist. Lessening the human-induced impacts of development projects contributes to identifying where enhancements can be made with an effective and conservative

impact in raising awareness of the local community, preserving the city's historic districts, reducing the cost of maintenance, and promoting the tourism sector as an economic growth engine. For instance, at Mansouri the Great, where *al-Athar el-Sharif* Room is only accessible for one day per year, DTs could significantly increase accessibility and visitor engagement.

DTs are powerful tools for introducing visitors to Tripoli's rich heritage. Beyond simply showcasing the city, digitalisation plays a vital role in how we present and interpret the past, creating a bridge between historical narratives and the living present. These are essential for local communities to fully display their (in)tangible heritage, including traditional music, soap production, gold craftsmanship, and local cuisine, which can generate income for artisans and local businesses. By integrating DTs into Tripoli's HSs, the city can highlight its significance, history, and traditions in a way that resonates more deeply with both local and global audiences. This would indeed make the city's CH feel more relevant and alive, fostering emotional rapport or a sense of pride.

The key stakeholders have all the capabilities and enough awareness to valorise and integrate the emerging DTs. Improving cultural encounters, Lebanese CT market (1) valorises the marketing and communication role of SM platforms, interactive websites, tourism applications, Google Maps, and booking and services applications; (2) facilitates the tourism experience by using quick-response (QR) codes, and mobile applications and offering various digital interpretation tools, at HSs, such as holograms, sound and light tours, DS and navigators, machine learning (ML), the internet of things, 5G network, VR/AR tour applications; and (3) contributes to applying a sustainable conservation process by using advanced documentation programs and applications, for instance, GIS mapping platforms, 3D (laser) scanning, drones and photogrammetry that recreates or reconstructs the cultural assets based on the collected data from its current state and forms immersive visitors' paths, comparable to these in Athens, upgrading cultural involvement.

Int.9: *In Acropolis (Athens), visitors can see virtual reconstructions of ancient buildings over the ruins using AR applications; you can imagine a similar experience for the Abu Ali River.*

Some stakeholders jointly seek to offer fascinating or well-tailored nostalgic CT paths for visitors by importing European experiments. They seek to ensure an immersive and extraordinary edutainment journey. Using AR applications, visitors can imagine all public spaces and traditional markets. It could be enhanced with scenes of real people and ancient artefacts' reconstructions.

Enhancing the integrated heritage values of Tripoli's historic landmarks, advanced digital and information technologies are currently being used. Besides QR coding, Tripoli municipality (TM) created a mobile application, "Visit a City", that facilitates municipal functionalities, building an integrated database, supporting traffic and a safer city (by setting up CCTV cameras and free WiFi), and providing a virtual guiding service and digital models. Understanding the visitors' preferences, TM added an interactive map to its website and the Ministry of Tourism's websites, as well as helping the visitors to better accessibility and perception of CT attractions that they are interested in, including a recommendation for the shortest route to visit all the interesting landmarks.

Int.25: *Technologies align with the digital habits and preferences of current and future generations, making cultural engagement more relevant and engaging.*

In cooperation with Marseille Municipality (France), IEA-NL (the urban community of al-Fayhaa) and TM launched the first project "Digital Scanning for Sites and Tourist Routes in the Cities of al-Fayhaa", enhancing around 51 monuments and visitors' routes with QR codes and VR, achieving site illustration and visualisation. This project was limited to providing narrative information containing descriptive text and historical background in three languages.

Then, the second project, entitled ISIMED, is underfunded at al-Mansouri Kabir Mosque, *Tekye Mawlawi*, *Hammam Ezzedine*, and *Eglise Mar Mikhael*, focusing on DS with special efforts by a group of engineers, architects, archaeologists, historians, restorers, and so on who are passionate about showcasing Tripoli's HSs. DS further improves the visitor encounter by advertising dynamics and updated data about cultural locales. Interactive shows can give real-time overhauls on events, shows, and site-specific data, keeping the visitors educated and engaged. Also, DS can offer interactive components, such as touchscreens that permit guests to access additional content or participate in virtual tests and games related to the

site's history. This project was commenced in 2023 with the restoration of a unique sundial, accompanied by detailed explanations of *minbar* and the characteristics of other architectural elements such as *al-Madrasa al-Shamsiyah*, *al-Mashad*, and *Ghrife al-Ather Al-Nabawiy*.

Also, the third project is underway for Taynal Mosque to reveal the hidden tiles inside the monument, which are concealed due to the mosque's prayer function. This project began in 2022 with a group of volunteer engineers and architects from Tripoli. They completed all the surveys, drawings, and QR code headlines that can be accessed via a mobile application and tools like VR goggles.

In collaboration with DGA and OEA, there is a recent project that was funded by ICONEM for Endangered Heritage in 2024. It works in a large area of Tripoli to conduct 3D (laser) scanning photogrammetry and AI-driven structural analysis. The project focuses on post-documentation interventions for Tripoli Old City and its extensions, such as Tripoli Citadel, Al-Sibat area and its surrounding buildings, Burtasi Mosque, Hamam Al-Nouri, and el-Rimeneh. DTs allow engineers and structural experts to detect early signs of damage or deterioration, especially in structural elements. The analysis helps categorise buildings based on their risk levels - these are in critical condition, these are at moderate risk, and those requiring immediate intervention. This comprehensive assessment results in a fully prepared dossier that can be presented to potential donors, providing them with a clear understanding of the site's condition and the urgency of preservation efforts. This proactive approach streamlines the decision-making process for funding and ensures targeted restoration where it's most needed. Furthermore, the project provides interdisciplinary capacity-building (CB) activities to enhance those professionals with both new updates. So, they can carry out comprehensive data collection and site documentation. Phase one was completed at *Khan el-Saboun* and *Khan el-Khayattin*, and phase two will begin soon. The used DT helps to transfer the photo data to 3D survey to perform structural analysis, identify and prevent potential structural dangers in buildings, and do drone scanning.

Thus, QR codes would provide instant access to multimedia content-including videos, descriptions, and historical facts-giving visitors a self-guided, enriched experience while exploring the old city. Photogrammetry creates detailed 3D models of Tripoli's HSs that could be added to Google Earth. This wouldn't only aid in education and research but also allow visitors to explore virtually Tripoli's CH, ensuring that these sites are documented for future generations. Moreover, 3D scanning could be used to digitally document Tripoli's HSs, helping to preserve their structural integrity and creating online museums, similar to Notre-Dame Cathedral, the Louvre Museum, and Petra. 3D reconstitution of partially damaged historical buildings and implementation of 2D explanatory boards on site helped remarkably in a better understanding of CH and motivated collective awareness towards its preservation. This would also assist in restoration projects by providing accurate models to guide future preservation efforts.

Various updated DTs haven't been well-realised in enhancing (in)tangible aspects of Tripoli's CH. Unfortunately, using technology is limited to QR codes, some VTs, and some achievements by some known private companies. XYZ Lebanon works on advanced 3D scanning techniques and VR tours (fig.2). AKDI 360 creates interactive VTs for Tripoli Castles' museums (fig.3), in collaboration with TM and the Ministry of Culture and 3D drone projects. Unfortunately, it was never published or made accessible to the public.

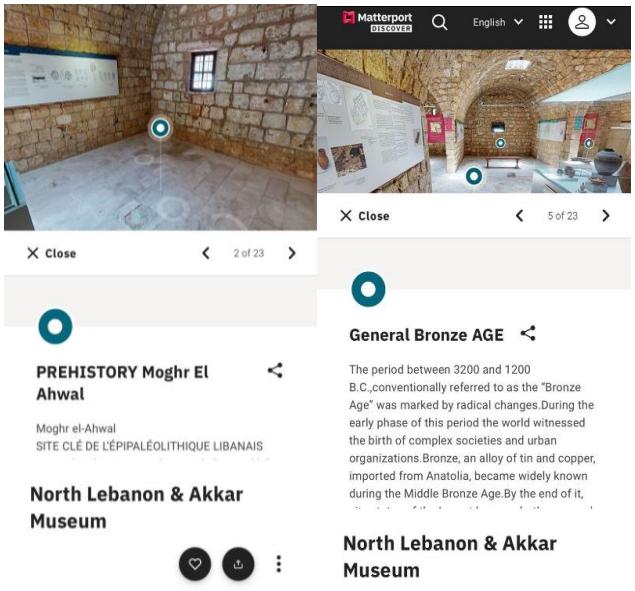


Fig.2: XYZ Virtual Tours/3D Photogrammetry Model Tripoli Citadel.
https://vt.xyz-lb.com/show/?m=J3Sg5QeP77G&mpu=876
[accessed 20 November 2024]

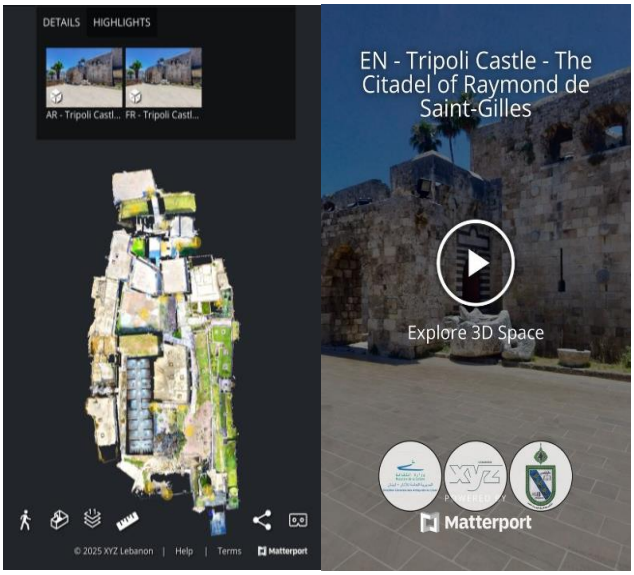


Fig.3: Virtual Tours - AKDI 360 Akkar Museum https://matterport.com/discover/space/Gp4pdGTtvP4 [accessed 20 November 2024]]

QR codes and VR/AR applications aren't often well-functional and haven't achieved the desired impact due to insufficient funding. Several VTs have been conducted in the Lebanese CT context: Raymond de Saint-Gilles Citadel, Nabu Museum - El Heri, Museum Anashar Basbous (Artist/Sculptor) - Rachana, Karam Museum, Sawfar Train Station, Batroun Aquarium in 3D, and Art Design, Tabbal Building in Sursock. While there are initiatives and efforts, there is a need to develop a comprehensive vision and strategic plan with short, medium, and long-term goals. Without a clear and well-funded plan, the full benefits of DTs for CH enhancement remain largely untapped. It should form a coordinated corporate committee/board like Business Improvement Districts.

Int.14: *More technologies need to be integrated into the city, but it needs to be monitored and updated with a plan of integration in the short and long term.*

Representing Tripoli's historic assets and valorising the visitor experience, stakeholders seek to integrate all updated DTs (e.g. data analysis software, digital accessibility applications, geolocation, etc.) to enhance CT experience. Cooperating with academia, some stakeholders indicated their enthusiasm for using AI chatbot methodology by promoting AI-based research projects and their applications in Lebanese HSs. Through the responses of the governmental bodies, the authors stated the current projects at Tripoli's HSs. AI can analyse 3D scans and images to detect early signs of structural damage or deterioration in HSs. AI Modelling can significantly enhance visitors' experiences in Tripoli by offering personalised tours based on visitors' preferences and behaviours. Through AI-powered systems, visitors can interact with specific artefacts or landmarks. Virtual construction and AI can promote conservation efforts by visualising restoration projects. Subsequently, it reshapes Tripoli's image for both local and international markets.

D.2. Current Technology Integration discovers the main responsibility for integrating advanced DTs in Tripoli's HSs and CT market, and from which perspective.

Result: Mobile applications, interactive websites, SM platforms and QR codes, photogrammetry, and VR are considered the most used DTs in Tripoli's HSs, such as *al-Madrasa al-Nouriyah*'s apes and al-Attar Mosque's apes under IEA-NL, and Raymond de Saint-Gilles Citadel and Attar Mosque under DGA administration, and 3D digital replicas of monuments, artefacts, and crucial objects. Moreover, interactive websites expand CT reach by advertising VTs, educational resources, and interactive shows. These online platforms can engage guests before and after their physical visit, providing them with extra context and data about cultural locales. For example, an interactive website for Tripoli's historical locales could offer VT to Saint-Gilles Citadel, detailed historical stories, and educational resources for students and analysts. So, it helps not only to boost visitor engagement but also plays a crucial role in safeguarding and maintaining Tripoli's invaluable CH for future generations.

Int.15: *In terms of preservation, technologies enable us to document and monitor the condition of cultural sites with remarkable precision.*

BAU students developed the application, facilitating the visit to Tripoli Old City. In cooperation with TM, a specialised team from BAU Faculty of Architecture did a 3D scanning project (2020) in Tripoli Citadel. It makes virtually all visitors step into different periods of history. VR experience could also offer comprehensive cultural information, enriching the visitor's knowledge and upgrading the interactive engagement level. Moreover, AR is used for the Taynal Mosque, Saint Georgios Church, and al-Mansouri Mosque, which are currently under

construction. Over the last decade, BU developed VR/AR platforms for churches across the North, which contribute to preparing the visitors' mentality before the actual in-person visit.

Int.15: *Technology can reveal the existence of past monuments, display demolished sections, or illustrate how a site functioned during different periods.*

Int.19: *I always seek apps or websites before visiting a historical site to take time to understand it before visiting. Sometimes for research purposes, I search for virtual tours, where I can save time and money.*

Int.20: *We used "Agisoft" software and a drone photograph survey in scanning and documenting the archaeological sites.*

The COVID-19 pandemic marked a turning point in how the youth approach tourism, as they now prefer to explore and engage with destinations from the comfort of their bubble. Many applications, e.g. BAM and Jedo, were developed to cater for their virtual and interactive experiences and demands. Jedo indicates that it lists more than 2000 Lebanese attractions, allows its users to prepare their outings and draws inspiration from preconceived plans and recommendations from local experts while offering them discounts and exclusive offers. BAM, as a new and innovative touristic and cultural guide to Lebanon, was launched in 2023. It was funded by European Union and developed by Cultural Agenda, adopting all tourism maps and activities. As a go-to application, it is interactive, personalised, and indispensable for all visitors who want to explore everything in Lebanon, such as restaurants, guesthouses, galleries, malls, etc.

D.3. Institutional Support and Development: Integrating with D.1&2's aims, D.3 estimates the key actors' future willingness and plans towards integrating the advanced DTs in Tripoli's HSs to enhance CT experiences.

Result: Unfortunately, there are no facts which indicate whether the key stakeholders support the decision-making toward integrating DTs in Tripoli's CT or not. Although there are various ways of enhancement, e.g. funding, building infrastructure, and doing CB for the staff, the main constraint is a lack of knowledge about the techniques and applications of the updated advanced DTs, especially AI. Tripoli Decision-makers should be well-trained and raise their awareness extensively to address this issue.

Int.9: *Once awareness and understanding of these technologies are established, securing funding will become a more manageable step.*

Currently, only a few people who are knowledgeable about DTs present projects and ideas to decision-makers and their institutions. Those often grant their full trust in those individuals, supporting their ideas and sometimes explicitly. Therefore, increasing awareness is a crucial asset.

DGA has been serving HSs since its establishment in 1921, marking 103 years of dedication. Despite the challenging circumstances faced by the country, particularly in Tripoli, DGA does its utmost with the limited available resources.

Int.10: *We trust you and your expertise, and since we aren't fully familiar with this, take the time to work on it.*

Int.16: *Typically, we contribute what we can in terms of infrastructure, location, and equipment to support these initiatives.*

DGA continues to rely on CB opportunities with organisations outside Lebanon, such as the recent collaboration with ICONEM and other local organisations and NGOs like OEA, providing CB activities when available for staff and Tripoli's citizens, etc.

There are various projects which are implemented by local NGOs. However, there isn't enough guidance or control by TM to monitor these and valorise its benefits or orient its funds or initiatives in the right way, filling the gaps. NGOs frequently collaborate with local communities to engage them in preservation endeavours. This community association can lead to increased awareness and appreciation of social legacy, cultivating a sense of pride and ownership among inhabitants. By integrating local information and expertise with advanced digital apparatuses, these NGOs play a vital part in bridging the gap between technological advancement and cultural conservation.

We aren't sure if the governmental bodies adopt spreading in advance digital and information technologies, whether through their efforts, local donations, international aid, or NGO involvement in Tripoli. On the other hand, TM and the Ministry of Tourism are always open to such development projects, but are slow in progress and waiting for external initiatives.

There aren't many indications about arranging CB activities, such as workshops, seminars, or

conferences, in Tripoli to discuss the significance of integrating the updated advanced DTs and their applications in CT. However, Omran, as NGO, is conducting several events to better preserve and protect historical monuments and limited online seminars and workshops by OEA, associated with AI applications. Making digital reproductions and interactive models of HSs, Omran helps to guarantee that Tripoli's cultural legacy is protected for future eras while making it accessible to a worldwide audience (Omran Group, *n.d.*). Local and international NGOs have conducted a workshop to teach how to use the Canvas Application to design visual content for entrepreneurs in Tripoli and provided small funds to support the procurement of such digital devices.

Int.18: *There are events on these topics, but I have never attended one linked to tourism.*

D.4. Challenges and Opportunities: It explores the obstacles, ways, methods, and requirements of applying and integrating the updates of advanced DTs in Tripoli's HSs and CT.

Results: Lack of funding, expertise, knowledge, technical limitations, appropriate usage, best investment, promotion, and insufficient infrastructure are considered the greatest challenges that face the integration process of DTs, especially AI applications, into Tripoli's CT market. In contrast, there are multiple managerial opportunities, enhancing the use of updated DTs and associated CT offers, such as (1) cooperation among the local authorities (e.g. TM and DGA) and other intellectual capabilities, (2) the support of universities and research, (3) raising the decision-makers' awareness toward the significance of attracting various segmentations, increasing the visitors' numbers and enhancing their onsite experience in Tripoli, providing information and entertainment digital guides, developing VTs, marketing interactive experience.

Int.12: *We can use AI to generate content for visitors by training models on trusted data.*

Int.13: *Tripoli is extremely rich in cultural baggage, has adequate technical resources, and has potential funding entities (politicians or wealthy individuals).*

Tripoli still needs substantial efforts to address fundamental needs and ensure basic rights to enhance effectively CT in Tripoli. DTs can cover diverse and unique epochs, showcasing intangible heritage aspects, especially since many artefacts today are no longer created using ancient methods. DTs can evoke a sense of nostalgia, allowing visitors to connect with the traditional craftsmanship and cultural significance of these historical periods. By covering CH, DTs expand the circle of knowledge, strengthen belonging and identity, and serve as powerful tools for sustainability. This, in turn, will lead to economic development and investment. Tripoli has so many hidden gems that need to be exposed, tourism creates job opportunities for the people residing in Tripoli and its surroundings.

Int.21: *The growth can spur collaborations between tech developers, cultural experts, and local communities, driving innovation and strengthening partnerships across various sectors. Such collaborations can lead to the creation of innovative projects and attract investment.*

There is a need for training and resources to implement these DTs effectively in Tripoli. Practical and technical training, along with awareness campaigns, would help in building the infrastructure of the new DTs (AR/VR/AI), raising awareness for Tripoli's CH and how to preserve it, especially for decision-makers and all stakeholders, how to develop interactive content, and how to make Tripoli appealing with the right message notably to the youth.

It is crucial to upgrade DTs' skills and the backgrounds of the decision-makers in municipalities, syndicates, schools, universities, NGOs, tourism offices and agencies, tourist guide associations, and tourism information points.

Training for startup companies and developers that focus on CH and technological applications is essential to foster innovation and effective implementation of these DTs. Moreover, participatory CB activities for the residents and the owners of shops around HSs guarantee more inclusivity and a sense of belonging, responsibility, and engagement.

Int.17: *Technological awareness is essential to encourage the training of storytelling for heritage, as it plays a crucial role in bringing cultural narratives to life and enhancing visitor engagement with historical sites*

Int.24: *Employing AI develops virtual assistants to provide real-time information and encourages local communities to create digital content platforms.*

All actors are grappling with internal and economic challenges regarding the current circumstances. There is a notable lack of vision and action plans, and collaborations with partners such as the endowment, NGOs, and DGA are very

limited and cautious. This lack of a cohesive strategy and insufficient engagement hinders the potential for effectively using DTs to enhance CT.

Int.29: *AI and digital technologies shouldn't act as replacements or tools for stealing tour guides' intellectual property.*

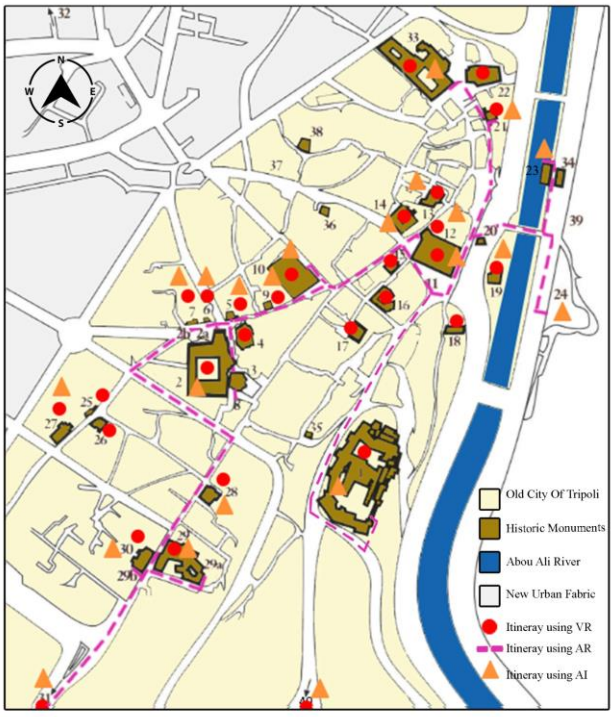
According to the collected interviews, it was indicated an absolute necessity of investing in DTs widely, triggering virtuous valorisation and promotion processes for (in)tangible heritage of Tripoli Old City. Additionally, it was economically and culturally stated numerous weaknesses and challenges exist, especially regarding CB activities of subjects capable of managing complex data layers, for creating such DT devices. Clarifying effectively the cultural paths that require DT, the authors create iconographically a schematised (interactive) urban map of Tripoli Old City (fig.4), identifying the cultural identity-associated places, paths, and areas of activity that are valorised and detected through DT.

5. Discussion & Findings

Ensuring conservative sustainability in relevance to UN SDGs 11 & 17, DTs enhance HSs without causing damage, especially with fragile/deteriorated statements or less accessibility for visitors. Maintaining HSs and ensuring their preservation creates a well-structured, comprehensive visitor base, providing easy accessibility. It encourages the new generations to embrace their identity, increasing a sense of belonging to Tripoli. Thereby, DTs reveal hidden values (Tab.1), showing the deeper message of Tripoli's CI manifestations.

Technological headways not only create more engaging and educational encounters for visitors but also support the conservation of cultural locales by archiving and monitoring them effectively and efficiently. Digital devices could maintain and restore legacy destinations through precise estimations and virtual reconstructions, guaranteeing that preservation endeavours are exact and comprehensive.

Integrating AR/VR in Tripoli's HSs and CT market represents a transformative step in upgrading visitor encounters, improving preservation endeavours, and increasing community engagement. Tripoli, a noticeable CT landmark, can benefit from these advances, like AR/VR, which revolutionise how visitors interact with HSs. These offer immersive and interactive encounters that bring the site's rich legacy to life, representing the authenticity and integrity factors.



1-The Citadel of Tripoli or Citadel Saint Gilles
2-Al Mansouri Great Mosque
2a- Madrassa Al Shamsiyat
2b-Anonymous Madrassa
3-Madrassa Al Qartawiyat
4-Hammam Al Nouri
5-Madrassa Al Nouriyat
6-Madrassa Al Malik Al Nasir
7-Madrassa Al Khayriyat Hasan
8-Arch and vaulted passage
9-Madrassa Al Twayshiyat
10-Khan Al Saboun
11-Hammam Izz-Ad Din
12-Khan Al Khayyatin
13- Al Attar Mosque
14-Khan Al Misriyin
15-Madrassa Al Quadiryat 16-Al Uwaysiyat Mosque
17- Abd Al Wahed Mosque
18-Madrassa Al Zahiriyat
19- Madrassa Al Burtasiyat
20- Bakia Ghanem
21-Souk Al Haraj
22-Al Tawbat Mosque
23-Khan Al Manzil
24-Byzantyne remains and multifoil arch
25- Madrassa Al Saqraqiat
26-Madrassa Al Khatouniyat
27-Arghoum Shah Mosque
28- Al Taham Mosque
29-Al Muallaq Mosque
29a-Khankah
29b-Al Tinat Fountain
30-Hammam Al Jadid
31-Taynal Mosque
32-Lion's tower
33-Khan Al Askar
34-Madrassa Al Zurayquiat
35-Madrassa Al Ajamiyat
36-Madrassa Al Rifayat
37-Madrassa Al Umariyat
38-Ruined Mosque
39-Hammam Al Hajib
40-Church of Saint John of the pilgrim mount

Fig.4: Interactive Map of Tripoli Historic City, Identifying Places, Paths, Areas of Activity to be Valorised & Detected through DTs

AR/VR technologies provide guests with detailed historical accounts and interactive reproductions, which essentially improve their understanding of Tripoli's cultural significance. AR can overlay digital data onto the physical environment, permitting visitors to utilise their smartphones or AR/VR goggles to view additional historical information, visual reproductions, and relevant data about different features of Tripoli. For instance, AR could empower visitors to see how Tripoli looked during distinctive historical periods or connect with virtual representations of authentic figures and events, as applied to the Kirkuk citadel. It was in its prime, to investigate

reconstructed rooms and fortifications and engage with historical scenarios in a completely reenacted environment (Abdul-Jabbar & Alwehab, 2023). AR/VR use, in Tripoli's old city, embodies how innovation can bridge the gap between the past and display, providing visitors with a more profound, more intuitive understanding of HSs. By integrating these advances, Tripoli can offer more engaging and educational encounters, making history available and compelling to a broader audience.

DTs demonstrate the construction methods of historical monuments, their defensive systems, and architectural connections. These are widely used in modern games, offering an interactive and engaging way of acquiring knowledge through seeing and active involvement, e.g. the Medieval Ages-themed games in Spain, Jordan, and Lebanon. These provide interactive experiences that are designed to immerse users in creative historical settings and events, exploring and interacting with virtual reconstructions of medieval architecture, battle scenes, and daily life.

Int.17: *Interactive methods, such as historical games that let users explore ancient sites or civilisations, can capture the curiosity of the new generation more effectively than traditional learning methods.*

Regarding Fayhaa project, DTs document the sites and provide the locals and international visitors with more detailed information while visiting. This not only enriches their experience but also fosters a deeper understanding of HSs' cultural significance. These provide explanatory details and information in an aesthetically appealing manner, including detailed features of the tiles and original decorative motifs, which are highly accepted and appreciated by the new generation.

Inte.20: *In St. Barbara church, an old medieval church, digital technologies allowed a better site understanding, documentation and provided a much more interesting and comprehensive explanation to visitors.*

Despite the noteworthy benefits, integrating innovation into CT market presents challenges and limitations. As highlighted by the interviews, funding issues are a major barrier, as the execution of advanced innovations frequently requires significant investment. Numerous historical cities, including Tripoli, confront budget limitations that can obstruct the securing and maintenance of cutting-edge technology. Without satisfactory monetary support, ventures may confront delays or be inadequate, restricting their impact and adequacy.

AR/VR advances require high-quality equipment and programs, which may not be continuously accessible or affordable. Additionally, the success of these innovations depends on their integration with existing foundation and their compatibility with different devices, which can be complex and costly. A comprehensive planning approach is significant to address these challenges. The interviews emphasise the need for vital and well-funded plans to actualise technology viably. This should also ensure that innovation projects are adjusted to the broader objectives of CT and heritage conservation.

As the main research finding, the paper could realise the significance of AI to the Tripoli and Lebanese CT market. It upgrades tourism by optimising management and protecting authenticity. AI-driven frameworks can analyse the visitor's information to supply personalised recommendations, streamline operations, and oversee visitor flows proficiently. For instance, predictive analytics can estimate peak times, empowering better resource allotment and lessening overcrowding at cultural locales. AI chatbots and virtual collaborators can offer real-time support, answer questions, and help with bookings, improving overall guest fulfilment and operational productivity.

Recognising NLP and ML of AI chatbots and CT (Fareed & Amer, 2023), AI is poised to transform tourism management by promising even more accurate predictions, offering personalised recommendations and interactions, optimising visitor flows, and preserving authenticity. AI can analyse visitor data to tailor suggestions, enhancing the visitor experience with relevant information. Predictive analytics can forecast peak times and optimise resource allocation, improving crowd management and visitor satisfaction. For instance, AI can use historical and real-time data to predict busy periods at HSs, manage congestion, handle inquiries, and assist virtually in the booking process. Leveraging AI can create more efficient, responsive, and engaging experiences, ensuring the continued success of CT in a digital age.

While DTs are powerful tools for showcasing Tripoli's cultural and historical wealth, they aren't enough on their own. These efforts must be

supported by well-planned awareness campaigns to effectively change the city's negative image. It is crucial to carefully select individuals who will lead these campaigns, people who are well-educated, knowledgeable about Tripoli's history and culture and trustworthy. Additionally, strategic advertising is essential to break the stereotypes surrounding Tripoli. Thoughtfully crafted campaigns can highlight the city's true identity, emphasising its vibrant heritage. Consequently, by combining digital innovation with targeted awareness efforts, Tripoli can reshape its image and attract more visitors, contributing to sustainable CT and economic growth.

As a result, by adopting tools like VTs and AI-driven platforms, TM can make Tripoli's HSs virtually accessible by charging low fees. The potential income generated could be significant. This approach both boosts the local economy and encourages businesses and cultural institutions to adopt and expand the use of these DTs. Thus, creating a ripple effect that transforms Tripoli into a vibrant CT destination.

Increasing the investments in technological infrastructure and projects, and encouraging continuous learning and adaptation towards the updated advanced DTs, enhances the effectiveness of CT initiatives and valorises the funding resources of technology projects. Thus, to foster sustainable CT in Tripoli, several strategies can be adopted:

Enhanced Collaboration: Strengthening partnerships between governmental bodies, NGOs, and the private sector is essential for supporting technology integration and securing funding. Collaborative efforts can pool resources, share expertise, and create synergies that enhance the effectiveness of technology projects. Engaging diverse actors ensures that various perspectives and requirements are considered, leading to more comprehensive and sustainable solutions.

Comprehensive Planning: Developing a detailed and well-funded plan for implementing and managing technology projects is critical. This plan should outline the specific goals, required resources, and timelines for technology integration. It should also address potential risks and challenges, providing strategies for mitigation. Effective planning ensures that technology projects are implemented smoothly and achieve their intended outcomes.

Proposing Participatory Capacity-Building Activities: Providing training for local professionals, decision-makers, and the local community is crucial for the effective use and maintenance of new DTs. Capacity-building programs ensure that local experts can manage, operate, and troubleshoot technological systems, leading to better long-term sustainability. These programs should be designed to equip professionals with the necessary skills and knowledge to leverage CT technology.

6. Conclusion

Adopting DTs in Tripoli holds promising potential for enhancing CT, education, and urban development. Given Tripoli's rich CH, DTs could provide immersive storytelling experiences, allowing tourists to visualise the city's architectural and socio-cultural practices in interactive formats. For instance, digitally reconstructed VR tours of the Mamluk-era markets or Raymond de Saint-Gilles Citadel could significantly elevate visitor engagement without the need for extensive physical interventions. In Tripoli, early-stage investments in such DTs' devices can be relatively cost-effective when partnered with local universities and international heritage organisations, especially through EU-Mediterranean grants and digital heritage funds.

However, the practical viability of implementing DTs in Tripoli requires addressing infrastructure gaps, limited digital literacy, and funding constraints. While the initial cost of AR/VR hardware and AI software development may be moderate in global terms, it is substantial in the context of Lebanon's ongoing economic crisis and limited public sector investment in heritage or innovation. Additionally, internet connectivity and stable electricity - both critical to the functionality of these devices - remain inconsistent in parts of the city. Despite these challenges, a phased, community-based implementation could make the rollout more feasible. In the long term, NGOs, technology-based startups and institutions might contribute to co-developing content and CB programs in the digital economy, conserving CH, and promoting CT, while ensuring that DTs are tailored to the city's unique CI and the visitors' requirements.

By developing innovative strategies and addressing these challenges, Tripoli can leverage technology to foster sustainable CT and promote its CH and legacy. Utilising AI-based mobile applications, DS can significantly enhance visitor experiences. These offer real-time information and

multimedia content. It provides dynamic updates about HSs. Valorising positively AI's role and tools, interactive websites can extend visitor engagement by collecting personalisation algorithms and offering VTs and educational resources. By leveraging these, HSs can create more engaging and informative experiences for visitors. Implementing these strategies can help overcome the challenges associated with technology integration and foster a more sustainable and effective CT ecosystem in Tripoli.

Finally, with ongoing innovation in XR, 3D photogrammetry, AI-powered personalisation, and blockchain, CT will become ever more immersive, accessible, and economically viable. The ongoing application of such tools accentuates their increasingly significant role in safeguarding CH and enhancing engagement, education, and financial viability in the field.

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