Indonesian Journal of Electrical Engineering and Computer Science
Vol. 28, No. 2, November 2022, pp. 980~986
ISSN: 2502-4752, DOI: 10.11591/ijeecs.v28.i2.pp980-986

Preservation of intangible and tangible cultural heritage using digital technology

Lanto Ningrayati Amali, Muhammad Rifai Katili, Wandi Ismail
Department of Informatics Engineering, Faculty of Engineering, Universitas Negeri Gorontalo, Gorontalo, Indonesia

Article Info

Article history:

Received Mar 23, 2022
Revised Aug 10, 2022
Accepted Aug 24, 2022

Keywords:

Digital technology
Information delivery
Intangible cultural heritage
Tangible cultural heritage
Preservation

ABSTRACT

There is presently a shortage of preservation of intangible cultural heritage and places for distributing tangible cultural heritage artifacts, regardless of their high value and usability for a nation. Despite efforts to protect cultural heritage, such as mapping and designing information systems to ensure the authenticity of information circulating in the community about intangible traditions and tangible sites obtained from different sources, many historical information places have been converted into new beliefs and buildings. Therefore, this research aims to provide information to promote public awareness about the distribution of tangible sites and intangible information about cultural heritage. A system development method with a prototype model comprising the stages of design and evaluation, system coding, and program testing, alongside system evaluation and usage, was employed. Subsequently, the results showed that the mapping information system increases the effectiveness and efficiency of delivering intangible and tangible cultural heritage information to the public and tourists.

Corresponding Author:

Muhammad Rifai Katili
Department of Informatics Engineering, Faculty of Engineering, Universitas Negeri Gorontalo
Universitas Negeri Gorontalo
Prof. Dr. Ing. B. J. Habibie Street, Gorontalo, Indonesia
Email: mrifaikatili@ung.ac.id

1. INTRODUCTION

Cultural heritage is the identity of a society or the bond between people and the past, which is inherited from previous generations, exists in the present, and is preserved for the future. It shapes the perceptions, identity, environment, and residence of a society or people. Generally, cultural heritage is categorized into two groups, intangible and tangible [1], [2], which are essential factors in maintaining cultural diversity in the face of rapidly growing globalization. This is significant because it refers to the wealth of knowledge and skills inherited through generations. According to Petronela [3], cultural heritage is an essential component of national identification and representation as a repertoire of meanings and values and the embodiment of symbols in certain societies.

Furthermore, Logan [4] defined intangible cultural heritage as an inheritance manifested in humans, not inanimate objects. UNWTO [5] and Lenzerini [6] also affirmed that it is embodied in practices, expressions, knowledge, and skills, alongside traditional objects and spaces, which communities and individuals recognize as part of their heritage. It is transmitted through generations and constantly reinvented to provide humanity with a sense of identity and continuity. The research concluded that intangible cultural heritage involves practices, representations, expressions, knowledge, skills, instruments, objects, artifacts, and cultural spaces that are related and recognized by communities, groups, and individuals as part of their heritage. Examples, according to Arbay and Laksmono [7], are oral traditions and expressions, including

language, performing arts, such as traditional music, dance, and theater, local knowledge, rituals, traditional skills, and crafts, as well as knowledge and practice about the universe.

Arbay and Laksmono [7] also stated that tangible cultural heritage refers to physical artifacts produced, maintained, and transmitted between generations in society. According to Fahik *et al.* [8], it can be seen or touched and is concrete or physical. Examples of tangible cultural heritage are physical artifacts or objects important to archeology, architecture, and science, such as historical buildings and places, monuments, and artifacts, which are considered worthy of preservation for the future [9]–[11].

Intangible and tangible cultural heritage in Indonesia, particularly Gorontalo Province, has attractive exploration potential. Although Gorontalo Province has approximately 134 tangible cultural heritage sites and 200 intangible cultural heritages, only 15 and 31 are officially registered. This tourism potential is used as an effort to maintain and preserve objects with significant historical, scientific, and cultural values, which consequently become education or learning material for the next generation. The preserved culture and historical stories also make Gorontalo a charming tourist destination.

Meanwhile, Bobrov [12] stated that many museums and cultural institutions are currently implementing new information, digital, and communication technologies in their management to significantly increase the accounting, preservation, search, and promotion of tradition. Kruglikova [13] explained that the management and preservation of cultural heritage are divided into conventional (classical), which has existed for centuries, and modern, which uses information technology and has developed with the emergence and introduction of computers in the cultural field. Using information and communication technology to manage cultural heritage can unite people and the world, appealing to those interested in the history of events and cultures of various countries with timeless values. Furthermore, ICT spread has significantly impacted global development and sustainable tourism, especially in less developed areas [14], [15].

In Gorontalo Province, the cultural heritage is managed by the Education, Culture, Youth, and Sports Office (DIKPORA) and the Cultural Conservation Protection Agency (BPCB). This management is still performed conventionally using a recording method with many shortcomings, such as data complexity and damage. This is because the data sources are still scattered, different, and disorganized, with many unidentified sources. Also, new buildings and traditions have replaced many information and historical places. The security of existing cultural heritage faces many environmental threats, such as pollution and climate change, as well as human-driven dangers like intentional destruction. Fortunately, technological change provides unprecedented opportunities to preserve and share cultural heritage [16].

Therefore, the rapid development of technology and information in various sectors can facilitate information delivery and cultural heritage mapping. Its use has increased significantly, with the most easily identifiable impact being the dissemination of information that is no longer limited spatially but penetrates time differences. The actual manifestation is the increasing dependence of humans on information technology. According to Shang [17] and Toader [18], the development of information and communication technology positively contributes to the socio-economic sector. These forms of technology ensure the conservation of a site's cultural significance because of its aesthetic, historical, scientific, or social value. As contained in the Burra Charter ICOMOS 1982, intangible and tangible cultural heritage that stimulates the recognition of specific values in humans should be protected with this approach. Koukopoulos and Koukopulos [19], Idris *et al.* [20], and Pappa and Makropoulos [21] also mentioned that information technology and the mapping of cultural heritage increase the understanding of culture and support togetherness in society.

This indicates preservation using technology aims to digitize information and map intangible and tangible cultural heritage to prevent extinction and preserve the nation's cultural heritage and local wisdom with the community's help. The system was created due to difficulty obtaining and disseminating information on cultural heritage, which also deters the preservation of the traditions and local wisdom of the community. Consequently, the amount of managed data and the complexity of documenting cultural heritage highlight the importance of information technology [22]. According to Tabone [23], Bello, *et al.* [24], and Golubinskiy [25], using digital technology to preserve cultural heritage allows the sharing of information and responsibilities aimed at preserving the cultural identity of a nation and promoting its easy access by users around the world.

2. METHOD

This research used a system development method with Pressman's prototype model [26]. The prototyping model is a systems development method in which a prototype is built, tested, and reworked as necessary until an acceptable outcome is achieved from the complete system. Figure 1 shows each stage carried out in this research.

a. Communication: Surveys, observations, and stakeholder interviews were conducted to collect primary and secondary data and determine the known software requirements. This was followed by describing areas that required further definitions for the next iteration.
b. Planning: The prototype iteration was accomplished swiftly by comprehensively describing the system requirements. This stage was performed by examining the description of the system requirements during meetings with the stakeholders. Then, the system was developed according to the target time and cost, and the required specifications were agreed with the user in writing. Following this step, the modeling was performed using a "quick design."
c. Modeling: This modeling was performed based on an analysis and agreement by the user. The system analysis used was the Unified Modeling Language (UML). The design comprised actor identification, system use cases, activity, sequence, class diagrams, database designs, and interface designs with attention to responsive display on the screen.
d. Construction: The system design was based on the representation of the aspects of the software that the end-user will see (e.g., user interface design or display format) and laid the foundation for the prototype construction. This stage used the PHP programming language with the Laravel framework, while the system and program were tested using Black-box and White-box.
e. Deployment: The prototype was submitted to stakeholders for evaluation and feedback to improve the required specifications, where iteration occurred when the developer made improvements. This stage was also evaluated using the System Usability Scale (SUS) to determine the conformity of the system design to user expectations. A contrast with expectations signified that the system would be repaired. At this stage, the tested and approved software was ready for use.

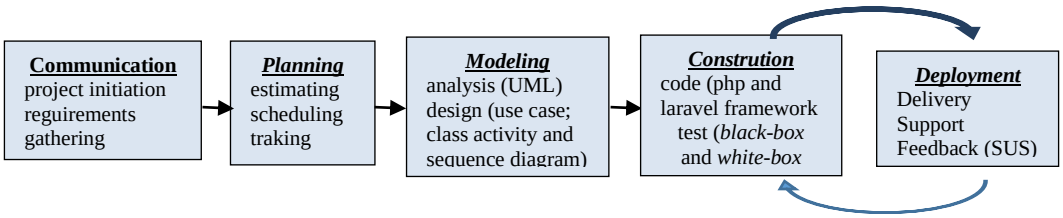

Figure 1. System development method with the prototype model

3. RESULTS AND DISCUSSION

The results of this research were obtained from a system that digitizes information and maps intangible and tangible cultural heritage. This system can improve the effectiveness and efficiency of information on intangible cultural heritage and manifest the citizens' and tourists' interests in historical events and culture to the government. Furthermore, the development was performed to promote ease in accessing heritage information through the mobile web and QR-code.

Functional requirements of the system include;

a. The system can input intangible and tangible cultural heritage.
b. The system can input activity/festival data.
c. The system can display information on intangible and tangible cultural heritage.
d. The system can display activity/festival information.
e. The system can display information on the area and location of tangible cultural heritage.

The non-functional requirements of the system are;

a. Ease of accessing the information on intangible and tangible cultural heritage.
b. The system can be run with the mobile web.
c. Information on intangible and tangible cultural heritage can be viewed via QR code.

The initial design began with the visualization of the system to be built using the unified modeling language (UML) model. This model consisted of system use cases, activity, sequence, class diagrams, and database and interface designs. The use case comprised four actors: super admin, admin manager1, admin manager2, and visitors. Figures 2 and 3 show the system flowchart and sequence diagram.

Sequence diagrams are used to show a series of messages exchanged by parts that perform a particular action. For example, the process that occurs in the sequence diagram on the tangible cultural heritage is shown in Figure 3. First, a visitor opens the website and displays the home page. Then the visitor selects the tangible cultural heritage menu, which will display the tangible cultural heritage information page, choose then read more; one of the tangible cultural heritage information will show details of tangible cultural heritage information.

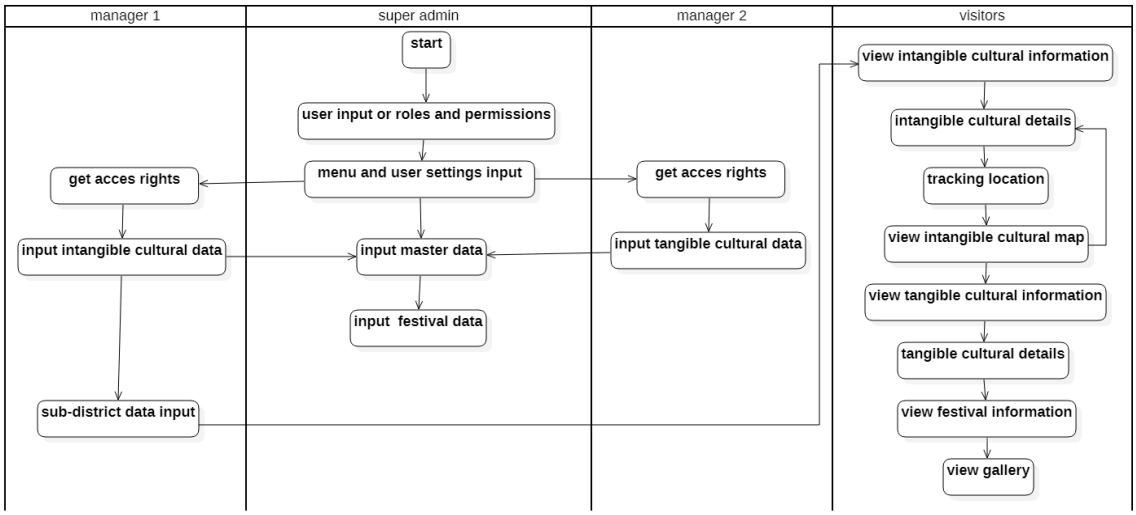

Figure 2. The system flowchart

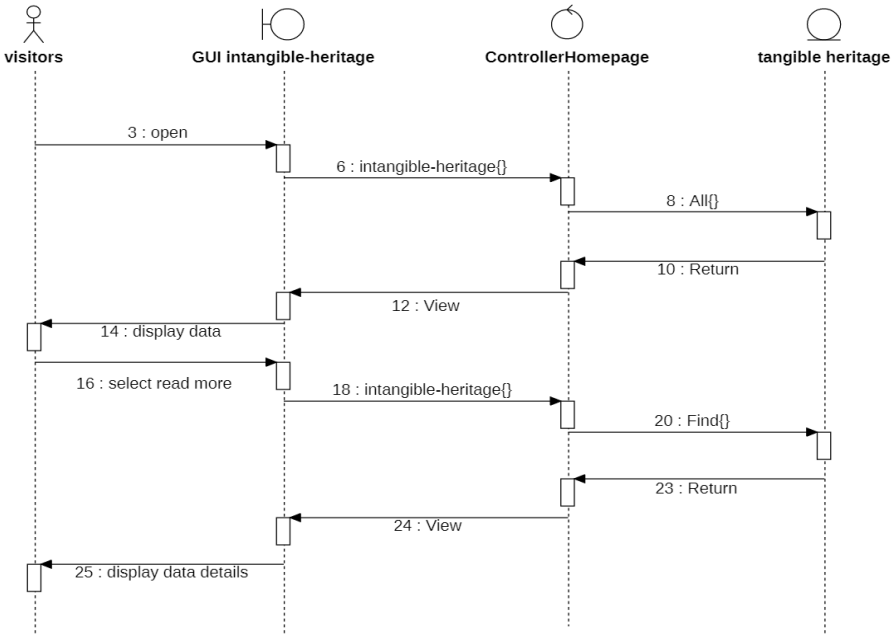

Figure 3. Sequence diagram model

This system can also display location tracking information in Gorontalo Province using Google Maps API and Qrcode for each place of tangible cultural heritage. The system was tested using Black-box and White-box. Meanwhile, the White-box evaluation was accomplished by evaluating one of the source codes for a method called Store in the Cultural Heritage Controller class, which was used to input cultural heritage data.

In the rapid design stage that has been made previously, a prototype will be made in a programming language. At this stage, we will utilize the Laravel Web framework in making applications and Bootstrap as a CSS framework. Laravel was chosen because its query function is based on Eloquent ORM, making it easier to present data from a large database. Laravel also functions to run various database operations on the website and supports multiple database systems [27]. In addition, Figures 4 and 5 display the design of the information digitization system and the mapping of intangible and tangible cultural heritage. The digitization system and mapping process have features to view information related to intangible and tangible cultural heritage, festivals held, and activities/galleries.

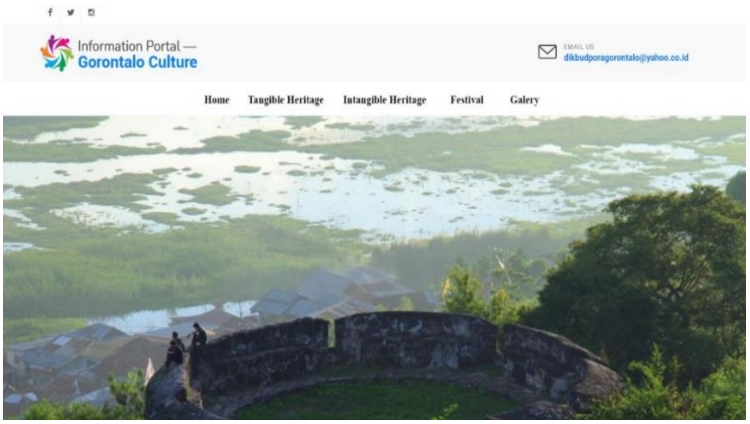

Figure 4. Home page visitors

Figure 5. Map visitors page

Figure 6 shows a flowgraph store, which is the test result for the above method, followed by a cyclomatic complexity measurement in Figure 6 that quantitatively measures the logical complexity of a program. Referring to these measurements, the simplicity or complexity of a program can be determined based on the logic applied. For example, the determination of v (g) was carried out using:

Formula v(g) = edge (line) – nodes (point) + 2

Number 2 from the cyclomatic complexity calculation shows the independent paths from the basis path testing. In addition, it indicates the number of tests that should be run to ensure all statements in the program are executed at least once (tested), as shown in Table 1.

Table 1. The independent path

Path	Number
Path 1	1-2-3-4-5-6-7-8-11
y	1-2-3-9-10-11

An independent path is any path traversed by the program that represents a new set of processing statements or from an unused condition. An independent path in a flow graph must pass through at least one edge that a previous path has never crossed. For example, the independent path results in Figure 6.

Black-box testing was used to check the function and performance of features, and the results for the login page displayed as expected. Consequently, this method can observe the results of test data in the application based on the practical aspects and only focuses on functionality and output. The system evaluation using the system usability scale (SUS) Score approach as a benchmark in measuring the usability

of the products generated a value of 79, which is classified as a very good qualification with a B grade. This also shows a global product assessment from the aspect of effectiveness, efficiency, and satisfaction subjectively perceived by users.

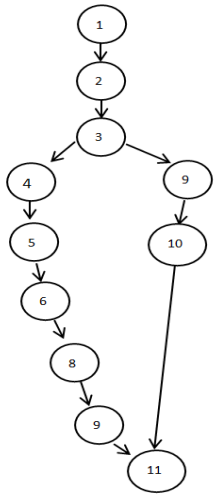

Figure 6. Flowgraph method store_culturaheritage

4. CONCLUSION

The preservation of intangible and tangible cultural heritage using this digital technology produces features or facilities designed to facilitate data processing. In addition, it provides convenience for users as information on intangible cultural heritage and mapping of cultural heritage to prevent extinction and preserve the nation's cultural heritage and local wisdom. This application also helps the community maintain and preserve cultural heritage and local wisdom.

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BIOGRAPHIES OF AUTHORS

Lanto Ningrayati Amali received her Doctoral Degree in Information Technology from the Universiti Utara Malaysia in 2015. Her research interest includes IT Governance, System Planning, and Management of Information System. She has published and presented her research nationally and internationally in IT Governance. She is currently a lecturer in the Faculty of Engineering at the Department of Informatics Engineering, Universitas Negeri Gorontalo in Indonesia. She can be contacted at email: ningrayati_amali@ung.ac.id.

Muhammad Rifai Katili received his Doctoral Degree in Information Technology from the Universiti Utara Malaysia in 2018. He is a faculty member at the Informatics Engineering Department, Faculty of Engineering, Universitas Negeri Gorontalo in Indonesia. His research interest includes knowledge management, information system, and IT governance. He can be contacted at email: mrifaikatili@ung.ac.id.

Wandi Ismail is an undergraduate student of Information Systems in the Faculty of Engineering at the Department of Informatics Engineering, Universitas Negeri Gorontalo in Indonesia. Currently, he has completed his study program. He can be contacted at email: wandy.ismail2022@gmail.com.