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Literature review on the information system for digitization of royal history and Waqf

R. Sudrajat[a*], Budi Nurani Ruchjana[b], Atje Setiawan Abdullah[c] and Rahmat Budiarto[d]

[a]*Doctor Program of Mathematics, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran, Bandung 40132, Indonesia*
[b]*Department of Mathematics, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran, Bandung 40132, Indonesia*
[c]*Department of Computer Science, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran, Bandung 40132, Indonesia*
[d]*College of Computer Science and Information Technology, Albaha University, Saudi Arabia*

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A B S T R A C T

There has been a significant increase in the study of the history and culture of historical artifacts, whether they take the form of cultural heritage or Waqf. A literature review of web-based information systems was conducted for digitizing historical preservation and Waqf. Papers were sourced from various databases, including Publish or Perish, which produced 1043 journals, 370 articles, and 673 items from reputable sources, Google Scholar, and Crossref, respectively. The focus of the literature review was the information system for digitizing history and Waqf and integrating ontology databases. This literature review study aims to trace the evolution of study objects related to history and endowments. The results showed that most studies emphasized the user-understanding aspect of digitization, while the technical aspect was focused on using cutting-edge technology, such as 3D and virtual reality.

1. Introduction

Cultural promotion aims to enhance a nation's cultural resilience and contribution to global civilization through the Protection, Development, Utilization, and Development of Culture. A cultural heritage site is globally recognized as having "outstanding" value for humanity, regardless of its location. The United Nations Educational, Scientific, and Cultural Organization (UNESCO), through the Convention on the Protection of World and Natural Cultural Heritage, seeks to promote the identification, protection, as well as preservation of Cultural and Natural Heritage worldwide (UNESCO, 1972). A cultural heritage that needs to be preserved in line with its purpose is Waqf, and it is contained in the Waqf mandate letter. Waqf is the Arabic word for "al-Habs", and it is in the form of masdar (*infinitive noun*), which basically means to hold, stop, or be still. When the word is associated with a property such as land, animals, etc., it means the freezing of property rights for certain benefits (Nafis, 2021). It is crucial to acknowledge that scientific guidelines are needed to ensure the sustainability of preserving Waqf as a cultural heritage. The cultural paradigm shift in society over the last two centuries has led to a demand for easier-to-understand features, posing a challenge to the preservation of culture (Cook, 2016). Digital technology offers an open world of information and requires open standards in the digitization of heritage and culture. At the same time, innovations in virtual reality through new information and communication technologies, such as mobile applications and cloud computing, are becoming increasingly popular. However, developing a web-based information system application is complex and requires choosing the best framework for the job, such as *Struts, JSF, Ruby on Rails, Grails, CakePHP, Django,* etc (Salas-Zárate et al., 2015).

* Corresponding author.
E-mail address: r.sudrajat@unpad.ac.id (R. Sudrajat)

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The digitization of resources to improve performance and expand organizational reach is known as digital transformation, which demands a higher level of socio-technical transition. The museum and heritage sector, as a cultural and educational organization, is prioritized for humanity. Recently, the topic of digital transformation has become a policy study area for exploring the concepts of digitalization and digital transformation (Liao et al., 2020). The preservation of heritage and culture through digital means is crucial for the secure storage of cultural content. This requires the creation of an Information and Communication Technology (ICT) system and the establishment of a national system for integrated search and access to digital cultural heritage. Meta-data aggregation is necessary for the compatibility of systems used in the industry, ensuring the long-term preservation and accessibility of digital content. The ICT system is based on international standards and best practices in the organization, management, permanent storage, and use of digital content. This necessitates the use of service-oriented software applications that are externally accessible, providing quick, precise, and accurate information (Lopes & Fiadeiro, 2012). The growing trend of individualization, complexity, and specialization, requires digitization in engineering and production, but digitization alone often leads to data silos that hinder the effective design and operation of applications due to the diversity of information available (Ocker et al., 2022).

2. Methodology

This literature review focuses on the digitization of historical information systems and Waqf as cultural heritage objects related to the genealogy of ontology-based database integration. The review was conducted by systematically collecting relevant literature through the *Publish or Perish* application, as well as searching the *Crossref* and *Google Scholar* library indexes for studies from 2011 to 2022. A total of 1041 pieces of literature were accessed in November 2022. Furthermore, data selection was carried out using the PRISM procedure, where the data source was obtained from the selected database, with keywords shown in Table 1.

Table 1
Search by four types of keywords

Type	Keyword
I	Information System digitalization History and Waqf
II	Keyword I AND Royal endowments
III	Keyword II OR Integration and Ontology database
IV	Keyword III OR Relation and genealogy

The data search based on the keywords in Table 1 produced a certain number of literatures as outlined in Table 2.

Table 2
The number of publications from two database libraries with four types of keywords

Source	I	II	III	IV	Total
Crossref	344	804	762	849	2,759
Google Scholar	*995*	*995*	*838*	*308*	*3,136*

Table 3
Manual and semiautomatic selection results

Filter	1	2	3	4
Crossref	2,759	2,668	1,973	673
Google Scholar	3,136	465	459	370
N	5,895	3,133	2,432	1,043

Furthermore, irrelevant and duplicated literature, such as books, editorials, and theses, were eliminated through manual and semi-automatic means. The results are shown in Table 3. The relevant database literature review procedure is performed systematically using PRISMA as shown in Fig. 1.

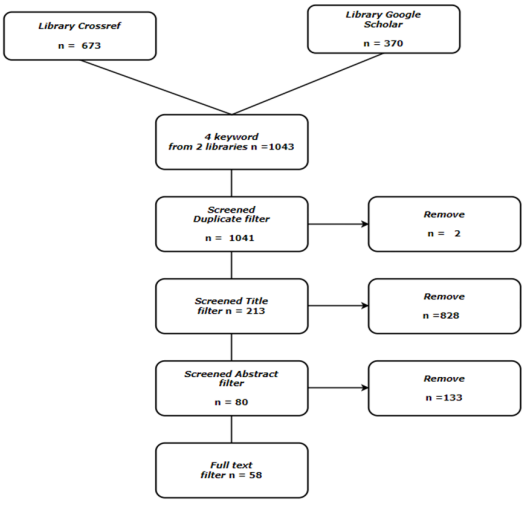

Fig 1. PRISMA systematic literature review procedure.

3. Research Findings

The systematic literature review of each article is interpreted and adapted to the study topic of digitization of historical information systems and Waqf, based on ontology database integration. Evaluation and review are performed to avoid duplication or plagiarism. In the context of digital transformation, the focus is on identifying key elements, components, or categories. Textual information analysis was conducted using various techniques to analyze frameworks. The database information includes the definition of the term "digital transformation" and related terms proposed by academia. Organizations have classified digital transformation into three categories, namely technology, process and management, and people (Verina & Titko, 2019; He et al., 2017). Study developments on digitization and other fields were visualized with *VOSviewer* using the keywords: heritage, Waqf, royal endowments, digitization, history, integration, and ontology as shown in Fig. 2.

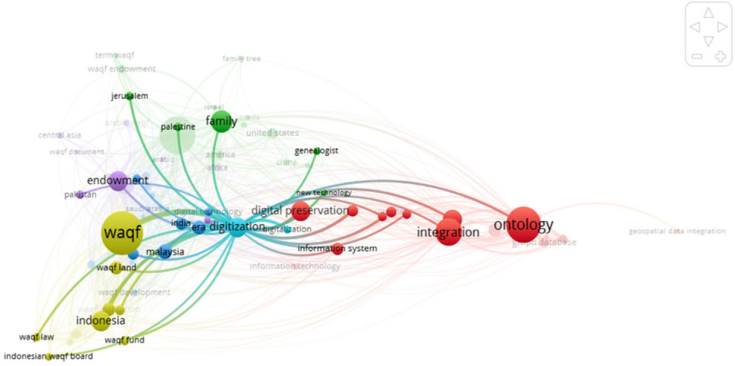

Fig 2. Mapping digitalization study with other fields of science

Fig. 2 shows that the study on the digitization of historical databases and Waqf using the ontology databases integration is limited, presenting an opportunity to explore the development of an information system for digitizing history and Waqf. The Cultural Heritage and Power Information System (CHIS) aims to examine the feasibility of creating technological infrastructure in order to support cultural and historical activities, enabling various users to engage with CHIS and shaping the technology utilized (Colace et al., 2013). Fig. 3 displays the connection between the information system aspect of digitizing historical and Waqf databases and the genealogy of ontology integration, as mapped by *VOSviewer* using some keywords, such as heritage, Waqf, royal endowments, digitalization, integration, and ontology.

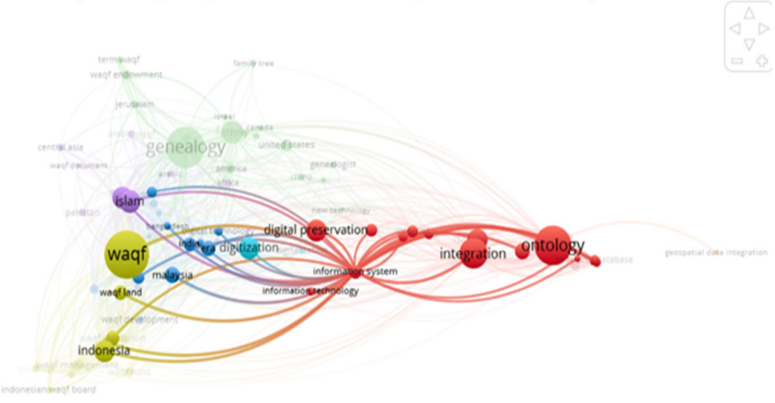

Fig 3. Mapping information system study digitization of historical and Waqf databases with other fields of science

Fig. 3 shows that information system study related to historical databases and Waqf within the framework of ontology database integration is still limited. This limitation offers an opportunity to investigate the development of an information system for digitizing history and Waqf using ontology database integration.

4. Related Works

The implementation of web-based information system applications in technology has an impact on cultural heritage, human memory structure, libraries, archives, and digital culture (Cuijuan et al., 2018). The need to preserve and manage cultural heritage presents new challenges and opportunities for conservation (DeSilvey & Harrison, 2020). The use of open-source software components in cultural preservation infrastructure makes further study of technical data easier (Vacca et al., 2018). *Genealogy tree* linkages can be designed to create an *adjacency* matrix, which can be used to search

for various metrics and potentially filter the data related to cultural heritage and genealogy (Anil et al., 2018). Archiving historical works of technological facilities and restoring them in the future can save time and costs (Varol et al., 2017). Examples of cultural heritage stored in the museum are collectible items. Currently, digital museum technology focuses on utilizing mobile devices to increase visitors and engage them in the museum experience (Sandvik, 2011). The role of digital technology in preserving cultural heritage involves analyzing its virtual forms in the context of contemporary social and cultural traditions. Effective management of museum data and information requires the use of open standards (Nikonova & Biryukova, 2017). The development of information systems for digitizing cultural heritage has 5 general characteristics (Wang et al., 2020), namely:

(1) Digitization of cultural heritage ontology
(2) Digitization of cultural heritage preservation
(3) Utilization of digitized cultural heritage
(4) Digital dissemination of cultural heritage
(5) Legal protections for digitally preserved cultural heritage.

Building cultural heritage data with the concept of ontology requires an understanding of the similarities and differences between ontology and database schemas. An ontology is a model that defines and specifies a set of meanings in a formal language. A meaning reflects an ontological understanding of the target material, including the types of things that exist and how they relate to each other. On the other hand, a database schema describes the structure of a database in formal language both conceptually, logically, and physically. Several questions arise regarding the similarities and differences between ontology and database schema, such as 1) What each is for, 2) What each looks like, 3) How each is made, 4) How each is implemented and used, and 5) Where the semantics are located (Uschold, 2015; Boulkroun et al., 2016). The cultural heritage sector entities need to be linked to the domain of human activity as well as the corresponding business model facilitated by modern information and communication technologies. The economic impact of the interaction between various actors, such as cultural heritage institutions, within the cultural and economic landscape becomes a digital and public "facilitator". This impact can be described through appropriate cybernetic representations, mathematical models, and a technology-based mobile approach with online practices. Instances have to be provided for virtual exhibitions in the cultural heritage sector, as well as clear digital collections to sustain the organizations and make informed decisions for the future of their collections (Filip et al., 2015).

The concept of cultural heritage can be closely linked to heritage and tourism availability. Adequate funding and investments can facilitate the adoption of new technologies, which are expected to attract more visitors and improve their level of satisfaction. Implementing the appropriate technology can enhance the visitor experience and strengthen the identity of heritage sites and museums. This enhancement can serve as a branding tool and create a sense of belonging. In this scenario, organizations face substantial costs to improve their legacy identity and promote more democratic management of their resources (Di Pietro et al., 2018).

The emergence of technological innovations, such as mobile phones, virtual reality, multi-touch screens, and interactive 3D, has provided creative ideas and perspectives for online communication, dissemination, and protection of cultural heritage. Also, digitizing the collections for the internet enhances understanding and engagement among visitors, creating a positive learning experience. However, the impact of technology on the visitor experience is an important behavior that greatly affects heritage management organizations and needs further discussion, including expanding the technology model, adding information quality, and increasing the wealth of information as characteristics of a reliable system (Y. Wu et al., 2022). Disseminating heritage and cultural information can also serve as a means of education and active learning for the public, both formally and informally. This serve enables active participation in the application of information and communication technology, thereby strengthening relationships between residents, managers, and visitors (R. Mendoza et al., 2015). UNESCO is responsible for the digital protection of cultural heritage through its law and regulations. Each country that is a party to the convention is obligated to ensure the identification, protection, conservation, presentation, and transmission of its cultural and natural heritage to future generations. These objectives can be achieved using the resources of the country, or through international collaboration, specifically in terms of financial, artistic, scientific, and technical support that are obtainable (UNESCO, 1972).

5. Analysis

In the literature selection process, several guiding questions are needed to help in narrowing down the parameters and uncover opportunities that have not been explored previously. These questions are regarding the types of culture and heritage objects, including:

Q1–What are the study objectives for the digitization of world heritage and culture?
Q2–What techniques are employed in the digitization of the world's cultural heritage?
Q3–What variables and data are relevant to preserving the digitization of world heritage and cultural data?

Table 4
Study objectives related to heritage and culture

Study purposes	Number of Authors	%
Heritage and cultural data preservation	(DeSilvey & Harrison, 2020), (Varol et al., 2017), (Filip et al., 2015), (Di Pietro et al., 2018), (Y. Wu et al., 2022), (Su et al., 2019)	10
Digitization of heritage and cultural data	(Liao et al., 2020), (Charykova & Markova, 2019), (Verina & Titko, 2019), (He et al., 2017), (Wang et al., 2020), (Eschenfelder et al., 2019)	8
Information system base	(Colace et al., 2013), (Vacca et al., 2018), (Vavliakis et al., 2012)	5
Regulation and influence of society	(UNESCO, 1972), (Nafis, 2021), (Cook, 2016), (Li et al., 2020), (M. A. D. Mendoza et al., 2023)	8
Developing a methodology	(Salas-Zárate et al., 2015), (Lopes & Fiadeiro, 2012), (Ocker et al., 2022), (Cuijuan et al., 2018), (Anil et al., 2018), (Nikonova & Biryukova, 2017), (Uschold, 2015), (Boulkroun et al., 2016), (R. Mendoza et al., 2015), (Malmi et al., 2018), (Blankenberg et al., 2021), (Pokorný, 2019), (Hamilton, 2017), (Freire et al., 2018), (J. Wu et al., 2022), (R. Mendoza et al., 2015), (Tibaut et al., 2018), (Zhao & Qian, 2017), (Sujatha & Raju, 2016), (Sharmila & Subramani, 2012), (Sharmila & Subramani, 2012), (Yunianta et al., 2019), (Pankowski, 2021), (Pankowski, 2016), (Raghavendra & Mohan, 2019), (Ramesh et al., 2015), (MaduraiMeenachi & Sai Baba, 2012), (Yunianta et al., 2019), (Abgaz et al., 2021), (da Silva Serapião Leal et al., 2019), (Michalakis et al., 2020), (Ferilli, 2021a), (Agárdi & Kovács, 2022), (Gong et al., 2018), (Chbihi Louhdi & Behja, 2019), (An & Park, 2018), (Munir & Sheraz Anjum, 2018), (Stanojević et al., 2011), (Abgaz et al., 2021), (Sir et al., 2015)	69

The graph in Fig. 4 provides a visual representation of the information presented in Table 4.

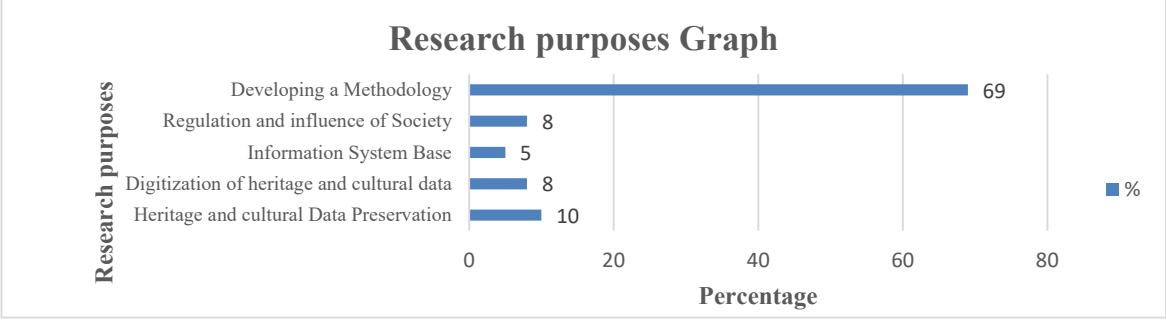

Fig 4. The results of the literature analysis, revealing the objectives of heritage and cultural study

In Fig. 4, it was observed that the digitization of heritage and culture is heavily dominated by the development of methodologies, accounting for 69%. The study methodology plays a crucial role in preserving heritage and culture. To ensure the continued preservation of heritage and culture, community participation can be a useful tool when applied globally for cultural heritage management. A comparative overview of the similarities and differences between locally and internationally used participatory methods, levels of participation, and steps in the management of cultural reserves, such as cultural, can help to better understand the position of cultural heritage management in relation to actual practices (Li et al., 2020). To answer the second question, about the nature of heritage and cultural study methodologies that are widely used, the results are analyzed and depicted in Table 5.

Fig. 5 provides additional information on the methodologies used in the development of heritage and cultural studies, as presented in Table 5.

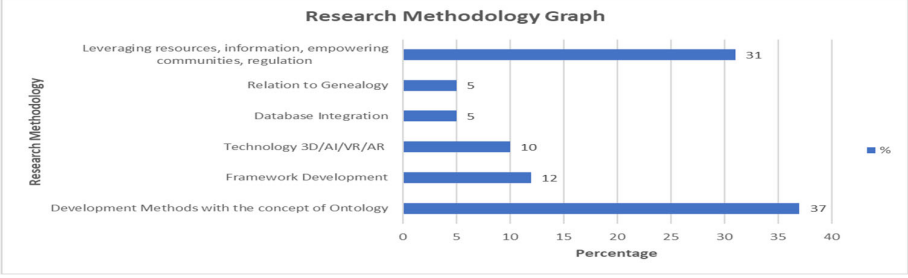

Fig 5. The results of the literature analysis showing the methodology used in heritage and cultural study

Table 5
Study methodologies related to heritage and culture

Study Methodology	Number of Authors	%
Development of methods with The concept of ontology	(Ocker et al., 2022), (Verina & Titko, 2019), (Uschold, 2015), (Sharmila & Subramani, 2012), (Blankenberg et al., 2021), (Tibaut et al., 2018), (Zhao & Qian, 2017), (Manukyan, 2019), (Sharmila & Subramani, 2012), (Yunianta et al., 2019), (Vavliakis et al., 2012), (Pankowski, 2016), (C et al., 2015), (MaduraiMeenachi & Sai Baba, 2012), (da Silva Serapião Leal et al., 2019), (Ferilli, 2021b), (Agárdi & Kovács, 2022), (Gong et al., 2018), (Chbihi Louhdi & Behja, 2019), (An & Park, 2018), (Munir & Sheraz Anjum, 2018), (Sir et al., 2015)	37
Framework Development	(Salas-Zárate et al., 2015), (Lopes & Fiadeiro, 2012), (J. Wu et al., 2022), (R. Mendoza et al., 2015), (Raghavendra & Mohan, 2019), (Dong et al., 2016), (Stanojević et al., 2011)	12
Technology 3D/AI/VR/AR	(Sandvik, 2011), (Nikonova & Biryukova, 2017), (R. Mendoza et al., 2015), (Yunianta et al., 2019), (Michalakis et al., 2020), (Abgaz et al., 2021)	10
Database integration	(Pokorný, 2019), (Sujatha & Raju, 2016), (Freire et al., 2018)	5
Relation to genealogy	(Anil et al., 2018), (Malmi et al., 2018), (Hamilton, 2017)	5
Leveraging resources, information, empowering communities, regulation	(UNESCO, 1972), (Nafis, 2021), (Cook, 2016), (Liao et al., 2020), (Verina & Titko, 2019), (He et al., 2017), (Colace et al., 2013), (DeSilvey & Harrison, 2020), (Vacca et al., 2018), (Varol et al., 2017), (Wang et al., 2020), (Filip et al., 2015), (Di Pietro et al., 2018), (Y. Wu et al., 2022), (Malmi et al., 2018), (Li et al., 2020), (Su et al., 2019), (Eschenfelder et al., 2019), (Vavliakis et al., 2012), (M. A. D. Mendoza et al., 2023)	31

The analysis results in Table 5 and Fig. 5 indicated that methodologies with an ontological basis, utilizing information resources and community empowerment are the most widely used, with 37% of the results. However, in practice, not all users are familiar with the search process and what is necessary or required to access the intended database. The increasing use of knowledge discovery applications has made it necessary for end users to write complex database search queries. This necessity requires them to understand both the structural complexity of the databases and the semantic relationships between the data. To overcome these difficulties, knowledge representation and interactive querying through ontology are needed, with a focus on improving the interface between data and search queries to provide results that align more closely with the user's knowledge. This requirement involves developing ontology-based applications, including their modeling, processing, and knowledge translation into database search queries (da Silva Serapião Leal et al., 2019; Ferilli, 2021a; Agárdi & Kovács, 2022; Munir & Sheraz Anjum, 2018).

More details on the use of variables and data in table 6 are illustrated in figure 6 below.

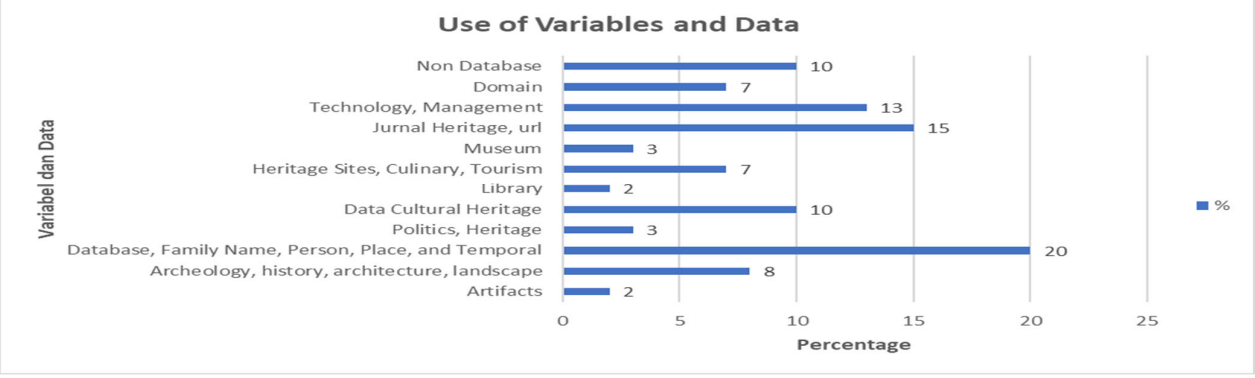

Fig 6. Results of literature analysis showing the variables and data in heritage and cultural study

Table 6
Variables and data used related to heritage and culture

Variables and Data	Number of Author	%
Artifact	(Sandvik, 2011)	2
Archeology, history, architecture, landscape	(He et al., 2017), (Vacca et al., 2018), (Filip et al., 2015), (J. Wu et al., 2022), (Tibaut et al., 2018)	8
Database, Family Name, Person, Place, dan Temporal	(Cuijuan et al., 2018), (Anil et al., 2018), (Uschold, 2015), (Malmi et al., 2018), (Pokorný, 2019), (Zhao & Qian, 2017), (Sujatha & Raju, 2016), (Pankowski, 2021), (Pankowski, 2016), (da Silva Serapião Leal et al., 2019), (Ferilli, 2021a), (Chbihi Louhdi & Behja, 2019), (Sir et al., 2015)	20
Politics, Culture,	(DeSilvey & Harrison, 2020), (Sandvik, 2011)	3
Cultural heritage data	(Varol et al., 2017), (Li et al., 2020), (Sharmila & Subramani, 2012), (Abgaz et al., 2021), (Michalakis et al., 2020), (Gong et al., 2018)	10
Library	(Nikonova & Biryukova, 2017)	2
Heritage Places, Culinary, Tourism	(DeSilvey & Harrison, 2020), (Di Pietro et al., 2018), (Li et al., 2020), (Vavliakis et al., 2012)	7
Museum	(Y. Wu et al., 2022), (Abgaz et al., 2021)	3
Heritage journal, URL	(Salas-Zárate et al., 2015), (Pokorný, 2019), (Blankenberg et al., 2021), (Su et al., 2019), (Freire et al., 2018), (Sharmila & Subramani, 2012), (Raghavendra & Mohan, 2019), (C et al., 2015), (M. A. D. Mendoza et al., 2023)	15
Technology, Management	(Colace et al., 2013), (Wang et al., 2020), (Eschenfelder et al., 2019), (R. Mendoza et al., 2015), (Yunianta et al., 2019), (Agárdi & Kovács, 2022), (Dong et al., 2016), (Stanojević et al., 2011)	13
Domain	(C et al., 2015), (MaduraiMeenachi & Sai Baba, 2012), (An & Park, 2018), (Munir & Sheraz Anjum, 2018)	7
Non-Database	(UNESCO, 1972), (Nafis, 2021), (Cook, 2016), (Salas-Zárate et al., 2015), (Ocker et al., 2022), (Verina & Titko, 2019), (Boulkroun et al., 2016), (R. Mendoza et al., 2015), (Hamilton, 2017)	10

Overall, this study observes that variables and data are dominated by cultural heritage and also connected to the identity of its origin, which is crucial for its preservation. Studies related to the preservation of technologies for cultural heritage indicated that 70% emphasized the importance of utilizing technology for preservation, while 30% focused on other types of interventions, such as 3D digital technology, augmented reality, and virtual reality (M. A. D. Mendoza et al., 2023).

6. Conclusions

The analysis result in table 4 showed that 69% of heritage and cultural digital information systems focused more on a reliable methodology for solving problems related to user data and understanding. The rationale behind this fact is because, in the digital era, users have a significant impact on the technical and design aspects presented by heritage and cultural property management institutions. Additionally, utilizing heritage and culture as a tool for boosting tourism can improve the local economy. It was found that the aspects of data preservation and security from loss of goods and information have not been thoroughly discussed, compared to the technology and user needs.

7. The path of promising future study

Heritage and cultural property differ from Waqf property because Waqf property is regulated by a unique set of laws that the Waqf giver must obey. Literature studies on the digitization of heritage and Waqf information systems are still relatively uncommon. This fact is particularly true for Waqf properties, especially in the form of real estate, which is only relevant in predominantly Muslim countries. Furthermore, conflicts between the descendants of Waqf givers and the mandated recipient who manages it are often observed in the case of Waqf property relics. Therefore, it is required to delve deeper into these conflicts and explore ways to preserve these relics digitally in a reliable and informative manner, in order to reduce conflicts as well as to ensure their sustainability.

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