Development of Aceh biodiversity information system

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Abstract. Aceh is rich in biodiversity, both flora, and fauna. Aceh's biodiversity has not been well documented. This can be seen from the absence of an information system that is open to the public regarding biodiversity in Aceh. This study aims to develop a web-based Aceh Biodiversity Information System of Aceh Biodiversity. This Aceh Biodiversity Information System will collect data on biodiversity in Aceh from various parties, including researchers, academics, government, and the general public. The waterfall model as the Software Development Life Cycle (SDLC) model is used in the development of this information system. The System Usability Scale (SUS) is used to determine user opinions in using this information system as input for improvement. The results showed that this information system was good enough to accommodate the data collection process from various parties. Improvements to the existing features used in this information system need to be done. It is hoped that these Aceh Biodiversity Information System can be utilized as a data collector for the education, research, management, conservation, and other fields of a task, especially bioinformatics.

1. Introduction
Indonesia is an archipelago country located on the equator. The tropical climate in Indonesia and the extent of the existing rainforests make Indonesia one of the countries rich in biodiversity [1]. Aceh one of the regions in Indonesia that are rich in biodiversity. Aceh province has biodiversity in flora and fauna. However, this biodiversity is not well documented. The information system that is open to the public regarding biodiversity in Aceh is hard to find. Therefore, the existence of the biodiversity information system for Aceh biodiversity collection is valuable to develop. Apart from being a center of data repository, this Aceh Biodiversity Information System (ABIS) later can be used for educational purposes. In other to add to the wealth of existing data collections, data contributions are expected not only from researchers in higher education but also from various parties, including independent researchers, government, non-government organizations, and the general public.

In this paper, we propose the Aceh Biodiversity Information System as a part of the Indonesia Biodiversity database collection, especially in the Aceh region. The second part of this paper will discuss the related works regarding the existence of the development of the biodiversity information system in other areas. The third part will discuss the method used in our proposed research. The result as a part of the discussion will discuss in the fourth part. Conclusion and future research opportunities will describe in the last section of this paper.
1.1. Related works

Many studies have been carried out related to biodiversity information systems. Some of these studies cover all types of biodiversity and other studies for certain types of biodiversity. The technology used also varies, including using the Software Development Life Cycle approach, Unified Modelling Language, and spatial approach.

Research conducted by [2] developed a biodiversity information system for tropical rainforests in Kalimantan, Indonesia. This biodiversity information system collects 2,006 species consisting of trees, wood, and medicinal plants refer to the sub-ethnic Dayak references, Kalimantan, Indonesia. This information system applies a Software Development Life Cycle process using the waterfall model. Data collected from various sources of government institutions and other non-governmental organizations were analyzed and designed using the Unified Modelling Language (UML) [3]. In their research, they developed a biodiversity information system using a spatial approach in the northeast India area. This study uses Visual Basic, Oracle as databases, and Open Database Connectivity (ODBC). By combining various information, both spatial and non-spatial using Internet GIS, several supporting software such as ArcSDE, ArcInfo, ArcIMS, and Microsoft Internet Information Server 4.0 used on this system.

Research conducted by Pathak [4], designed and implemented a fish biodiversity information system in the Western Ghats region in India. The information system built using Visual Basic Language. MS Access used as a Data storage and image processing using Adobe image technologies. The system consists of several features, including a search for taxonomy, morphology, environment, and other things related to fish species information. The information system displayed includes pictures of fish species with good image quality. In total, there are 373 types of fish species collected in the fish biodiversity information system.

Another research conducted by Johan [5] developed a biodiversity information system specifically for medicinal plants found in the Dayak tribe, Kalimantan, Indonesia. 233 Data obtained from various existing sources such as government, residents, and other scientific publications. The dataset structure consists of plant species, family name, identification, taxonomy ID from NCBI. This research also collects geographical information on plants. In addition, the parts of the plant that used, ethnobotany, morphological characteristics, local name, the efficacy of medicinal plants, and chemical values are also documented. Information related to distribution, locations, data sources, references, and descriptions related to the medicinal plants is an important part of species documentation that is inseparable from the system as a whole. The class diagrams are used to model data and an object-oriented approach using a three-tier-architecture used for database management system development.

![Figure 1. Aceh biodiversity information system architecture.](image-url)
2. Method

2.1. Data collection process

The data collection process is done by using literature studies related to the existing biodiversity information system. In addition, data collection on species that will be input into the system is also performing. These data come from field study data collection. The data processed in laboratory bioinformatics, Faculty of Mathematics and Natural Science, Syiah Kuala University. The biodiversity classification data structure refers to the International Code of Botanical Nomenclature (ICBN) as an example shown in Table I below.

| Rank   | Ending | Example         |
|--------|--------|-----------------|
| Kingdom| -      | Plantae         |
| Division| -phyta| Spematophyta    |
| Class  | -opsida| Magnoliopsida   |
| Order  | -ales  | Sapindales      |
| Family | -aceae | Meliaceae       |
| Genus  | A noun | Swietenia       |
| Species| Depends| Swietenia Mahagoni |

2.2. Software development life cycle process

We implement the waterfall model in the development of this information system, which is one of the models in The Software Development Life Cycle (SDLC) processes [6]. The literature study and observation was performed on the existing biodiversity information system as the first step. Based on the data obtained in the previous stage, the system and software design implementation is applying. The application of the design results is using native PHP combined with the bootstrap framework. At this stage, we implement MySQL as the backend database. System integration and testing performance using the BlackBox and Scalable Usability Scale (SUS) [7] testing. Receiving feedback from the end-user is the last stage of this cycle.

![Figure 2. SDLC waterfall model for Aceh biodiversity information system.](image-url)
2.3. **System usability scale**

The System Usability Scale (SUS) is used to determine user opinions in using this information system as input for improvement [7]. The measurement uses ten questions and using a scale of 1-5 as the answer options. This measurement is applied after the user uses the system that has been implemented. For odd-numbered questions, the value given for each answer is reduced by 1. As for even-numbered questions, 5 is deducted from the answer given. The final value is the multiplication of the sum of all values with 2.5. Interpretation of SUS scores refers to the research conducted by Bangor [8][9] as shown in the following Figure 3.

![SUS score categorization](image)

**Figure 3.** SUS score categorization [8][9].

2.4. **Blackbox testing**

Black box testing is software testing that looks at the functional capabilities of a system [10]. Tests were carried out on user registration and login (Table 2), data uploaded by users (Table 3), data validation by validator (Table 4), and data species search (Table 5). The expected results are indicators that will be used against the test results.

| ID | Testing Scenario                  | Expected Result                  |
|----|-----------------------------------|----------------------------------|
| TC01 | User register a new account         | Successful register notification |
| TC02 | User register with an existing account | Failed login notification       |
| TC03 | Same user account login simulant    | Failed login notification         |

| ID | Testing Scenario                  | Expected Result                  |
|----|-----------------------------------|----------------------------------|
| TC04 | User input the same data           | Notification to contributor       |
| TC05 | User upload non-image files        | Failed notification upload       |
| TC06 | User upload large file image       | Failed notification upload       |

| ID | Testing Scenario                  | Expected Result                  |
|----|-----------------------------------|----------------------------------|
| TC07 | User input data                   | Data available on validator dashboard |
| TC08 | User input the same data          | Notification to validator on the dashboard |
| TC09 | User verify/reject data           | Notification to contributor via email/dashboard |
### Table 5. Blackbox testing scenario for data query and detail information.

| ID   | Testing Scenario                      | Expected Result                          |
|------|---------------------------------------|------------------------------------------|
| TC10 | User searching data by keyword        | Related result by keyword shown          |
| TC11 | The user selects detailed species     | Detail species data showed               |
|      | information                           |                                          |

3. Result and Discussion

3.1. Application view

In addition to providing the main page containing information related to the number of species and other news, the system also provides a search feature as shown in Figure 4 below. The search is carried out based on keywords which are the names of part of the taxonomy. The search result is a collection of images.

![Figure 4. Image searching table.](image)

As explained in Figures 5 and 6, the search results of images can be explored further for more detailed information. As shown in Figure 6, the information contained in the species picture also contains the local language of the species’ origin. A brief description of the species provided in this section.

![Figure 5. Image Species Data Collection.](image)

![Figure 6. Description of Data Collection.](image)
3.2. System usability scale evaluation

Based on the calculation of the System Usability Scale (see section 3.3) for respondents who have used this system, the following results are obtained in Table 6.

| Question | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 |
|----------|----|----|----|----|----|----|----|----|
| Q1       | 4  | 4  | 4  | 3  | 3  | 4  | 3  | 4  |
| Q2       | 1  | 1  | 4  | 3  | 3  | 4  | 4  | 4  |
| Q3       | 3  | 3  | 3  | 3  | 3  | 4  | 3  | 4  |
| Q4       | 2  | 1  | 4  | 3  | 3  | 3  | 3  | 3  |
| Q5       | 2  | 3  | 3  | 3  | 4  | 2  | 4  | 3  |
| Q6       | 0  | 2  | 3  | 3  | 4  | 2  | 4  | 3  |
| Q7       | 2  | 2  | 3  | 3  | 4  | 3  | 3  | 4  |
| Q8       | 0  | 1  | 4  | 3  | 4  | 4  | 4  | 4  |
| Q9       | 3  | 3  | 4  | 3  | 4  | 3  | 4  | 4  |
| Q10      | 1  | 1  | 4  | 3  | 3  | 2  | 3  | 2  |
| Total score | 18 | 21 | 36 | 30 | 30 | 37 | 30 | 37 |
| SUS Score | 45 | 53 | 90 | 75 | 75 | 93 | 75 | 93 |

Average SUS Score = \( \frac{\sum \text{SUS Score}}{\text{No of Responden}} \) = \( \frac{598}{8} \) = 75

The value returned by SUS is a percentile. Based on the calculation, the Aceh Biodiversity System SUS score is 75. This value indicates that the Aceh Biodiversity System has a grade scale "C" with minimum acceptability and has an adjective rating of "Good".

3.3. Blackbox evaluation

| ID  | Testing Scenario                             | Expected Result               | Result                           | Conclusion |
|-----|---------------------------------------------|--------------------------------|----------------------------------|------------|
| TC01 | User register a new account                 | Successful register notification | No error message notification    | Accepted   |
| TC02 | User register with an existing account       | Failed login notification     | Failed login message notification appears | Accepted   |
| TC03 | Same user account login simultant           | Failed login notification     | Failed login message notification appears | Accepted   |
| TC04 | User input the same data                    | Notification to contributor    | Notification via email not appear | Not Accepted |
| TC05 | User upload non-image files                 | Failed notification upload    | Failed login message notification appears | Accepted   |
TC06 User upload large file image | Failed notification upload | Failed login message notification appears | Accepted
---|---|---|---
TC07 User input data | Data available on validator dashboard | Data appear in the dashboard | Accepted
TC08 User input the same data | Notification to validator on the dashboard | Validation appear in the validator dashboard | Accepted
TC09 User verify/reject data | Notification to contributor via email/dashboard | Notification via email not appear | Not Accepted
TC10 User searching data by keyword | Related result by keyword shown | Data appear in the query result | Accepted
TC11 The user selects detailed species information | Detail species data showed | Detail data appear in the query result | Accepted

Based on the test results in table 7 above, it can be seen that in general shows acceptable results. However, two tests do not get good results, namely testing for “notification if the user inputs the same data” and testing “notification to the contributor” regarding the verification results by the validator”. These results appear because the mail server function not running properly.

4. Conclusion
The results showed that this information system was good enough to accommodate the data collection process from various parties. Improvements to the existing features used in this information system need to be done. In the future, the development of the Aceh Biodiversity Information System (ABIS) can be integrated with other services owned by related work units, for example; the natural resource conservation office. In addition, it is possible to develop technology in ABIS related to artificial intelligent-based data search.

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