



The Role of Information Technology in the Conservation of Intangible Cultural Heritage at Bagamoyo, Tanzania

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study assessed the role of information technology in the Conservation of intangible cultural heritage in Tanzania specifically at Bagamoyo. It assessed the role of information technology in the protection and inheritance of intangible cultural heritage and the development of information technology in the protection and inheritance of intangible cultural heritage. The study used a quantitative approach through a case study design as the framework for data collection. The study collected data from 40 respondents through questionnaire and observation guide. The data was analysed using SPSS, where frequencies and percentages as well as mean scores were computed after which tables were derived. The study found that Information technology is important in conservation of both intangible and tangible cultural heritage albeit with some challenges. Some of the important aspects of information technology in cultural heritage conservation were such as Digital documentation, analysis and restoration, enhancing accessibility, virtual and augmented

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reality, language and accessibility, Documentation and archiving, digitization of performances and art forms, oral history preservation, and enhancing accessibility were important aspects through which information technology is used for cultural heritage conservation. The study recommended for enhance digital documentation and archiving, increase funding and resource allocation, develop collaborative partnerships, implement community engagement programs, enhance accessibility and sharing of digital resources and leveraging mobile technology and social media.

Keywords: Information technology; conservation; intangible cultural heritage; Bagamoyo.

1. INTRODUCTION

1.1 Background and Problem Statement

Cultural heritage became widely recognized in the mid-20th century, primarily through efforts by organizations like UNESCO. According to UNESCO's 1972 Convention for the Protection of the World Cultural and Natural Heritage, cultural heritage includes all material and intangible forms of cultural expression (Puerta et al., 2021). In contrast, the activities, representations, expressions, and knowledge that a nation or region acknowledges as part of its cultural legacy are all included in UNESCO's definition of intangible cultural heritage. The same paper emphasises tangible cultural legacy as well as heritage that is visible and touchable. It consists of structures and historical landmarks, monuments, antiques, and more that are deemed significant and worthy of preservation for future generations (Manzhong, 2022). Additionally, tangible cultural heritage encompasses physical remnants of human endeavors, creations, and accomplishments, including structures like cities, towns, palaces, villages, temples, mausoleums, and factories (Huang & Chen, 2021). This form of heritage can be categorized into two types: immovable and movable heritage. Immovable heritage refers to historical buildings, monuments, and archaeological sites, while movable heritage includes items such as paintings, sculptures, furniture, and wall art, typically exhibited in museums or kept in archives and research facilities.

Since the 1990s, there has been significant advancement in information technology. This technology is not only extensively applied across various industries but has also provided new opportunities for the preservation of cultural heritage (Suárez et al., 2019). Beyond industrial applications, modern scientific and technological methods have increasingly been utilized in the preservation of intangible cultural heritage, opening a new door and a new chapter for the

development of cultural heritage protection (Kwon, 2016). Information Technology is useful in information collection, storage and processing where both lost and damaged culture reappear and help in new perspective of interpretation that observes the unique culture and attain additional clearness and suitability (Yelmi, 2016).

As information technology continues to advance, people are gradually realizing that it can play a role in intangible cultural heritage development and preservation that goes beyond traditional protection and development (Chen, 2015). Intangible cultural heritage has been appropriately preserved through digitization thanks to recent advancements in computer and information technology as well as digital storage hardware technology. Using effective digital technology to preserve and advance intangible cultural heritage is an unavoidable trend (Li, 2018). A conservation opportunity for the preservation of intangible cultural heritage is presented by the advancement of computer-based information digitization knowledge.

Essentially, the quantity and effectiveness of data processing are what give digital technology its advantages. Artificial intelligence has advanced significantly in recent years in terms of comprehending and producing data content. In order to provide a shortcut for the preservation and advancement of intangible cultural heritage, information technology can convert a great deal of extremely complex information into quantifiable data. These data can then be used to create suitable models (Springstubb, 2018). The use of digital tools to preserve intangible cultural heritage is still in its infancy in developed nations. The development of digital tools remains extremely challenging due to the unique characteristics of intangible cultural heritage, as well as the inadequacies of the management mechanism and format specification (Li, 2016). Digital preservation of intangible cultural heritage is an inevitable conservation trend as Tanzania's social informatization grows, and investigating the methods of protection is extremely important

from a practical standpoint (Lv & Li, 2016). Digital information technology offers additional opportunities and conservation potential for the preservation of intangible cultural heritage. In order to better safeguard Tanzania's intangible cultural heritage, this article examines the critical role that information technology plays in its conservation.

1.2 Objectives of the Study

The following objectives were the focus of this study:

1. To assess the role of information technology in the protection and inheritance of intangible cultural heritage
2. To assess the development of information technology in the protection and inheritance of intangible cultural heritage

2. LITERATURE REVIEW

2.1 The Role of Information Technology in the Protection and Inheritance of Intangible Cultural Heritage

Innovative techniques for gathering and documenting intangible cultural heritage are made possible by information technology. These techniques include motion capture, digital photography, holographic photography, stereo scanning, graphic scanning, and more. Several cutting-edge techniques for safeguarding intangible cultural assets are also provided by information technology, such as the efficient use of databases, disk arrays, optical fiber, and network connections, in addition to several pertinent laws and guidelines.

According to Chen et al. (2016), the use of digitalization in the dissemination of intangible cultural heritage can further break down regional barriers to intangible cultural heritage under diverse backgrounds, facilitate ongoing cross-cultural contact, guarantee the objectivity and accuracy of cultural communication, and improve the impact of intangible cultural heritage communication. According to (Wesener, 2017) science and technology became one of the primary implementation components of Tanzania's project to safeguard intangible cultural heritage, which aims to document intangible cultural assets systematically and thoroughly using contemporary scientific and technology tools like digital multimedia. The term "digital protection of cultural heritage" describes

the use of digital technology to preserve, safeguard, and promote traditional cultural resources while maintaining the original form of cultural heritage within a particular cultural background.

The initial method of transferring intangible cultural content into museums is outdated and does not support the development and inheritance of intangible cultural assets, since society has evolved. Using cloud computing, cloud storage, cloud analysis, cloud playback, etc., we need to transform the conventional idea of the museum database and create a full and comprehensive digital cloud data system (Manzhong, 2022). The digital museum, powered by a unified digital media platform, brings together intangible cultural heritage from various media and shares it through channels like telecommunications, wireless, the internet, cable TV, and digital networks. This approach removes the barriers of time and location, offering a modern platform for wide-reaching communication (Springstubb, 2018). The technical standards of data collection and conservation format used by Tanzania's intangible cultural heritage protection fluctuate due to the varying technology and software levels, which causes data incompatibility across different protection departments. In light of the aforementioned issues, the national digital library, digital museum, and national cultural information resource sharing project should all be built using contemporary information technology.

Information technology protection is better suited to the features of contemporary society than classic protection techniques. It is possible to swiftly record and preserve intangible cultural heritage that is in danger of disappearing in order to slow down its loss and give future protection and development efforts more time. Digital technology of intangible cultural heritage, scene modeling and behavior control technology, resource management and service technology, and visualization technology make up the majority of the technological system (Huang & Chen, 20219).

Traditional cultural expressions and the cultural space they rely on are examples of intangible cultural heritage. It is challenging to maintain intangible cultural heritage in its entirety since single digital storage typically overlooks the features of the cultural environment it depends on. With the use of digital media, all forms of cultural content whether they be words, music,

figures, or images gradually come together to form global shared cultural resources through intercommunication and mutual dissolution, fostering the global dissemination of cultural accomplishments and their genuine recognition and acceptance (Huang & Chen, 20219). The advent of digital technology, including new scanning and digital photography tools, can convert current textual and image material into digital storage in addition to offering effective information gathering for intangible cultural property. This allows for the long-term and seamless preservation of intangible cultural treasures. This priceless intangible cultural legacy can be preserved more safely and for a longer period thanks to modern digital information acquisition and processing technology, which also efficiently organizes, collects, and preserves the information of intangible cultural heritage (Manzhong, 2022). It also overcomes the presentation requirements and fidelity effects that traditional protection techniques cannot reach. Utilizing new scanning and digital photography technologies, the advent of digital technology can not only efficiently gather information on intangible cultural material but also alter current texts

The challenge of passing down intangible cultural heritage ultimately stems from changes in production methods and living conditions, as preserving the original methods of production, lifestyle, and even living conditions is in opposition to the universal human need for modernization. As time passes, the natural and social environments will have an impact on intangible cultural legacy. These effects can be reduced as digital technology continues to advance (Puerta et al., 2021). The emergence, application, development, and evolution of a particular intangible cultural legacy throughout history can be depicted using digital photographs, which can also restore the historical and cultural context of intangible cultural heritage projects and replicate the way of life and conditions of people in various eras when this heritage was in effect. Traditional intangible cultural heritage resources can be digitized and turned into visible virtual products through inheritance, allowing individuals to learn, share, and develop in the field of intangible cultural heritage. Intangible cultural heritage is more widely shared thanks to digital technology. The goal of digitalizing intangible cultural heritage is to use information technology to create a virtualized version of traditional culture (Ott et al., 2015). In addition to giving the audience the

chance to reinterpret intangible cultural content, the use of digitalization in the inheritance process promotes people's cultural consciousness and encourages more people to take part in the inheritance of intangible cultural heritage.

Although its potential has not yet been fully realized, digital technology has proven crucial to the preservation and transfer of intangible cultural assets. As information technology advances, digital technology will become increasingly important for the preservation, transfer, and advancement of intangible cultural heritage. The true worth of intangible cultural heritage is found in its rich cultural components, which may be produced, circulated, and sold to create outstanding cultural products with distinctive local and national styles that can be reintegrated into society and become part of people's everyday lives (Puerta et al., 2021). In terms of visualization technology, material and intangible cultural assets vary fundamentally. Videos, animations, and images can all be used to display the former. Displaying cultural meanings is the primary focus of the latter's digital visualization, which falls closer into the knowledge visualization area. These crucial technologies will be overcome and high-end equipment will be produced as science and technology advance, as well as digitalization and informalization grow. This will significantly increase the productive protection capacity of intangible cultural assets.

2.2 The Development of Digital Technology in the Protection and Inheritance of Intangible Cultural Heritage

Intangible cultural heritage has been practically inherited. It can stand in for a local culture, which encompasses a range of customary cultural manifestations as well as cultural venues that are intimately tied to people's daily life. People have a deeper and more thorough grasp of intangible cultural heritage following digital promotion and inheritance, and some intangible cultural heritages have a larger audience (Huang & Chen, 20219). An increasing number of people start to embrace them, grow from them, and eventually put them into practice. The culture of a region or even a country can be embodied through intangible cultural heritage that has been filtered through history and transmitted through long-standing customs. It has deep meanings and is intimately tied to people's lives. It is

challenging for users to completely convey certain cultural implications when these cultural heritages are recorded and stored digitally and only shown as text, photos, audio, and video (Yalçinkaya, 2015). The distinct cultural space characteristics of several cultures are ignored by one digital storage. Therefore, a technical system that combines digital technology, scene modeling technology, and visualization technology is required for the preservation and inheritance of intangible cultural heritage. Intangible cultural heritage's digital metamorphosis transcends regional boundaries, enabling its inheritors to better integrate it with pragmatic demands and facilitating public understanding and acceptance.

This study examines the components of knowledge about intangible cultural heritage from the viewpoints of folklore, sociology, anthropology, aesthetics, history, and psychology. It does this by extracting the characteristics of knowledge and summarizing it, based on the liveness, tradition, and integrity of intangible cultural heritage as well as on thorough analysis and research on the systematic, complex, and implicit aspects of its knowledge. Intangible cultural heritage is easily digitized, networked, and virtualized. It may be utilized to create interactive, open, and expansive digital museums of intangible cultural heritage, as well as to share global resources over the Internet and create engaging games, virtual environments, and industrial design products (Huang & Chen, 20219). New industries and derivative goods can be formed by using digital virtual reality technology to achieve the creation and usage of intangible cultural assets. This extends the industrial chain and increases the share of cultural industries.

The technical challenges of interactively producing three-dimensional sceneries of cultural activities and role animation are the main issues facing the digital development of intangible cultural property. Digital technology can be used to safeguard intangible cultural heritage by presenting the traditional moral spirit from a fresh angle. This approach transcends time and place, increases the reach of communication, and improves the audience's exposure to traditional culture through subtle influence (Springstubb, 2018). High-caliber digital technical skills are hard to come by in practical employment, which prevents digital technology from reaching its full potential. Cultural heritage resources can be

converted into cultural capital through the symbolization of intangible cultural heritage (Artese & Gagliardi, 2015). Utilizing the real touching character model development technology, we should produce realistic character models for the manufacture of intangible cultural heritage inheritors' character animation. We should also efficiently construct character action animation using the action data in the resource library. Finally, visual product communication is encouraged, effective interaction on the built platform is accomplished, and the visual production of intangible cultural heritage materials is realized through knowledge, behavior modelling, and interaction. To conserve intangible cultural assets, digital technology should be actively exploited to help it establish its own distinctive culture based on inheritance and protection. This will improve Tanzania's standing internationally, increase economic and social benefits, and encourage quicker and better economic development.

3. METHODOLOGY

This study employed a case study design for data collection and analysis, as it allows for a detailed examination of a single case" (Bryman, 2012). This study was done at Bagamoyo, one of the richest cultural heritage towns in Tanzania with a lot of historic backgrounds, including buildings such as forts, temples, landscapes, objects, and buildings (Lerise F., 2004). Bagamoyo is famous through historical, cultural and tourist sites such as Kaole ruins, the exit point of the body of Dr David Livingstone, the Old Boma, the Catholic Museum which is one of the oldest Cathedrals in Africa, and the exit point of slaves and ivory. The study sampled 40 respondents comprised of twenty (20) local community members, ten (10) respondents from government institutions like TANAPA, TAWA and TFS, and ten (10) respondents from different cultural heritage resources Conservation stakeholders. This study employed non-probability sampling strategies which allowed the researcher to select the respondents who suited the study deliberately (Kothari, 2004). The respondents were selected by using purposive sampling particularly, snowball sampling and generic purposive sampling. Data was collected through structured questionnaires that had a series of questions that covered the topic. The collected data were processed and analysed through SPSS through which frequencies and percentages were computed.

4. RESULTS AND DISCUSSION

4.1 The Role Information Technology in Preserving Intangible Cultural Heritage

Practices, representations, expressions, knowledge, and abilities that communities, groups, and individuals acknowledge as belonging to their cultural heritage are referred to as intangible cultural heritage (ICH). These include oral traditions, performing arts, rituals, festivals, and traditional craftsmanship. With globalization, urbanization, and technological advancements, many forms of ICH face the threat of extinction. However, information technology (IT) has emerged as a powerful tool in safeguarding and promoting ICH by ensuring its documentation, dissemination, and accessibility. In this part, the study first focused on the awareness of participants as to the role of information technology in preserving intangible cultural heritage for which the findings are presented hereunder.

The findings are presented in Table 1 revealed that the category of Experts was generally well-informed about information technology tools used in conservation as they are familiar with a range of tools and their applications in Bagamoyo, recognizing their impact on preserving cultural heritage. They may provide specific examples and detailed feedback on how these tools are used. Experts are generally well-informed about information technology tools like GIS, 3D modelling, drones, and digital archiving. They recognize how these tools are employed in preserving Bagamoyo's cultural heritage. They often discuss specific applications and benefits.

Heritage Managers were aware and their awareness level were rated to moderate to high awareness as they understand the practical applications of information technology tools like

GIS and digital archiving in managing and preserving heritage sites but may not have comprehensive knowledge of every tool. Heritage managers are aware of some information technology tools, such as GIS and digital archiving, and understand their applications in conservation but may not be familiar with all tools or their full capabilities.

Local Government Officials were aware, and their level of awareness were rated to moderate awareness as they were familiar with the use of some information technology tools in planning and monitoring but might not be fully updated on all available tools and their specific uses in heritage preservation. Officials are aware of tools like GIS and drones, especially in planning and documentation, but might not be fully informed about all tools and their detailed uses in heritage preservation.

Tourism Professionals were aware, and their level of awareness were rated to moderate awareness as they are aware of information technology tools that enhance visitor experience and public engagement but may not have detailed knowledge of their application in conservation efforts. Tourism professionals know about the use of information technology tools for enhancing visitor experiences and conservation awareness but may not be fully aware of the tools used specifically for preservation. The general Public were low to moderate awareness, and their level of awareness were rated to more common to be unaware as the public often lacks detailed knowledge about specific information technology tools used in preservation. Their awareness might be limited to general information presented in public campaigns or tourism materials. The public might be aware of some information technology applications in cultural heritage through public campaigns or tourism information but often lacks detailed knowledge of specific tools or their roles in preservation.

Table 1. Summary of respondent's awareness on applicable information technology tool

Response option	Respondent group	Feedback summary
Yes	Experts such as Archaeologists, Conservationists, Urban Planners)	High awareness of various ICT tools.
	Heritage Managers	Moderate to high awareness.
	Local Government Officials	Moderate awareness.
	Tourism Professionals	Moderate awareness.
No	General Public	Low to moderate awareness.

Table 2. Preserving cultural heritage using Information Technology

Question items	Strongly disagree		Disagree		Neutral		Agree		Strongly agree		Mean
	F	%	F	%	F	%	F	%	F	%	
Documentation and Archiving	45	31.0	42	29.0	16	11.0	22	15.2	20	13.8	4.52
Digitization of Performances and Art Forms	18	12.4	42	29.0	24	16.6	43	29.7	18	12.4	4.95
Oral History Preservation	19	13.1	44	30.3	24	16.6	41	28.3	17	11.7	3.76
Enhancing Accessibility	32	22.1	46	31.7	22	15.2	33	22.8	12	8.3	3.63

Generally, Awareness of information technology tools for preserving Bagamoyo's cultural heritage varies significantly among different respondent groups. Experts and heritage managers generally have a higher level of awareness and understanding of these tools. In contrast, local government officials, tourism professionals, and the general public show varying levels of awareness, with the general public often having the least detailed knowledge. Increasing awareness and education about information technology tools across these groups can enhance their effectiveness in preserving cultural heritage.

Table 2 on the survey of the role of information technology in preserving cultural heritage at Bagamoyo, exposed that information technology is very important in cultural heritage conservation. Mean scores of Statements 1, and 4, show high agreement (mean scores 4.52 and 4.95) with the idea that information technology is important for documenting and archiving and digitization of performances and art forms of cultural heritage respectively. Statement 3 posted a more moderate agreement perspective with a mean score of 3.76, suggesting that participants were well conversant with means of how information technology can help preserve oral history. Similarly, statement 3 had a mean score of 3.76 highlighting that information technology is influential in preserving cultural heritage through enhancing accessibility of such information.

These findings conform with those of a study by Alivizatou et al. (2020) who asserted that Information technology performs a crucial part in the digital documentation of intangible cultural heritage, which often relies on oral transmission or ephemeral performances. Through the use of advanced tools like audio and video recording, digitization of manuscripts, and 3D modelling, traditional practices can be preserved for future generations.

In the same vein, the findings reflect the study by Chang and Lee (2020) highlights the potential Technologies like high-definition video recording, motion capture, and virtual reality (VR) enable the capture of performing arts such as dance, theatre, and music, which are central to many cultural traditions. These performances can be archived in digital libraries, providing permanent records for future generations to access and learn from.

The above findings agree with those of a study by Chen et al. (2017), which revealed the effectiveness of interactive mobile applications in teaching folklore and mythology to students, enhancing their understanding and appreciation of intangible heritage. Oral traditions, such as storytelling, chants, and dialogues, can be recorded and stored in retrieval systems. These findings align with Alivizatou et al.'s (2020) study, which emphasized that information technology, particularly tools like audio and video recording, is vital for documenting intangible cultural heritage. The moderate level of agreement in Statement 3 further reflects the growing recognition of IT's role in preserving oral traditions, as highlighted by Chang and Lee (2020).

5. CONCLUSION AND RECOMMENDATIONS

The research on the useful application and roles of science and technology in preserving critically endangered and threatened built heritage assets in Tanzania, with a specific focus on Bagamoyo District, highlights the transformative potential of digital and technological tools in heritage preservation. Bagamoyo, a town with rich historical significance, exemplifies the urgent need for innovative strategies to protect its built heritage from the challenges posed by natural decay, urbanization, and climate change. Science and technology have become indispensable in modern heritage conservation efforts. Technologies such as Geographic Information Systems (GIS), 3D laser scanning, photogrammetry, and digital archiving play a vital role in documenting, monitoring, and managing heritage sites. In Bagamoyo, these tools have enabled detailed mapping of historical structures, which aids in understanding the extent of deterioration and planning targeted conservation efforts. The application of these technologies ensures that even as physical structures face threats, accurate digital records are maintained for future restoration and research.

The study recommends for utilization of digital documentation tools such as 3D laser scanning, photogrammetry, and Geographic Information Systems (GIS) to create accurate and detailed records of heritage assets in Bagamoyo. Digital documentation provides a comprehensive record of heritage sites that can be used for restoration, research, and education. It also serves as a backup in case of further deterioration or loss of

physical structures. Develop and implement training programs for local professionals, heritage managers, and community members on the use of advanced technologies in heritage conservation. Building local capacity ensures that there are skilled personnel available to operate, maintain, and innovate with new technologies. Training should focus on practical skills, including the use of digital tools for mapping, condition assessment, and data management, to enhance the sustainability of ICT initiatives. It further advocates for increased funding from both governmental and non-governmental organizations dedicated to heritage preservation, particularly for projects that integrate science and technology. Adequate funding is crucial for acquiring, deploying, and maintaining advanced technological tools. Additional resources will support comprehensive documentation, conservation, and community engagement initiatives, ensuring that Bagamoyo's heritage is preserved for future generations.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

I, Nakashari Kivada hereby declare that, in editing this work, generative AI technology was employed ChatGPT, based on the GPT-4 architecture. This version is an advanced language model with various functions including enhanced understanding, improved context management, and the ability to handle images in addition to text.

Details of the AI usage are given below:

1. Improved context management
2. Ability to handle images
3. Advanced language model

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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