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Web-based information system framework for the digitization of historical databases and endowments

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A B S T R A C T

With the digitization of historical databases and endowments, care must be taken when designing the framework for an information system on the web. Because conflicts arise frequently in reality, different data management requirements are necessary for the preservation of waqf property. For the purpose of creating and putting into place historical information systems and endowments for this inheritance, it is necessary to develop an acceptable management plan. An inheritance that is thought to be distinct from customary ones since it is governed by its own law is referred to as waqf, as an example. They typically comprise histories and endowments that need to be protected to ensure sustenance among the population and to ensure they live up to the standards of the community and country. This research was compiled and analyzed to support stakeholders in producing a more practical, focused, and value-delivery framework. The datasets were mapped based on relationships, graph databases, and semantic networks. Moreover, the framework was developed using several data representation models to ensure easier, faster, and more accurate methods of displaying the data. Relationships, graph databases, and semantic networks were used to map the datasets. The design was made available to users, administrators, and managers, with the latter group being in charge of maintaining data control over each entity. The case study was conducted using historical information and waqf from the Nadzir Pangeran Sumedang Indonesia Waqf Foundation (YNWPS) in the Kingdom of Sumedang Larang Indonesia (KSL).` The creation of a web-based information system to keep track of the data in each entity and ensure better preservation of historical genealogical databases and endowments was made simpler by the structured framework design.

1. Introduction

Emerging technologies such as mobile learning or augmented reality, have opened a really increasing set of opportunities to improve heritage education by offering alternatives to customize, locate and contextualize learning (Mendoza et al., 2015). To create organizational rules for the long-term preservation of items, various approaches have been proposed (Tripathi, 2018). Based on the Web development framework, a hierarchically planned information system framework is created using design patterns (Ning et al., 2008). This framework somewhat lessens the load of system design and improves the standardization of development (Ahlemann et al., 2023). As a result, design and development costs can be lower overall, and developers can concentrate more on creating specialized business models (Dong et al., 2016). Heritage and culture are considered life-evolving expressions with environmental values from the present and past which are needed to be sustained into the future (Nowacki, 2021). Thus, there is a need to develop a strategic framework to design and develop a preservation information

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system for these objects (Culture et al., 2015). The phenomenon is considered important due to the influence of the information age on how people communicate and think (Roetzel, 2019). Furthermore, digital information culture and art dissemination methods are more easily accepted compared to traditional narrative techniques (Cheng & Kam, 2008). This can be observed from the increasing application of new technologies and concepts such as the internet, information and communication technology, digital media technology, and interactive design theory in heritage practices such as museums (Di Matteo et al., 2021). The concept has enhanced the function of museums beyond physical preservation, exhibitions, cultural memory, public education, information dissemination, and academic research purposes (Wu et al., 2022; Nofal et al., 2017).

Defining metrics for app effectiveness is crucial for improving the overall user experience, and is a valuable resource for designers looking to create engaging and intuitive applications (Malik et al., 2023). We urgently need a robust sustainable framework for digital cultural heritage preservation. (Paschalidou et al., 2022). 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 (Sudrajat et al., n.d.). 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 (Hilal & Latit, 2019). 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 (Wang & Wu, 2020).

This research proposes a web-based information system framework to digitize the preservation of historical databases and endowments (Quisbert, 2006). The proposed framework uses several data representation models and queries to ensure easier, faster, and more accurate methods of displaying the data (Bokulich & Parker, 2021). Data were compiled and analyzed to support stakeholders in producing a more practical, focused, and value-delivery framework. The information system considers users, administrators, and managers as entities with the managers responsible for the controlling of the data on each entity (Toufaily et al., 2021). This research chooses the history and endowments of the Kingdom of Sumedang Larang Indonesia (KSL) managed by the Nadzir Waqf Pangeran Sumedang Indonesia Foundation (YNWPS) as the case study. Which in accordance with the Decree of the Ministry of Law and Human Rights of the Republic of Indonesia Number: AHU-0014381. AH.01.04. In 2017, YNWPS was appointed as the manager of waqf artifacts and land/rice fields from the Kingdom of Sumedang Larang Indonesia. This research contributes towards supporting the foundation in managing the data in each entity to guarantee better preservation of historical genealogy databases and endowments, through an efficient web-based information system. The created datasets were mapped based on relationships, graph databases, and semantic networks, thus, assure the integrity of the data.

2. Theoretical Background

A framework is defined as an application generator for one particular domain. It is alternatively explained as an application consisting of the complete code associated with the basic functions of a system and customizable to meet specific needs. The framework is usually expected to be based on arbitrary problem domains represented by metamodels. It uses architectures to generate applications to be subsequently implemented on Create Read Update Delete (CRUD) database operations as the basis for the specified problem domain (Stanojević et al., 2011). However, the framework has some limitations. First, it is designed for social platforms containing textual data but cannot currently be easily used on those with mainly images and videos. These platforms require different methods to extract topics and sentiments.

The phenomenon shows that the process of handling non-textual data such as images and videos can be challenging due to the need for additional preprocessing steps including image and video captions, object recognition, and sentiment analysis on text. Moreover, the implementation of frameworks requires three activities which include *(i)* finding users with the capacity to create and maintain communities reflecting their sentiments on a topic, *(ii)* studying how the user or community sentiment on a topic develops over time, *and (iii)* cross-rescuing between the user community and its environment. The scalability of the framework can be easily implemented in any underlying models (Tomanek et al., 2015)(Bonifazi et al., 2023). *Concept* has some components that define it. A conceptual framework is defined as a network or a “plane” of linked concepts. Conceptual framework analysis offers a procedure of theorization for building conceptual frameworks based on grounded theory methods. The advantages of conceptual framework analysis are its flexibility, its capacity for modification, and its emphasis on understanding instead of prediction (Adom et al., 2018). This concept is considered the backbone of semantic web ontology because building ontologies for new domains is time-consuming and expensive but the framework for the construction of semi-automated ontologies uses knowledge discovery techniques to reduce the effort required (Buccella et al., n.d.)(Munir & Sheraz Anjum, 2018).

Future research is also expected to combine web structure mining with this approach of developing ontologies to produce favorable results (Rames et al., 2015). There is a need to develop a framework to ensure preservation efforts are conducted based on applicable regulations and legislation. The process requires understanding the importance of digital transformation data with a focus on ensuring the community element knows it is not just about the implementation of information technology solutions (*The Importance of Data Management in Digital Transformation | Box, Inc.*, n.d.). The developers need to think about "organizational change", "cultural transformation" and the "move towards a user-centric approach" (Jones, 2013). In

this context, the "people" element assumes paramount significance, necessitating a well-structured qualitative study process that impeccably aligns with the overarching digitalization strategy, inherently valuing strategic digitalization above every other thing (Verina & Titko, 2019).

3. Materials and Methods

Although no formal guidance exists on how to develop a methodological framework, this scoping review found an overall consensus in the approaches used, which can be broadly divided into four phases: (a) *Data Analysis and Identification*; (b) *Representation of the Dataset*; (c) *Platform Architecture and Data Management;* and (d) *Data Organization and Governance* (McMeekin et al., 2020). The data used in this research were retrieved from interviews and available documents, and the data was obtained from interviews with YNWPS Trustees and obtained in the form of hardcopies (not circulating in public) complete according to the original. The methodology applied is explained further in the following subsections.

3.1 Data Analysis and Identification

Product life cycle analytics plays an essential role in data-driven product planning. In addition to the actual analysis, analytics projects must always take into account the use case, the data collection and acquisition (Massmann et al., 2020). The design principles for data analysis are prioritized qualities or characteristics that are relevant to the analysis and can be objectively observed or measured. Driven by statistical thinking and design thinking, a data analyst can use these principles to guide the choice of which data analytic *elements* to use, such as code, code comments, data visualization, non-data visualization, narrative text, summary statistics, tables, and statistical models or computational algorithms (McGowan et al., 2023). Qualitative methods usually have theoretical underpinnings to guide research with an emphasis on ensuring the data analysis takes inventory of available resources. This led to the adoption of interviews to form a framework based on the understanding of the phenomena and sequence of occurring events existing in the object of research (Osanloo et al., 5929). Data analytics frameworks are integral to all large-scale data management and optimization efforts. They combine efficient processes with cutting-edge data technologies to create insight-rich strategies for enterprise operations. Older models didn't look at the organizations' needs as a whole-—thereby siloing data and creating roadblocks to efficiency (Tabarak Ahmad, 2018).

The endowments studied were observed to be scattered in urban areas with a lack of appropriate management systems, especially in relation to the design of efficient decision-making systems involving relevant stakeholders. The situation was discovered to be more demanding for the management of heritages involving diverse conservation and development actors. Therefore, the research indicators were identified using a theoretical framework supported by actual data (Aftabi & Bahramjerdi, 2023). This was followed by the analysis of the data needed to design information systems to functionally describe the genealogical history of KSL endowments starting from the period of establishing the kingdom in 1340 up to the time of the Unitary State Government of the Republic of Indonesia in 1949 (Muhsin, 2008). There is also the need to make historical and present data available and accessible in the near and distant future, in order to go back in time and see new relationships and combinations of data. Data sustainability is critical in achieving progress in the process of sustaining social and environmental aspects (Jarvenpaa & Essén, 2023). Meanwhile, the challenges identified need to be locked into the old socio-technical regime to avoid being transferred to the new regime. Moreover, the dataset framework design has a significant influence on the process model to be used. The datasets were retrieved using the steps in the globally recognized waterfall process model as indicated in Fig. 1.

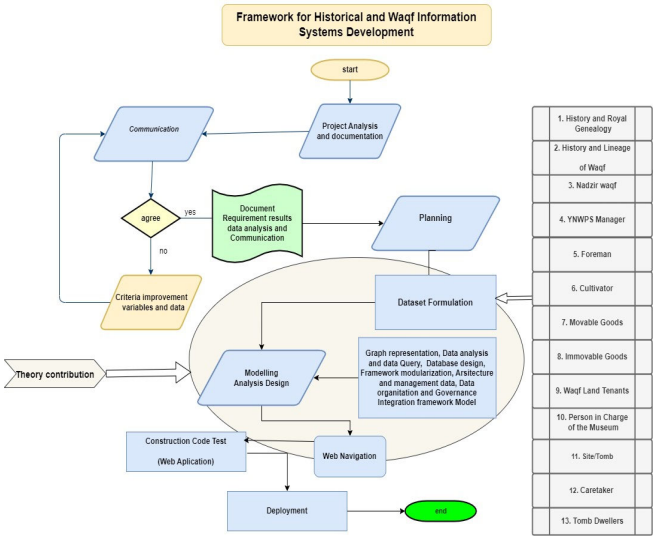

Fig 1. Conceptual Framework of Historical Information Systems and KSL Endowments

Fig. 1 shows the first step of the framework, which is designed to document and analyze the projects. Second, discussions and communication with the manager were carried out to obtain data. Third, carry out requirements analysis to document inputs and record variables and datasets. Fourth, create a work plan while compiling datasets for framework modelling, In analyzing and designing, related theories are taken into account to facilitate implementation. Finally, incorporate the design using web navigation that is specific to user, administrator, and manager access capabilities.

3.2 Representation of Dataset

The protection of this heritage at the national level was discovered to be incomplete due to insufficient scientific and technological resources and a lack of proper orientation on conservation for people living in these locations. Meanwhile, international conventions, recommendations, and resolutions on cultural and natural property have shown the importance of protecting unique and irreplaceable properties for everyone in the world (UNESCO, 1972). Therefore, relevant entities are required to be more careful and implement periodic audits of data to resolve and mitigate conflicts. The operational data management process for the history of KSL is described as an entity dataset in Fig. 2.

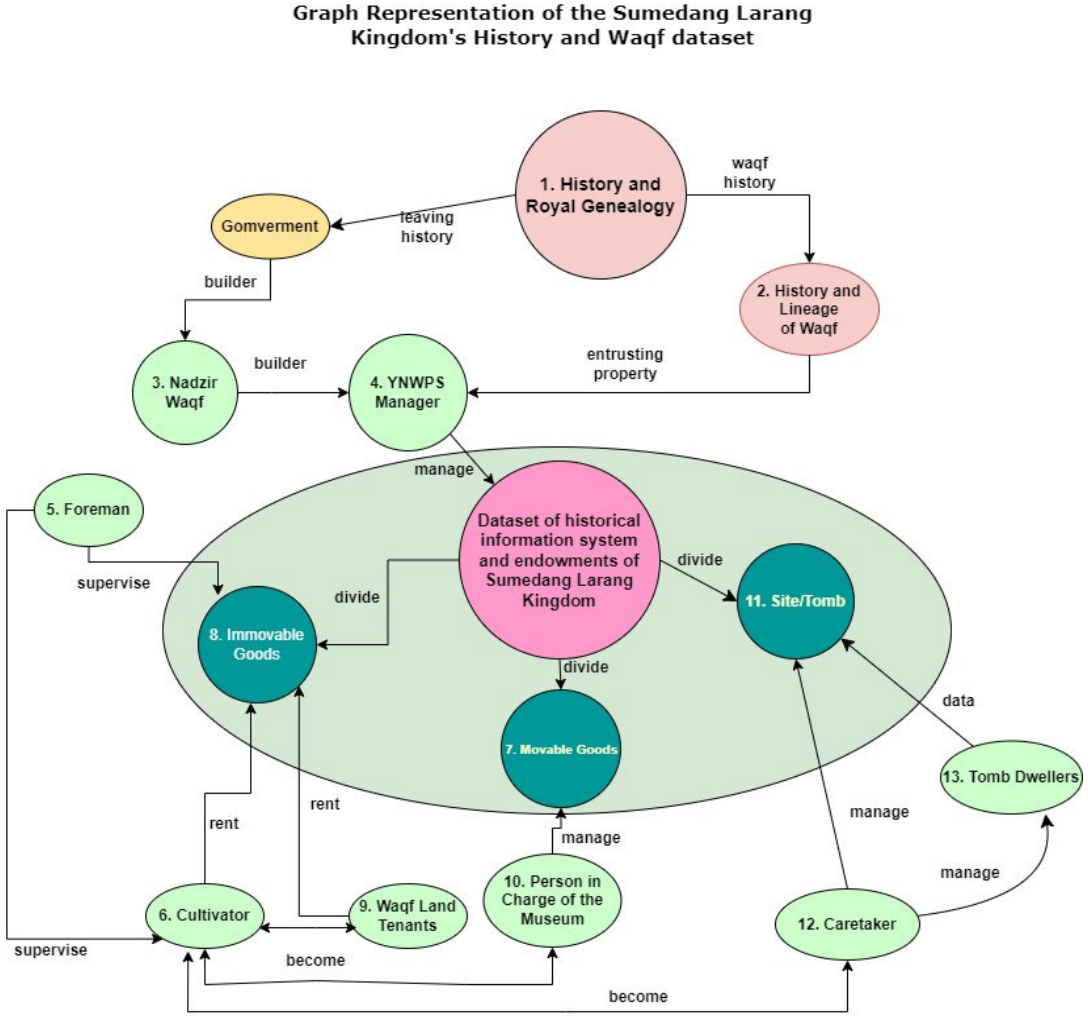

Fig. 2 Graph Dataset Representation of the History and Waqf Sumedang Larang Kingdom's

Image color captions:

- Government as Chairman of Nadzir Waqf
- Historical manuscript and endowments
- Waqf manager
- Waqf dataset
- Movable and immovable goods data

The dataset relationships are shown in Fig. 2, where each data entity is related to other ones. The 13 dataset entities are broken down into 4 categories for ease of framework design: historical and waqf genealogical manuscript data, waqf administration data, moveable goods data, and immovable goods data. Entity Relational Diagram (ERD) in Figure 3 provides more information about the relationship between entities.

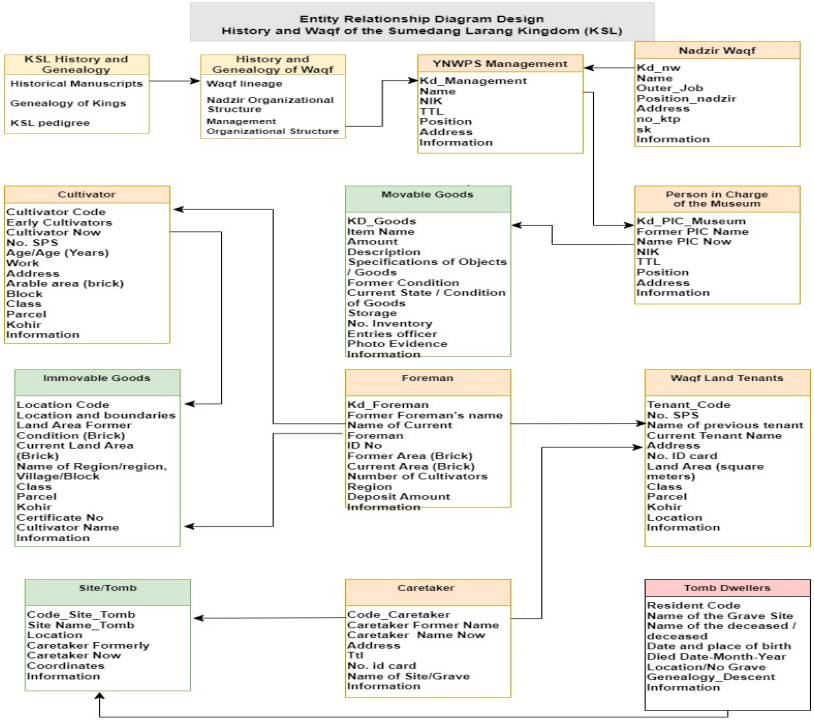

Fig. 3 Entity Relationship Diagram for the History of KSL

3.3 Platform Architecture and Data Management

These platforms are compared by considering their architecture, support for metadata, existing programming interfaces, as well as their search mechanisms and community acceptance. In this process, the stakeholders' requirements are also taken into account (Amorim et al., 2017). Relevant data management platforms and architecture are presented in Fig. 4 based on the information collected from the articles of association of the YNWPS maintainers.

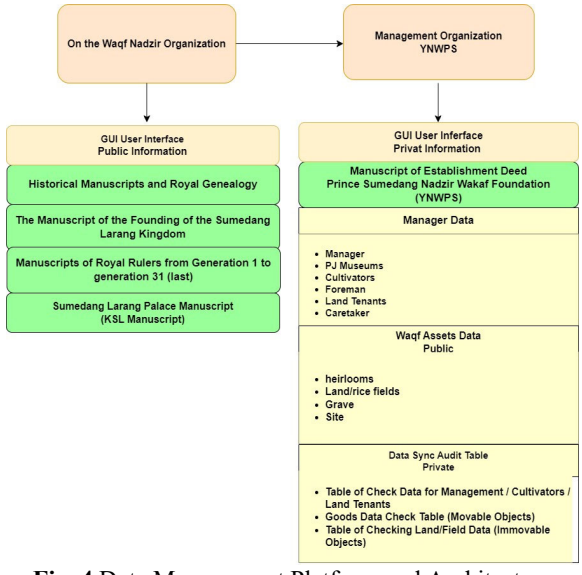

Fig. 4 Data Management Platform and Architecture

For users, managers, admins, and coaches, a GUI interface is necessary for platform architecture and data management (Nambiar & Mundra, 2022). It is advised that coaches specifically have access to all the current data, but not as an admin with CRUD access.

3.4 Data Organization and Governance

The waqf Nadzir was observed to be the stakeholder in relation to the data needed due to the responsibility of making more data-driven decisions across the organization (Abraham et al., 2019) through the waqf managers as described in the framework in Fig. 5.

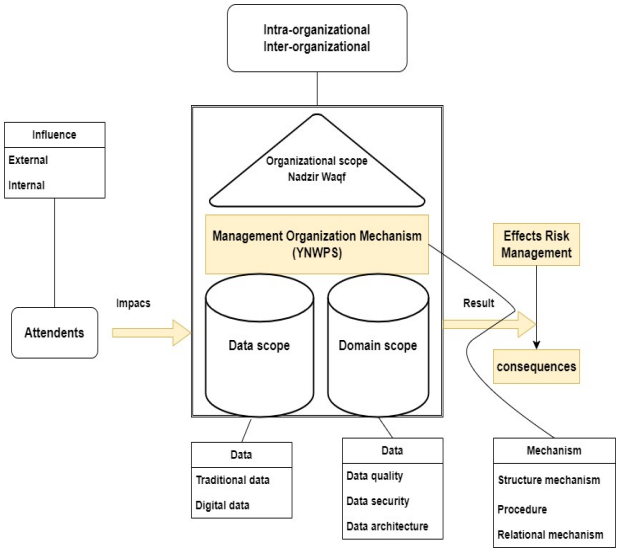

Fig. 5. Ideas from the conceptual framework for historical data and endowments for data organization and governance

Fig. 5's intra-organizational and inter-organizational relationships illustrate how both internal and external organizations participate in management and oversight. The prior approach is intended to make management and supervision easier, both practically and conceptually. Similar to how fundamental scale data is described, scale data is detailed to form data structures. Before the application launches, standard operating procedures must be created to reduce risk, especially regarding data updates. This makes it possible to carefully plan out data mitigation for risk management.

4. Result

The broad insight of the stakeholders including the waqf Nadzir and YNWPS as the managers was needed to improve the sustainability of digital and physical data preservation (Paschalidou et al., 2022). This insight led to the design of the following web-based information system framework based on the information retrieved from these stakeholders (Adetunji et al., 2018). Technology integration is very important in the twenty-first century learning society (Bajracharya, 2021). The framework module's integration design is shown in four components in Figure 6: the management module, the movable goods module (museum artifacts), the immovable goods module (land and buildings), and the genealogy module to view the lineage of the monarchs who passed down endowments.

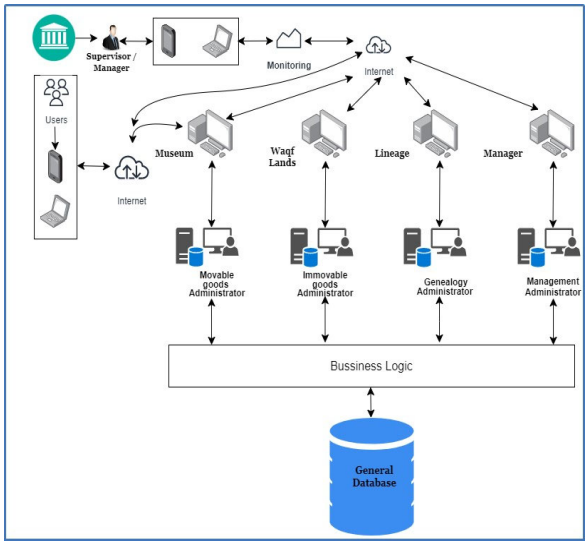

Fig. 6. Framework module's integration design

The implementation of the framework shown in Figure 6 is described in more detail in the web navigation framework design shown in Fig. 7.

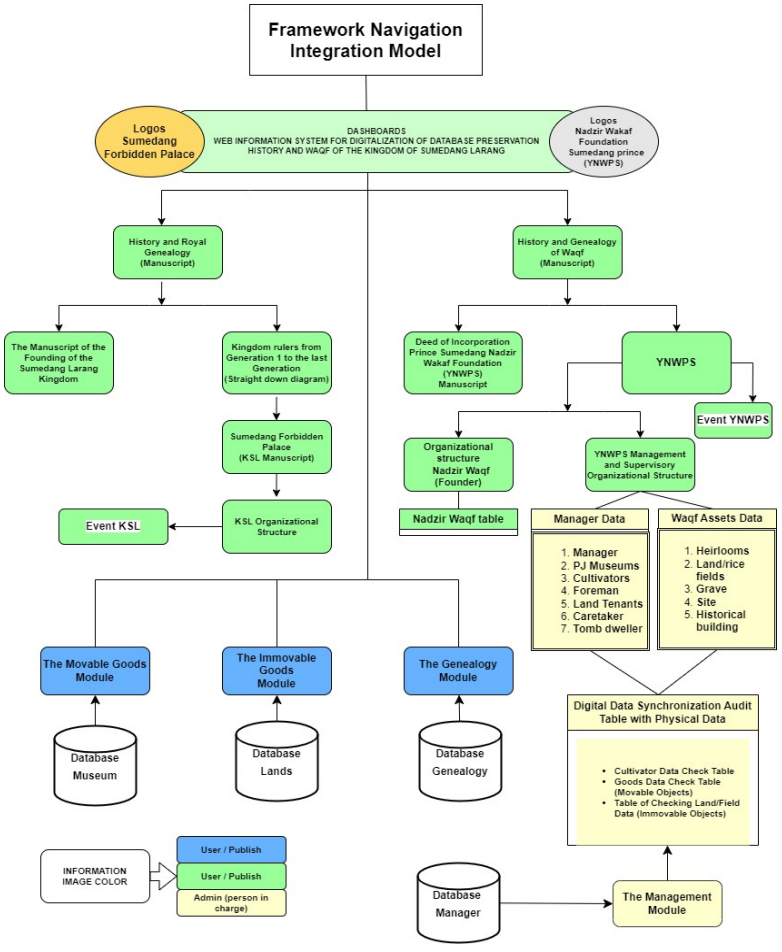

Fig. 7 KSL history and endowment web framework design

The framework was built with policies for users, administrators, and managers. The extent of the preservation process was directly aligned with the specific goals set by the organization responsible for overseeing historical artifacts and legacies (Zaagsma, 2022). These entities played a pivotal role in catering to public requirements by safeguarding cultural memories and heritage, thereby paving the way for posterity. By furnishing such content to the public, they addressed the inherent necessity for reestablishing connections and deriving significance from the bygone eras, consequently illuminating the relevance of history in the contemporary world. The wider use of models may require broader discussion among heritage professionals and the provision of training (Richards & Brimblecombe, 2023).

5. Discussion

Various kinds of heritage and culture, as well as heritage in the form of waqf consisting of physical and non-physical data, are scattered in every country (Giliberto & Labadi, 2022). Cultural heritage data in physical form is increasingly threatened with extinction, while research to preserve heritage and cultural data in physical form using the latest information technology requires extra caution (De Masi et al., 2021). Collections of heirlooms, building architecture, historic buildings, land, rice fields, protected forests, building architecture, literature, musical instruments, cars, and other physical data types are all included in the preservation of physical data and have a variety of meta-data (Al-Sakkaf et al., 2020). Similar to this, each nation will need to handle its distinct heritage and cultural data in a certain way. Notwithstanding its shortcomings, information technology always seeks to document digitally (Georgiou et al., 2021).

An essential need exists for the creation of an ontology-based framework for interoperability (Fraga et al., 2020). Because ontology can adapt to what people do in accordance with their common sense acceptance, the information system for digitizing cultural heritage with an ontology-based methodology finds a major match (Kramm, 2021). Nonetheless, it continues to pose a threat to the survival of cultural assets and legacy due to the evolution of society in the information age, political cultures in different nations, as well as the results of the current climate (Loach et al., 2017). There are still many cultural heritage sites that, in certain circumstances, have not been protected in compliance with UNESCO guidelines (Brumann & Gfeller, 2022).

Hence, addressing the physical data contained in the database must be a part of building a framework for digitizing heritage and culture so that the loss or degradation of these items is documented for use in education and future generations' history (Lightstone et al., 2007).

6. Conclusions and Recommendation

In conclusion, the proposed framework was efficiently and easily implemented to digitally preserve existing data elements through the commitment of historical and endowment managers. The KSL historical and endowments assets used as the case study showed the need for the data disclosure to be more secure than ever, strengths and weaknesses explored, and implementation potential assessed. The analysis of the case study further indicated that strong environmental sustainability elements have not been fully adopted but there is potential. The transition to digitally-sourced preservation efforts was discovered to be providing new and exciting opportunities to protect endangered cultural heritage better and expand the scope of knowledge beyond what was envisioned in the pre-digital era. The data-driven technologies were expected to increase research capacity and lead to the development of new perspectives on agricultural land management and land use according to their functions. Moreover, preparatory steps were required to ensure structural and technical support for the digital-based initiatives to avoid causing turmoil among managers. The limitations of the technology currently available also needed to be understood with the identification of appropriate improvements. The results showed that the proper implementation of digital technologies could protect existing heritage and open pathways to comprehensive digital humanities for future generations.

The regeneration process can involve data-based analysis of assets, documents, qualitative interviews, and inductive approaches. These are necessary considering the importance of stakeholder interactions in managing conflict (Kim et al., 2023). Managers may not be taking advantage of modern digital tools such as social media to engage with local stakeholders. Broader research champions the importance of local com- munity engagement (Durrant et al., 2023). The purpose of the process should be to suggest future goals, justify data assets, develop web-based information systems, and accomplish data preservation to gain a strategic advantage through the use of data. It is also possible to implement digital forensics on digital data with precise synchronization of physical data by working with experts in the heirloom assets, land, and rice field sectors (Sunde, 2021).

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