DIGITALIZATION AND ASPECTS OF APPLICABILITY OF SMART TECHNOLOGIES AIMING PROMOTION OF THE THRACIAN ROCK SANCTUARY "TATUL"

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Abstract: *The objective of this paper is to provide a comprehensive analysis of the potential applications of smart technologies and intelligent solutions for the digitization of the Tatul Sanctuary, alongside an assessment of the resources necessary for their implementation. This evaluation will serve as a foundational basis for the development of a future management plan for the sanctuary complex. To achieve this objective, the paper outlines guidelines for the creation of a 3D model of the sanctuary, the integration of an augmented reality (AR) experience, the development of a virtual reality (VR) model, and the installation of interactive displays and touchscreens. Additionally, recommendations are provided to guide decision-making regarding the appropriateness and feasibility of implementing laser scanning technologies. In the context of promoting cultural heritage, and specifically the Thracian Rock Sanctuary "Tatul," smart technologies facilitate digital visualization of the site, along with the presentation of its historical narrative through audio and video recordings. Digitalization further enables the recreation of the sanctuary's past, allowing visitors to experience an immersive representation of its historical ambiance. This approach offers tourists a unique opportunity to engage with the sanctuary in a way that bridges the gap between the present and the past. The proposed best practices offer a framework for promoting the Thracian Rock Sanctuary "Tatul" as a premier tourist destination, enhancing its appeal through innovative digital experiences that add value for visitors.*

Keywords: *Smart Technologies; Digitalization; AR Experience; Virtual Reality; Laser Scanning.*

Introduction

Tourism is one of the most critical sectors for the social and economic development of nations, necessitating the implementation of diverse strategies and approaches to ensure the competitive advantage of tourist destinations (Kaleichev, 2020). As a contemporary global phenomenon, tourism transcends basic daily needs and addresses a broader spectrum of material and spiritual demands. Within the global tourism landscape, destinations are differentiated by a combination of natural and anthropogenic resources, as well as the range of services they offer to tourists. Consequently, the formulation of regional tourism policies is essential to meet the evolving expectations and requirements of modern travelers (Linderova et al., 2021). Effective management of any tourist destination involves the coordinated and integrated administration of various aspects, including tourist facilities, transportation, accommodation, food services, infrastructure, and attractions. Strategic objectives in destination management focus on enhancing competitiveness, increasing tourist satisfaction, and achieving a balanced approach that

aligns the interests of all stakeholders—national and local governments, the tourism industry, local communities, and tourists. Furthermore, the pursuit of sustainable tourism requires responsible practices from all involved parties, ensuring the long-term viability and equitable development of tourism (Schonherr, 2024).

The quality of the tourist product, which encompasses a variety of goods and services designed to meet the needs of tourists, is of paramount importance for the development of the tourism sector (Kanwel et al., 2019). The tourist services market plays a crucial role, as it provides a wide array of services, including informational support for travelers (Szostak, 2023). The intensifying competition within the tourism market, coupled with the forces of globalization, has resulted in a shift in the focus of tourist offerings, moving from traditional, standardized packages to more individualized and tailored tourist experiences.

Methodology

The research methodology encompasses a comprehensive literature review of global scientific studies to assess the efficacy of applying modern technologies and intelligent solutions for the digitization of tourist destinations. The search process was carried out within established academic databases, such as Google Scholar and ResearchGate, with a focus on recent publications within the last decade. The findings from this review serve as the basis for formulating recommendations regarding the development of a 3D model for the Tatul Sanctuary, as well as the implementation of augmented reality (AR), virtual reality (VR) models, and the integration of interactive displays and touchscreens. Additionally, recommendations are provided concerning the appropriateness and feasibility of utilizing laser scanning technologies for decision-making purposes.

Results

Specifications of modern technologies

The Fourth Industrial Revolution signifies a profound advancement in the automation and digitalization of processes, integrating extensive Internet connectivity and the autonomous interaction of cyber-physical systems. This paradigm shift is characterized by the capacity of artificial intelligence to process and analyze vast datasets, enabling machines to perform decision-making tasks traditionally executed by humans. Key components include robotics, the deployment of digital cloud infrastructure, and the digital modeling and simulation of production processes through virtual reality (Piano, 2020). Furthermore, intelligent automation and the large-scale production of customized goods underscore its transformative impact. The emergence of novel technologies and the development of cutting-edge business models highlight the trajectory of digital transformation as a direct outcome of the increasing integration of automated processes into daily activities. These advancements reshape industries, redefine operational

paradigms, and establish new benchmarks for efficiency and innovation (Wagner et al., 2017).

Digital transformation has catalyzed the emergence of artificial intelligence (AI), a field increasingly associated with the development of applied methodologies through specialized hardware and software. AI involves the creation of algorithms that replicate aspects of human intelligence, enabling the design of machines capable of mimicking human cognitive functions. These systems are engineered to think and respond in ways that make their actions both predictable and effective. Artificial intelligence is a subdiscipline within computer science, primarily concerned with simulating intelligent behavior in machines, specifically their capacity to imitate—and, ideally, enhance—human actions. This process necessitates the replication of human cognitive functions, such as learning and problem-solving. Simulation of these processes is distilled into specific characteristics aimed at addressing the complexity inherent in human decision-making (Cowls, 2020). Advances in information technologies have facilitated the application of AI across a diverse range of domains, including human capital management, manufacturing, business strategy, marketing, logistics, tourism, and beyond (Grab et al., 2019).

The integration of artificial intelligence in the digitization process yields several notable benefits, as outlined by Piva (Piva and Vivarelli, 2017):

- Optimization of business processes due to the possibilities of analyzing data in real-time, checking the quality of manufactured products, reducing the risk of stopping the production process due to lack of human capital, introducing adaptive production through 3D printing, as well as achieving a comprehensive operational efficiency.
- Improving processes in the field of transport and logistics by using data from movement sensors, predicting necessary maintenance of the systems and means of transport used and reducing transport costs.
- More efficient use of the raw materials and reduction of the harmful impact on the environment, contributing to a circular economy and implementing activities related to the Green Deal.

AI systems are designed to tackle a broad spectrum of specific tasks that require both intellectual and material resources. Intellectual resources encompass the requisite knowledge that enables AI to generate rational, effective solutions. These resources are typically sourced from the external environment, with knowledge being extracted through analytical processes that lead to logical conclusions. Technological advancements continue to introduce sophisticated methods for knowledge extraction and utilization within AI systems. The appeal of AI lies in its capacity to provide swift data analysis, create simulations, automate production, and deliver added value to customers through innovations like 3D printing and augmented reality. Consequently, AI adoption is expanding rapidly across industries, as businesses increasingly recognize its potential to enhance efficiency and drive innovation (Andreeva et al., 2019).

Smart technologies are essential for promoting tourist destinations. In essence, smart technologies are intelligent software and hardware solutions that use built-in sensors, big data, new methods of connectivity and information exchange (such as artificial intelligence), data analysis and extraction, and generation of intelligent solutions. A specific feature of smart technologies is real-time data, which is why their concept is associated with technological innovations that create benefits and added value (Matyusupov et al., 2024). It is important to clarify that the term "smart" does not refer to a single technology, but to the use of modern technologies in a way that allows mutual connectivity and the use of the benefits of different technologies. Smart technologies include numerous sources of information and computing solutions, as the main ones are the Internet of Things (IoT), cloud computing technologies, artificial intelligence, mobile communication technology, mobile devices and applications, big data, virtual and augmented reality, chatbots, wearable devices, and various networks (De Laat, 2018). The mentioned technologies allow a real-time communication, while simultaneously facilitating the accumulation, processing and analysis of data from the physical environment. In tourism, smart technologies are used to help tourists analyze the various advantages of tourist destinations and explore tourist sites, etc. (Kazandzhieva, 2021).

Possibilities of using modern technologies and intelligent solutions for digitalization of the Tatul sanctuary and assessment of the required resources for their implementation

Modern trends in information security at leading tourist destinations highlight the pressing need for the development of a comprehensive system that consolidates information about all elements of a destination's tourism product. By implementing such a system, tourists would gain access to detailed information about upcoming events, tourist attractions, accommodation options, dining establishments, transportation links, and other relevant services. This system plays a crucial role in shaping the perception of tourists, presenting the destination as a vibrant and dynamic environment where optimal satisfaction can be achieved during their visit. Tourists frequently visit renowned destinations worldwide, yet certain areas require targeted promotional efforts to attract specific markets, particularly those with a high demand for historical and cultural experiences. Technological advancements have facilitated the widespread accessibility of mobile devices, enabling users to retrieve information at any time and from any location. Virtual tour guides represent an emerging trend within the travel industry, with mobile devices increasingly serving as electronic travel companions. As technologies evolve, these virtual guides have become more interactive, offering tourists the ability to modify their itineraries in real time, select sites to visit, and account for factors such as traffic and weather conditions, among other functionalities (Ouerghemmi et al., 2023).

Virtual tourism is increasingly recognized as a hybrid concept that integrates virtual reality with tourism, aiming to enhance the tourist experience by eliminating the need for physical travel to a destination. This concept manifests in various forms, with the extent of its implementation dependent on the technological capabilities employed. Early developments in virtual tourism included the creation of virtual travel guides, which were

designed to promote tourism and facilitate the adaptation of the sector to emerging technologies (Verma et al., 2022). Over time, the tourism industry has incorporated increasingly sophisticated technologies, including virtual reality, to overcome the traditional limitations faced by tourists when seeking information about attractions or evaluating accommodation options. Despite the proliferation of information systems and applications in recent years, many have been developed for specific services within the tourism sector, necessitating the use of multiple applications by tourists when visiting destinations (Bilynets et al., 2023). There remains a significant gap in the market for integrated applications that provide tourists with comprehensive access to all available services, offer detailed information, and incorporate real-time situational analysis of conditions at the destination (Ye et al., 2022). A review of the specialized literature highlights several types of virtual tourist guides that have been developed to address these needs (Beck et al., 2019):

- Virtual tourist guide – an application providing detailed information about tourist attractions available in a specific destination.
- Virtual tour based on virtual reality and 3D - an application that allows users to experience a virtual view of tourist sites and take virtual tours.
- These tours are used as training systems for tour operators and tour guides. This 3D virtual training system enables users to virtually visit tourist attractions and present them to potential tourists.

A significant body of research has focused on virtual tourist guides, particularly applications designed to provide tourists with information about destinations they wish to visit. These applications typically enable users to view images of tourist attractions and access supplementary details. When a tourist seeks information about a specific attraction, the app not only provides descriptive content but also offers directions to the site, utilizing Google Maps data to guide users from their current location to the destination. Some applications have integrated artificial intelligence, incorporating chatbots that assist users by responding to inquiries, including those related to locating emergency services when needed (Jawale et al., 2020). Despite these advancements, many existing virtual tourist guides remain limited in scope, collecting information and images from only a select number of attractions. Furthermore, these guides are often restricted to Android mobile platforms and require users to have proficiency in the English language. This limitation underscores the potential for further development, including the expansion of available attractions and the incorporation of multi-language support (Atienza, 2024). A considerable portion of the discussed virtual tourist guides leverage virtual reality (VR), a computer-generated simulation that enables users to interact within an artificial three-dimensional environment using specialized electronic devices, such as VR headsets or gloves equipped with sensors. Traditional online travel experiences often involve the virtual exploration of travel destinations and the associated activities available to tourists (El-Said & Aziz, 2022). The application of virtual worlds within the tourism industry spans four key areas: planning, tourism management, marketing, and customer experience. The core advantages of virtual worlds lie in their ability to virtually present tourist destinations to

potential visitors, offer immersive tours of attractions, and provide real-time information about transportation options. This fosters the creation of virtual communities and enriches the overall tourist experience. Moreover, virtual tourism can offer a competitive advantage to a destination, serving as an invaluable tool for tourism management and development (Dybsand, 2022).

In creating virtual tourist guides, a system can facilitate traditional information searches and the reservation or purchase of tickets. These designed systems should minimize the time tourists spend searching for information about attractions, their operating hours, optimal visiting times, and routes to reach them, allowing for more effective time management. The information provided by the application should be accessible at all times, as the system operates online. A virtual tour guide requires a user-oriented design to meet the needs of its users and facilitate the application process. User-centered application design should be interactive, requiring user input during its development to create a usable and accessible product. The user plays a significant role in the system, and the user interface should be interactive, allowing for the identification of the most optimal routes to reach selected tourist attractions.

In many published studies on the subject, it has been found that virtual reality (VR) in tourism is currently primarily used to market tourist destinations and accommodations (Rosli et al., 2023). However, the potential of VR also reveals numerous advantages for virtual tour guides. While the field of virtual tour guides is relatively new, it has been well-researched (Prabowo, 2022). Some studies analyzed the effectiveness of using a QR code because of its advantages for tourists, related to the ease of using information on a mobile phone and low costs. QR codes are now placed in various places in tourist destinations such as museums, monuments, and other areas that tourists information about the respective place; the tourist only needs to read a QR code that is placed, after which he is redirected to a website containing information, photos, videos, etc. for the tourist attraction. Despite the undeniable advantages of QR codes, their use requires tourists to visit the given tourist attraction to get more information about it, which is only sometimes possible because tourists are unaware of its existence. A system for reading QR codes of individual tourist attractions is built into some of the virtual tourist guides (Chiao et al., 2018).

A study by Chadil et al. (Chadil et al., 2008) describes the creation of an automatic tourist guide, a mobile application that provides users with information about tourist routes, attractions and various events. The app displays a map of users' areas of interest (sights, places to eat, shops, facilities, etc.), helping them discover and navigate to these locations (Chadil et al., 2008). Another study explores the possibility of using existing technologies to create a virtual tour guide system that utilizes an interactive VR platform to attract more tourists to Taiwan (Lo and You, 2020). Additionally, solutions for integrating GPS technology into the development of virtual tourist guides have been proposed to analyze users' current locations. Such applications use a predetermined database linked to a specific range of GPS locations (threshold range) that are calculated and pre-programmed based on the location of tourist attractions. When the app detects the user's GPS location,

it compares it to the available list of threshold ranges. As the user moves, the GPS location changes, prompting a repeat of the comparison process (Chakraborty et al., 2022). Kisal et al. (Kisal et al., 2023) describe the functionalities of an application designed to enhance tourists' visit to Sri Lanka. This web application encompasses four main aspects: a virtual tour of tourist attractions, the sharing of tourist opinions, personalized recommendations, and improved safety measures. The virtual tours offer a new experience for tourists, allowing them to learn about attractions before visiting. The app serves as a convenient tool for trip planning and deciding which attractions to explore. Its sharing features enable tourists to share their experiences and insights about various destinations. Personalized recommendations assist tourists in finding accommodation and dining options, while safety features help users seek emergency assistance or contact local authorities such as the police or fire department in real time (Kisal et al., 2023).

The application of advanced technologies presents an opportunity to position the Eastern Rhodopes as a prominent global tourist destination distinguished by its cultural and historical significance. To support this objective, the development of a virtual information platform is proposed, aimed at enhancing the visibility and accessibility of the region’s heritage. Furthermore, the establishment of a physical information hub, designated as the “Gate to Past Times”, is planned near the village of Tatul in the Momchilgrad municipality of the Kardzhali region. The selection of this location is grounded in its historical and archaeological importance. Specifically, multiple seals attributed to George Palaiologos, the founder of the Sevast imperial lineage, have been uncovered in proximity to the Orpheus Temple near Tatul. These findings underline the site's significance within the broader historical narrative of the region. The "Gate to Past Times" is envisioned as a state-of-the-art information center designed in accordance with sustainable, green construction principles. This facility will serve as a multidisciplinary hub for the dissemination of knowledge, featuring integrated educational, interpretive, and research-oriented components. The center aims to foster a deeper understanding of the Eastern Rhodopes' cultural heritage while promoting sustainable tourism practices that align with contemporary global standards. The proposed hub is planned to include the following key components:

- Chamber hall- designed to reflect the spirit of the times, this space will serve as a venue for cultural, scientific, and educational forums. It will host events led by expert archaeologists, historians, geographers, scientific researchers, tourism industry representatives, and local authorities.
- Visitor sector - a dedicated area for tourists to access comprehensive information about the region, including details about historical and cultural sites, optimized travel routes, accommodations, guides, and available tourist activities. This sector will also periodically conduct promotional campaigns to encourage visits to regional sites and provide updated information, such as the monitoring of black vultures near Madjarovo, to foster interest in photographic tourism.

- Laboratory room - a specialized facility for the research and analysis of archaeological artifacts from the Eastern Rhodopes.
- A small observatory- a space dedicated to astronomical observation and research.
- 3D visualization of Tatul Shrine- a digital mapping of key historical sites within the Eastern Rhodopes, highlighting the significance of the Tatul Shrine.
- A detailed, interactive map of the Eastern Rhodopes region, featuring legends and information on various sanctuaries, providing a rich resource for tourists.
- Eco-Houses - One-bedroom, sustainable eco-houses designed to accommodate tourists, digital nomads, and guest experts from the fields of business and science.

The ultimate goal of this project is to establish an information center that caters to the tourist needs of visitors while simultaneously generating international interest in the region. This will contribute to the promotion of the Eastern Rhodopes as a prominent destination for alternative, cultural, and photographic tourism, positioning it on the global tourism map.

In the contemporary landscape of tourism, there is an increasing demand for personalized and immediate access to information, irrespective of temporal and spatial constraints. The integration of advanced technologies has proven to be pivotal in meeting these expectations, with a discernible shift from traditional paper-based brochures and leaflets toward digital mobile applications. These applications, often leveraging Virtual Reality (VR) technologies, provide immersive 360-degree views of tourist sites, thus enhancing the user experience. Virtual tours typically begin at the entry point of a destination, directing users through the space via interactive navigational cues. By engaging with these virtual environments, tourists are afforded the opportunity to explore and familiarize themselves with destinations in a simulated format prior to their physical visit. The development of such virtual experiences involves the meticulous capture of extensive visual data from the site, which is then processed to create highly realistic, three-dimensional representations. Furthermore, some applications are equipped with geolocation functionality, enabling notifications to alert users when they are in proximity to significant tourist attractions. The primary objective of these technological innovations is to provide timely, contextually relevant information, thereby enriching the overall tourist experience. In particular, virtual tour guides are instrumental in significantly reducing the time required for visitors to navigate unfamiliar cities and efficiently locate key points of interest.

The digitization of cultural heritage sites, such as the Tatul Sanctuary, offers numerous advantages, including:

- Enhanced Problem-Solving for Tourists: Applications can address common inquiries by allowing users to ask a series of questions, ensuring a seamless experience.
- Personalized Travel Routes: Tourists can receive customized itineraries tailored to their specific preferences and requirements.
- Time Efficiency: The need to visit tourist information centers is minimized, as comprehensive information becomes accessible via mobile platforms.
- Accessibility: Tourists can access information at any time and from any location, facilitating greater convenience.

Despite their significant benefits, certain limitations of implementing modern technologies for the digitization of the Tatul Sanctuary should be acknowledged:

- Dependence on Internet Connectivity: Remote or less accessible destinations may face challenges due to the requirement for a stable internet connection.
- User Registration Requirements: Initial registration processes may deter some users, particularly those seeking immediate access to information.
- Limited Information Scope: Some applications may fail to provide comprehensive details about specific tourist sites, diminishing their utility.
- High Development Costs: The creation of sophisticated applications, including the collection and processing of high-quality imagery, requires substantial financial investment.

Despite these challenges, the digitization of the Tatul Sanctuary using modern technologies presents a transformative opportunity to enhance the tourist experience. Such innovations are demonstrably more convenient and effective than traditional brochures or sporadic online searches. Over time, these digital tools may even supplant conventional tour guides, further driving the adoption of technology across the tourism sector. Moreover, the growing preference for digital solutions among modern tourists underscores the necessity for destinations to integrate such technologies. The Tatul Sanctuary stands to benefit significantly from these advancements, aligning with broader trends in the digital transformation of cultural heritage tourism.

Conclusions

The research conducted yields the following key conclusions:

- In the realm of smart tourism, the seamless connection between physical and digital infrastructures plays a pivotal role in enhancing the tourist experience throughout their journey.
- The application of digital and smart technologies offers substantial opportunities to augment visitor awareness of the Thracian rock sanctuary

"Tatul." Through the creation of audio and video narratives, as well as the dissemination of intriguing facts, visitors can receive tailored content directly on their smartphones by scanning barcodes placed at various locations within the sanctuary.

- To further increase tourist engagement, the use of augmented and virtual reality technologies offers a compelling means of immersing visitors in the rich historical narrative of the sanctuary. These technologies facilitate a deeper understanding of the sanctuary's significance, enhancing the visitor experience.
- Smart technologies enable the digitization of the tourist site, thereby offering tourists an intelligent experience even after their visit. This includes providing real-time traffic updates to guide tourists to the site, using sensors to deliver contextual voice information during the visit, and offering details on nearby accommodations and dining options.

In conclusion, modern tourism must increasingly prioritize the integration of digital and smart technologies to enhance the overall tourist experience. The deployment of such technologies offers multiple benefits across various dimensions, including improved visitor satisfaction, enhanced business operations, and economic growth for tourism destinations. Specifically, the application of smart technologies at the Thracian rock sanctuary "Tatul" is crucial for attracting greater tourist interest, fostering sustainable tourism development, and generating increased revenues for the local economy.

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ДИГИТАЛИЗАЦИЯ И АСПЕКТИ НА ПРИЛОЖИМОСТ НА СМАРТ ТЕХНОЛОГИИТЕ С ЦЕЛ ПОПУЛЯРИЗАЦИЯ НА ТРАКИЙСКОТО СКАЛНО СВЕТИЛИЩЕ „ТАТУЛ“

Резюме: *Целта на тази разработка е да се представи цялостен анализ на възможностите за използване на съвременни технологии и интелигентни решения за дигитализация на светилището Татул и оценка на необходимия ресурс при прилагането им. Тази оценка ще послужи като основа за бъдещо изготвяне на проект за управление на едноименния комплекс. За постигането на тази цел са представени насоки за разработване на 3D модел на светилището, както и внедряването на AR изживяване, модел за виртуална реалност (VR) и интерактивни дисплеи и сензорни екрани. Представени са препоръки за вземане на решения относно целесъобразността и осъществимостта на прилагането на лазерно сканиране. С цел популяризиране на културното наследство и в частност на тракийското скално светилище „Татул“, дигитализацията позволява дигитално разглеждане на светилището, както и представяне на неговата история чрез видео и аудио записи. Смарт технологиите позволяват и да се правят демонстрации, за да се види как е изглеждало в миналото тракийското скално светилище „Татул“, което предоставя възможност на посетителите да се потопят в атмосферата му отпреди векове. Предложените добри практики могат да се използват за популяризиране на тракийското скално светилище „Татул“ като туристическа дестинация, включително за привличане на туристи.*

Ключови думи: *смарт технологии, дигитализация, AR опит, виртуална реалност, лазерно сканиране.*

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