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Information system of Limboto Lake potential management

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Abstract

Limboto Lake is one of the lakes in Gorontalo Province; its water supply is generated from 23 small and large rivers. The lake holds potential in several sectors, e.g., tourism, fisheries, socio-economy and culture. However, such an advantage has no quality information system as it is found that there are no particular services that manage the information regarding Limboto Lake accurately. The objective of this research is to create an information system for the management of the potential area of the lake to provide quality services to access the information accurately and completely. The provided information is also updated timely. This research employed the System Development Life Cycle (SDLC) method in the development of the information system. Furthermore, the data were collected from interview, observation, and reviewing literature and document. This system is tested using white box and black box where it generated the expected outcome and is web-based. The output of this research is a system that eases the society to access the information regarding the management of the potential area in Limboto Lake.

Keywords: information system, Limboto Lake, management, potential area

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1. Introduction

A lake is the source of freshwater that holds the potential to fulfill the needs for people and it's a very attractive components of urban landscape [1]. In addition to the home for germplasm, a lake basically functions to supply water for the agricultural sector and the society and to generate energy for power plants. Tourism sector can also benefit much from the lake [2, 3].

Limboto Lake is among the lakes in Gorontalo Province; it is located approximately three kilometers from the west of Gorontalo City. The water supply of this lake is from 23 small or large rivers, e.g., Bironjo River, Mekopo River and Alo-Pohu River [4]. As an estuary of several rivers, the lake is considered quite large with the surface area around 3000 hectares. Margandj reports that Indonesia has more than 500 lakes with the total area of more than 5,000 km², meaning that the lakes dominate 0.25% of the area of the landform [5]. Limboto Lake is among those 500 lakes; it is located at Gorontalo regency. This lake is an asset to abundant natural resources for its role to prevent flooding; it also supports the living of the fisherman, and it serves as a tourist attraction. Research by Lehmusluoto and Machbub reveals that the shrinking and silting of Limboto Lake is faster than any other lakes in Indonesia [6]. In 1932, the area of the lake was around 7,000 ha with the depth 30m at maximum. The shrinking and silting became progressive until the 1970s. Recently, the area of Limboto Lake reaches 42,958 with the depth of ±2.5 m. The approximate volume of the sediment is one to two million m³ per year, and the population of water hyacinth dominates 20% of the area of the lake. In 52 years, the lake lost 4304 or 62.60% of its area, meaning that it loses ±65.89 ha every year and ±5.49 every month. A number of studies argue that the lake will no longer remain by 2025 [7].

With that being said, preserving the lake by developing the management of the potential area is essential. This research plays a major role in supporting the management and preservation of Limboto Lake through creating an information system of the potential area of

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 Muhammad Rifai Katili⁶

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the lake. This system is expected to maintain the condition of the lake and promoting other sectors, such as the socio-cultural aspect or the wellbeing of the community near the lake. It also provides information regarding the tourism attraction and educative information for the researcher and for those who are interested in studying culture.

Identifying the potential of Limboto Lake is necessary to explore its natural resources, the way people (human resources) benefit from it, the land suitability and capacity, as well as the general condition of Limboto Lake. Doing so is of great advantage for the lake community. However, such an advantage has no quality information system as it is found that there are no particular services that manage the information regarding Limboto Lake accurately. The information regarding Limboto Lake can only be accessed by searching some websites discussing the lake or using search engines, such as Google. Such a method is common, yet it spends too much time, and it does not ensure that the information is valid as ones need to be selective to confirm the reliability of the website and its sources. In the light of the above discussion, creating an information system that manages the potential area of Limboto Lake, especially the one providing the detail of the lake is essential. This web-based system comprises varied contents, i.e., texts, images and videos, as well as some geospatial information about Limboto Lake.

Limboto Lake Area

The existence of the area of Limboto Lake plays a major role, in terms of the ecological, hydrological and socio-economic aspects, for the society in Gorontalo [8]. The hydrological function of the lake as the estuary of some rivers is crucial. It serves as a water absorption area, and it helps in the management of flooding and preventing erosion. From the perspective of biology, the lake serves as habitats of several plants and animals. Many people benefit much from the lake as it supports the livelihood of the fishermen through freshwater aquaculture. Furthermore, Limboto Lake is also a tourist destination where many people can visit it for some purposes, such as to conduct research and promoting cultural development [9]. Considering the above advantages, several stakeholders and more particularly the government are demanded to pay attention to the sustainability of the lake [10].

The foremost concern in Limboto Lake is the uncontrolled growth of water hyacinths that damage the lake. It causes the silting of the lake as the water volume of the lake reduces [8, 11]. Other factors affecting the condition of the lake are erosion and sedimentation. It is revealed that the level of the erosion in the catchment area of the lake reaches 9,902,588.12 ton per year where the area of the lake in 2006 was less than 3,000 ha with the average depth 2.5 m [12-14]. This is due to illegal logging and conversion of the lake area for cultivating maize. Such issues lead to the problem in balancing the nature of Gorontalo province by which it also affects the society. With that being said, rehabilitation, conservation and other efforts are needed to preserve and even to reconstruct the area of Limboto Lake.

Information System of the Management of Potential Area of Limboto Lake

Information system implementation in both the public and government sectors has been among the priorities for the needs of the business. This is due to its function in promoting the efficiency of public service and its competitiveness. The principle of developing an information system is synced between the demands of an institution for the information and the planning as well as the development of the system. Such consideration is necessary as the system contributes to some factors, e.g., management, organizational structure, human resources and policies.

The more complex an information system or computerized technology, the higher the possibility of the risks that is caused by some issues related to data integrity, privacy and misuse of the system [15]. An immediate and accurate decision-making process, competitiveness, and the development of business demand a sophisticated and reliable technology. In such a context, the success of an organization is determined by its optimum management of information system and technology. An information system is an intertwined element that manages the data to produce useful information. Some traits, e.g., relevance, complete and accurate are the characteristics of reliable and quality information. Hall and Alter define the term information system as a series of procedures where the data are grouped and processed which results in useful information [16, 17]. This output is further distributed to some parties that need this information. The information system of the management of the potential area of Limboto Lake serves to manage the data regarding the lake. To sum up, the term

information system describes a system that functions to gather, process, and transform data into valuable information.

Accuracy and timeliness are the aspects that should be considered when particular information is needed as this notion is the tenet of the importance of information. The use of digital technology promotes the effectiveness and efficiency of the provision of information. Furthermore, it also lowers the cost for the use of paper [18, 19]. An information system is expected to satisfy the user [20, 21]. Considering whether the system is able to satisfy the needs of the users or to conceptualize the ideas of the creator of the system is also essential. A quality information system should be able to fulfill the demands of the users despite that it might not encompass all users in some aspects other than the provision of access to information.

Nowadays, the development of an information system seems exclusive to the needs of the business where the management of such a system or technology is carried out by each functional unit. This results in a segregated process and information pieces as each system is not synced to use the data. Therefore, an integrated approach is required to overcome the aforementioned issue. This resonates to the idea by Al-Sudairy and Vasista that creating an integrated information system or application has been a challenge in the development of technology that demands certain data and its resources must be heterogenic [22, 23].

An integrated information system is able to incorporate data or information within an organization. Such a system is expected to boost the effectiveness and efficiency of the distribution of information. It also allows the process of data inputs, specifically the data regarding the potential area of Limboto Lake and attempts that should be made according to the established procedures.

2. Research Method

The object of this present study is the information system of the management of the potential area of Limboto Lake. This research employed the System Development Life Cycle (SDLC) method in the development of the information system [24, 25]. Furthermore, the data were from interview, observation, and reviewing literature and document. The processes of research procedure are depicted in the following Figure 1.

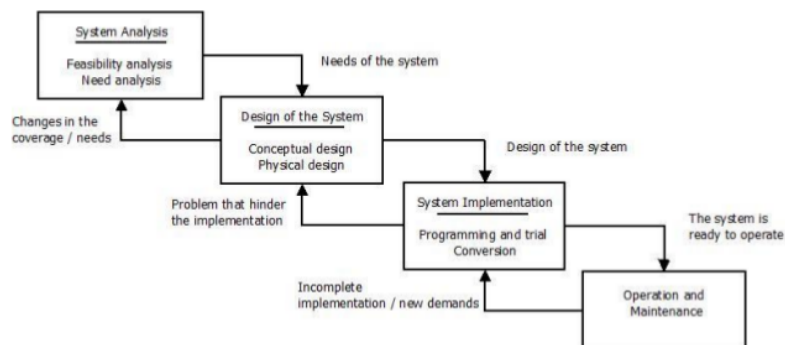


Figure 1. Research procedure

– System Analysis

The analysis of the system covers the feasibility and need analysis. It focuses on the issue relating to the management of the potential area of Limboto Lake through processes, i.e., problem identification, the feasibility of the creation of the system, the needs of the information users, and comprehending the system and the findings.

– Design of the System

The design of the system comprises two sub-processes, i.e., conceptual design (evaluating the alternative design, preparing the design specification and report of

the conceptual system) and physical design (the design of the input/output, a platform, user and system arithmetic, the basis of data, the model and its control).

- System Implementation

This step encompasses the programming and trial of the system, installation of the hardware and software, disseminating the information regarding the operation to the user through workshops and documentation.

- Operation and Maintenance

These steps cover the whole processes needed to ensure the sustainability and the completion of the system.

3. Results and Analysis

3.1. Analysis

The result of interview and observation with related stakeholders, such as the Tourism Board and Bappeda (Regency Development Planning Agency) reveals that the primary issue is the lack of quality information system and particular services that manage the information regarding Limboto Lake accurately. The information regarding Limboto Lake can only be accessed by searching some websites discussing the lake or using search engines, such as Google. However, the data from the websites is not confirmed reliable. This step encompasses the identification of the problem, i.e., the information that should be incorporated into the system. This information includes the history of the lake, its geographical location, photos and videos, article and news, and other information regarding the tourism area within the lake, such as the annual Limboto lake festival. The system is created as a web-based program that is expected to provide accurate, comprehensive and up-to-date information regarding Limboto Lake. Furthermore, this system also serves to promote the tourism sector and by providing services to access the tourism campaign. People can access the system as it is an open-access system. An administrator is assigned to manage the services of information access. The primary role of the administrator is to update and edit the information and news regarding Limboto Lake.

3.2. Designing the System

This step is aimed to boost the effectiveness and efficiency of the management of the campaign and the system regarding the potential area of Limboto Lake. Furthermore, its main objectives are twofold, namely:

- Developing a website that manages big data faster and it is integrated with some stakeholders, e.g., the Department of Tourism and Department of Maritime Affairs and Fisheries.
- Coping with the issues within systems that are yet to employ the recent technology, such as brochures or leaflets, and social media, i.e., Facebook, Instagram, and WhatsApp in the campaign of the tourism attraction of Limboto Lake is the objective of designing the new system. The design of this application system contains Unified Modeling Language (UML) that encompasses Use Case Diagram, Activity Diagram, and Sequence Diagram.

3.2.1. Use Case Diagram

This process is done by the administrator the visitors. The administrator is responsible for managing the homepage data, galleries, and tourism data regarding the lake while the visitors are able to access this information in the form of photos and videos. This process is illustrated in Figure 2.

3.2.2. Activity Diagram

This process illustrates the series of the activity constructed in operation. It also functions to assist other processes, such as use case and interaction. Figure 3 provides information regarding the process of the activity diagram; see the details of the data regarding the management of the lake area (administrator).

3.2.3. Sequence Diagram

This diagram indicates the object's behavior in the use case by describing the object's lifetime and message, delivered and accepted between the objects. Figure 4 is the scenario of details on lake management information (administration).

3.3. System Implementation

The information system of Limboto Lake is created by using the Sublime Text as the script writing medium of PHP. Meanwhile, the database employs the MySQL server, and software testing utilizes the white-box and black-box testing.

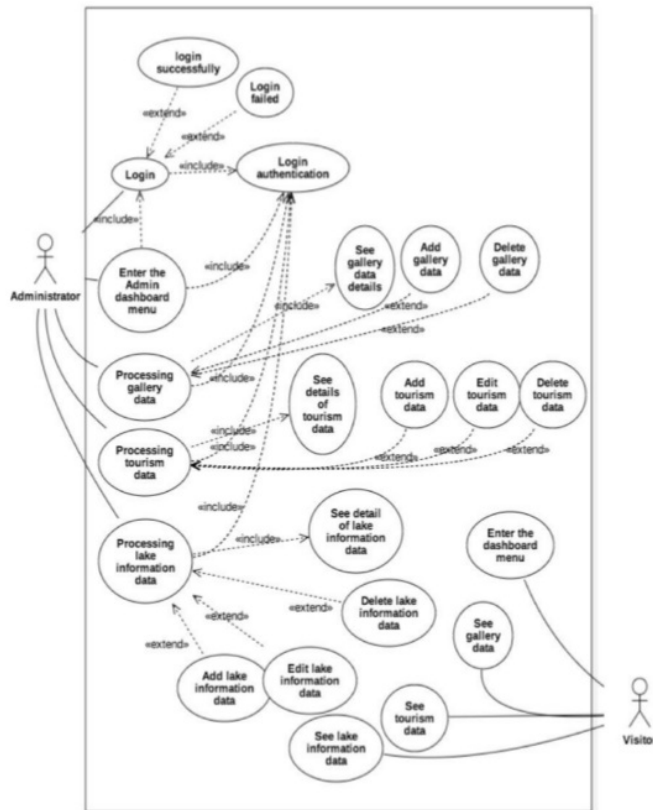


Figure 2. Use case diagram information system of Limboto Lake potential management

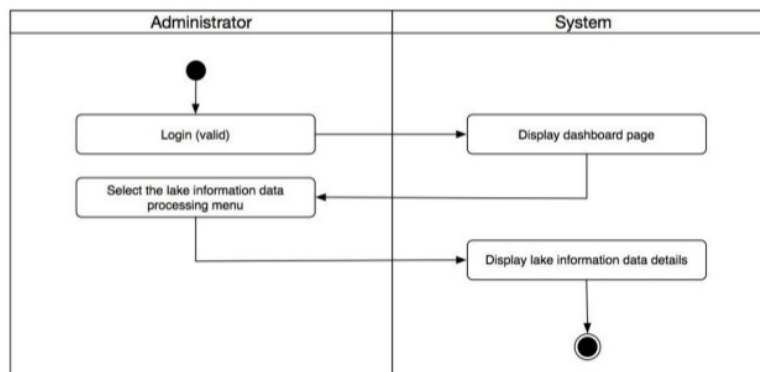


Figure 3. Activity diagram

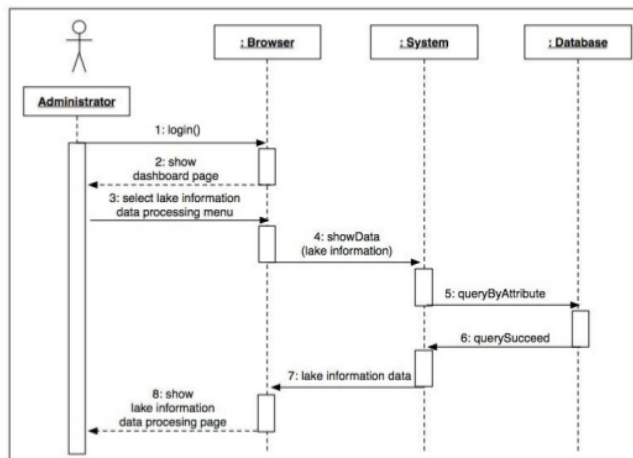


Figure 4. Sequence diagram

3.4. Operation and Maintenance

Based on the results of white-box testing in the article menu in which $V(G) = 5$ and Cyclomatic Complexity (CC) = 5, it is concluded that the flowchart article menu is running effectively and efficiently. Further, the result of black-box testing, i.e., system testing reaches the expected result. Therefore, this system is able to be implemented in the site area.

3.4.1. Interface

The user interface is very significant to meet the criteria, easy to use, attractive, and comfortable for the user. Interface design is intended to show the form of software that is going to be established based on the created system structure. Such a design includes menu structure, input, and output designs.

3.4.2. User Page Interface Design (Main Page)

The menu design is used to facilitate the established website search. The menu display in the information system of the management of the potential area of Limboto Lake is presented in Figure 5. This is the first page shown after entering the website address. It contains the whole menu. The menu consists of Home, Gallery, Tourism, Information, and Login. Each of the menus also has the sub-menu.



Figure 5. Main page

3.4.3. White-box Testing

The article flowchart form in the ¹information system of the management of the potential area of Limboto lake is presented in Figure 6 and article flowgraph form in Figure 7.

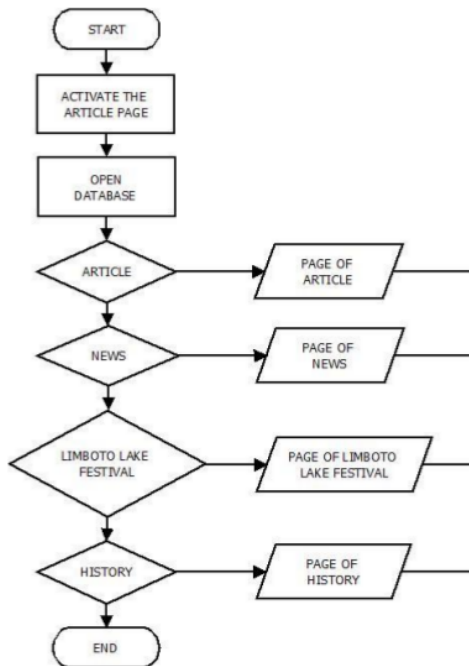


Figure 6. Article flowchart form

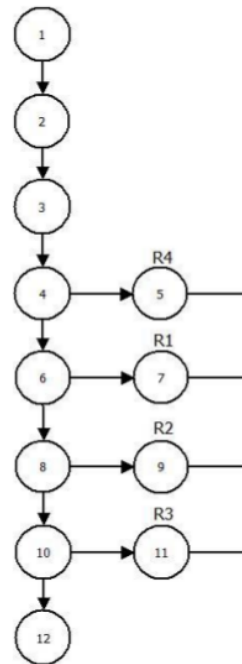


Figure 7. Article flowgraph form

Pseudocode:

- Node 1 : Start
- Node 2 : Activate the article page
- Node 3 : Open the database
- Node 4 : Select Article, if not, go to node 6, if yes, go to node 5
- Node 5 : The article page is displayed
- Node 6 : Select News, if not, go to node 8, if yes, go to node 7
- Node 7 : The News Page is Displayed
- Node 8 : Select Limboto lake festival, if not, go to node 10, if yes, go to node 9
- Node 9 : The page of Limboto lake festival is displayed
- Node 10 : Select History, if not, go to node 12, if yes, go to node 11
- Node 11 : History page is displayed
- Node 12 : End

The ⁴calculation of Cyclomatic Complexity:

- Region (R) = 4
- Node (N) = 12
- Edge (E) = 15
- Predicate Node (P) = 4
- Cyclomatic Complexity ($V(2)$) = $E - N + 2$
 where $E = 16$, $N = 12$
 $V(G) = E - N + 2$
 $= 15 - 12 + 2$
 $= 5$

$$\begin{aligned} \text{Cyclomatic Complexity } (V(G)) &= P + 1 \\ \text{where } P &= 4 \\ (V(G)) &= 4 + 1 \\ &= 5 \end{aligned}$$

Cyclomatic Complexity ($V(G)$)

R1, R2, R3, R4 = 4

The calculation result of Cyclomatic Complexity for flowgraph in the process of filling out information is 5. The independent path is:

Path 1: 1-2-3-4-6-8-10-12

Path 2: 1-2-3-4-5

Path 3: 1-2-3-4-6-7

Path 4: 1-2-3-4-6-8-9

Path 5: 1-2-3-4-6-8-10-11

The result of white-box testing reveals that the flowchart is correct. This result signifies that the system is running very well and is feasible to be used.

3.4.4. Black-box Testing

The black-box method is employed to test this system, and it focuses on the functional software requirements as shown in Table 1.

Table 1. Black-box Testing

Input / Even	Function	Expected Results	Test Res
Open the website	Display the home	Home displayed	fit
Click the gallery menu	Display the gallery sub menu	The gallery menu displayed	fit
Select photo gallery	Display the page gallery photo	The gallery page photos displayed	fit
Select video gallery	Display the page gallery video	The gallery page video displayed	fit
Click the tourism menu	Display the tourism sub menu	The tourism menu displayed	fit
Click the information menu	Display the information sub menu	The information menu displayed	fit
Select article	Display the article menu	The article displayed	fit
Select news	Display the news menu	The news displayed	fit
Select Limboto lake festival	Display the Limboto lake festival	The Limboto lake festival page displayed	fit
Select history	Display the page history	The page history displayed	fit
Select login	Display the page login	The page login displayed	fit

4. Conclusion

The information system for the management of the potential area of Limboto Lake can facilitate the community to have information regarding the management of the potential area of Limboto Lake, Limboto lake festival, and other information about Limboto Lake and Gorontalo Province. This system is also able to facilitate the community and government of Gorontalo Regency in promoting activities and information of Limboto Lake. Since the information is already on the website, it can be easily accessed.

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