Zero : Jurnal Sains, Matematika, dan Terapan
E-ISSN : 2580-5754; P-ISSN : 2580-569X
Volume 9, Number 1, 2025
DOI: 10.30829/zero.v9i1.24371
Page: 310-321

Design and Development of an Information System for Recognition of Endangered Animals in Indonesia Based on Android Using the RAD Method

[1] **Mhd Syahputra Hasibuan**
Department of Information System, UIN Sumatera Utara Medan, Medan Indonesia

[2] **Muhamad Alda**
Department of Information System, UIN Sumatera Utara Medan, Medan Indonesia

Article Info

Article history:

Accepted, 28 June 2025

Keywords:

Android;
Endangered Animals;
Information Systems;
RAD.

ABSTRACT

Animals are considered rare if their population is declining rapidly and their numbers worldwide are less than 10,000. Natural factors or those influenced by human activities cause animals to become rare and endangered. Based on a report from the International Union for the Conservation of Nature (IUCN), there are 1,225 animal species in Indonesia that are threatened with extinction. Digital media that provides informative and interactive information is still very minimal. This results in minimal public knowledge about rare and endangered animals. Therefore, the purpose of this study is to build an Android-based information system to identify rare animals in Indonesia. The system development method used is the Rapid Application Development (RAD) method. This information system is built using Kodular and the Firebase database. Based on the test results, most users are helped by this system in obtaining information about rare animals in Indonesia.

Corresponding Author:

Mhd Syahputra Hasibuan
Department of Information System,
UIN Sumatera Utara Medan, Medan, Indonesia
Email : m.syahputra2510@gmail.com

1. INTRODUCTION

Indonesia has the nickname as the second megabiodiversity country in the world after Brazil, because Indonesia is a country that is unique in its biodiversity and very high levels of endemism [1]. Indonesia has 17,504 large and small islands, with a total area of around 7.81 million square kilometers (km2) [2]. Of the many islands there are various types of flora and fauna. There are animals that are unique and characteristic of every island in Indonesia. There are several types of animals that are rare and almost extinct.

Rare animals are animals that are few in number and very rarely found. An animal is said to be rare if its population is decreasing rapidly and its number worldwide is less than 10,000 [3]. Natural factors or those influenced by human activities cause animals to become rare and endangered, for example low reproduction rates, insufficient types of food available, habitat destruction, or poaching. Based on a report from the International Union for the Conservation of Nature (IUCN), there are 1,225 animal species in Indonesia that are endangered. From this, there are several problems that can be identified. Most people do not know or are not aware of this information. In addition, digital media that provides informative and interactive information is still very little. This results in a lack of public knowledge about rare animals [4].

Technological advancements are accelerating, leading to profound transformations in human existence, notably exemplified by the advent of smartphones. Smartphones serve as instruments that enhance the dissemination of information, communication, and various activities. This need is clear evidence of developments

in today's era. The increasing use of smartphones has ultimately influenced people's need for mobile applications that can make it easier for people to carry out their daily activities. It can be seen from the many applications that can help people's needs and interests, for example online shopping, communication with colleagues, directions, playing games, online payments and online learning [5].

Similar research was conducted by [6] in 2025. This research discusses the development of interactive multimedia as an alternative learning tool, with a special focus on rare animals in Indonesia which need to be better understood by the public in the form of desktop-based game applications. In this study, there are still findings that the application is made in the form of a game, so that the information displayed is still limited, in addition, the application is built on a desktop basis and can only be accessed on a computer or laptop device. To overcome this problem, the author conducted research by building an android-based rare animal recognition information system using the RAD development method. The purpose of the research conducted is to provide information and knowledge to the public about rare animals in Indonesia through Android smartphones, so that the public can provide protection for these animals.

2. RESEARCH METHOD

2.1 System Development Methods

This research employs the Rapid Application Development (RAD) methodology for information system development. The three primary phases of this methodology are planning, Rapid Application Development (RAD) design, and implementation. The RAD development method likewise prioritizes speed in the development process. where the development process can be completed quickly [7]. The Rapid Application Development (RAD) method is a software development process model that follows a linear sequence and emphasizes a very short development cycle [8]. The RAD method is used because this method focuses on an iterative cycle of inspection, discussion, development, and change until user requirements are met [9]. Another method that is often used is the waterfall method. The advantages of the RAD method compared to the waterfall method are that it is more effective than the waterfall model in creating a system that directly meets user needs, can be worked on productively with a small number of members, in the manufacturing process using several tools and frameworks, can be done in a short time [10].

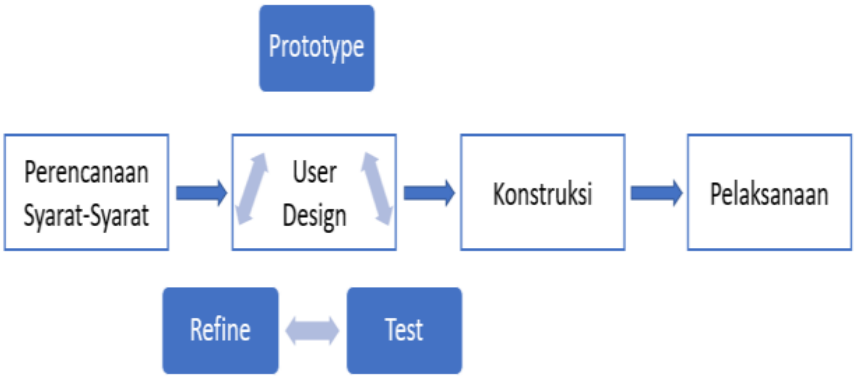

Figure 1. RAD Models [11]

The stages contained in RAD can be explained as follows [12]:

1. Planning, At this step, the author conducts a problem analysis and identifies the requirements for the information system to be developed. Actions taken include:
   - Identifying what occurs in the community environment related to public knowledge regarding rare types of animals in Indonesia.
   - Identify functional requirements and information needs.
   - Presents alternatives to the suggested system. Any requirements for software, hardware, and human resources are listed in this section.
   - System selection and continuity. Namely choosing one of several alternative system solutions available.
   - Object modeling. The system will be modeled into objects and related classes in this section.
2. In the RAD Design Workshop, the author elucidates the process of developing an information system. The current step involves modeling the information system to be developed. UML (Unified Modeling Language) encompasses Use Case Diagrams, Sequence Diagrams, Activity Diagrams, and Class Diagrams, is used to model this system. In this step, the new system design is written and described, and the following tasks are completed:
   - Combines diagrams with features that allow the creation of models, outputs, processes and transactions using specific symbols.
   - Designing database and table requirements.
   - Designing the interface class (Interface) implementation view, which involves converting all previously completed work into an information system that utilizes the Kodular framework and Firebase database.

3. Implementation entails transforming all previously accomplished tasks into an information system that employs the Kodular framework and Firebase database.

Table 1. Stages of RAD Method Development

RAD Stages	Activities	Sub Activities
Planning	Problem Analysis	- Identifying what is happening in the community environment related to community knowledge about rare animal species in Indonesia. - Identifying functional needs and information needs.
	System Requirements Analysis	- Presenting the proposed system alternatives. Software, hardware, and human resource requirements. - System selection and sustainability. That is choosing one of several available system solution alternatives.
Design Workshop	Visual Design	UML (Unified Modeling Language) includes: - Use Case Diagrams - Sequence Diagrams - Activity Diagrams - Class Diagrams
	System Interface Design	Designing the implementation view of the interface class (Interface), which involves converting all previously completed work into an application.
Implementation	System Development	Transform all previously completed tasks into an information system using the Kodular framework and Firebase database.
	System Testing	- Conduct testing of the system that has been built using the black box testing method. - Conduct testing on system users.

2.2 Method Of Collecting Data

The methodology employed by the author to gather the requisite data for this research endeavor is as follows:

1. Observation
   The author made direct observations in the community environment to determine public knowledge regarding rare types of animals in Indonesia.
2. Interview
   The author conducted questions and answers to the public regarding public knowledge regarding rare types of animals in Indonesia and the problems they face.
3. Literature Study
   The author seeks reference materials required for the research process and information system creation, including books, journals, the internet, and other sources.

2.3 Data Source

In this study, the author uses rare animal data sourced from the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.20 / MENLHK / SETJEN / KUM.1 / 6/2018 concerning protected plant and animal species. The number of rare animal data entered into the application is 50 animals.

2.4 Research Tools

In the research process, the author uses the required hardware and software. The following are the devices used in conducting the research, namely:

Hardware

1. Laptop with specifications:
   a. Intel Core I5 vPro 8Th Gen Processor
   b. 8GB Memory
   c. 256 GB Nvme SSD
2. Smartphone with specifications:
   a. Processor Details Snapdragon 6 Gen 4
   b. RAM 12 GB
   c. Memory 256 GB
3. And other supporting hardware

Software

1. Windows 10 Pro Operating System
2. OS Version Android 15
3. Java Programming Language

4. Kodular Application
5. Firebase Database
6. Kodular Companion
7. Google Chrome Browser
8. And other supporting software

3. RESULT AND ANALYSIS

3.1 Planning

Problem Analysis

Some problems that can be identified in the introduction of rare and endangered animals in Indonesia. Most people do not know or are not aware of rare and endangered animals in Indonesia. In addition, digital media that provides informative and interactive information is still very minimal. This results in a lack of public knowledge about rare and endangered animals.

System Requirements Analysis

The solution that can be taken to resolve the problems that occur is to build an Android-based endangered animal recognition information system using the RAD development method. The existence of an information system can help the public obtain information related to endangered animals in Indonesia via Android smartphones.

3.2. Design Workshop

In designing the information systems to be built, the author uses UML diagrams. Unified Modeling Language (UML) is a tool/model for designing object-oriented software development [13]. UML itself also provides standards for writing a blueprint system, which includes business process concepts, writing classes in specific program languages, database schemas, and components needed in software systems [14].

UML is a system design paradigm that facilitates system developers in designing the intended system due to its object-oriented characteristics. Given the current issues, it is essential to develop an information system that optimizes the research process. System design utilizing UML aims to optimize design concerning system functionality and streamline development [15].

Use Case Diagram

A Use Case Diagram is a model that illustrates the interaction between one or more actors and the information system to be developed. In general, use cases are used to find out what functions exist in an information system and who has the right to use those functions [16].

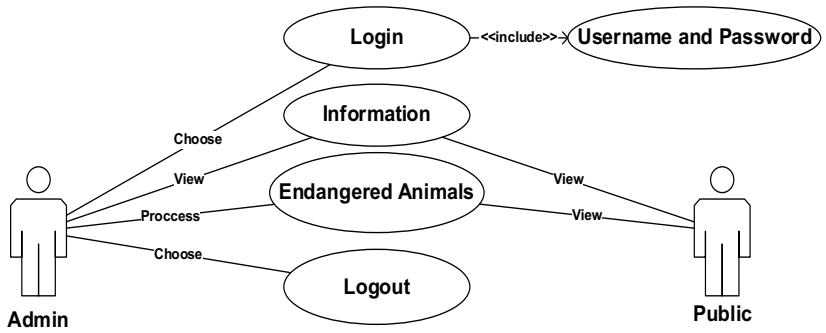

Figure 2. Use Case Diagram

Sequence Diagram

Sequence Diagrams are visual depictions that illustrate interactions among things within a use case. This diagram shows how objects communicate with each other through sending and receiving messages, and displays the sequence of interactions based on time flow. Apart from that, the Sequence Diagram also represents the life cycle (lifespan) of each object, starting from when the object is created until it is no longer used in the process [17].

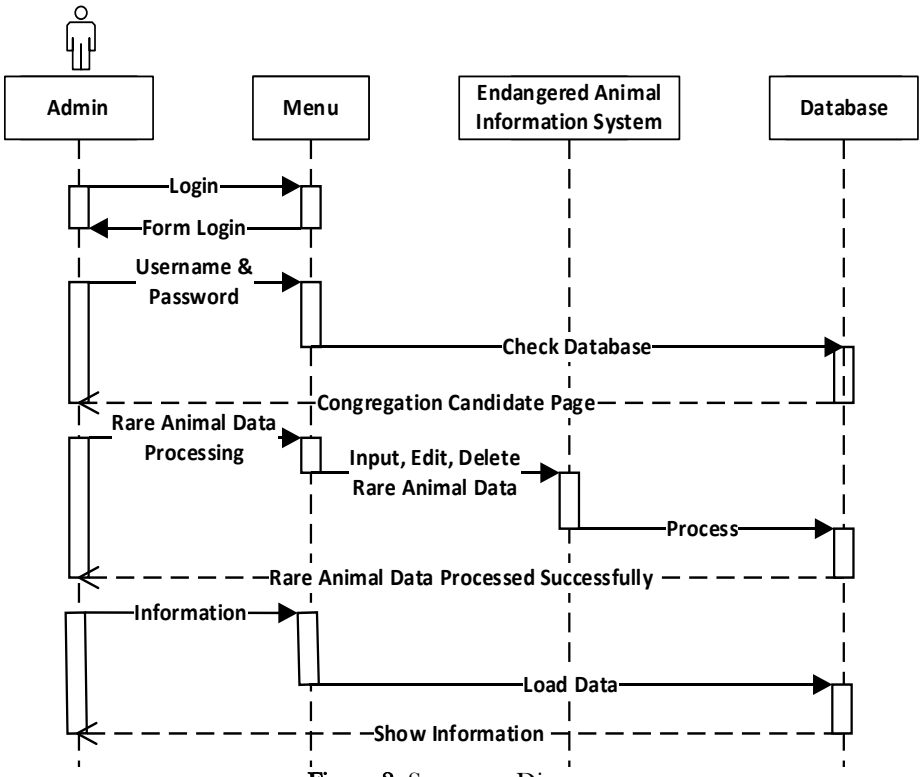

Figure 3. Sequence Diagram

Activity Diagram

An Activity Diagram delineates system activities, focusing on the actions executable by the system rather than those performed by actors. "Activity diagrams describe the workflow or activities of a system or business process or menu in the software." What needs to be noted here is that activity diagrams describe system activities, not what actors do [18].

Activity Diagrams are visual representations used to describe workflows or series of activities in a system, especially in software development. This diagram displays the sequence of activities, decision-making processes, as well as control and data flows that occur in a business process or system functionality [19].

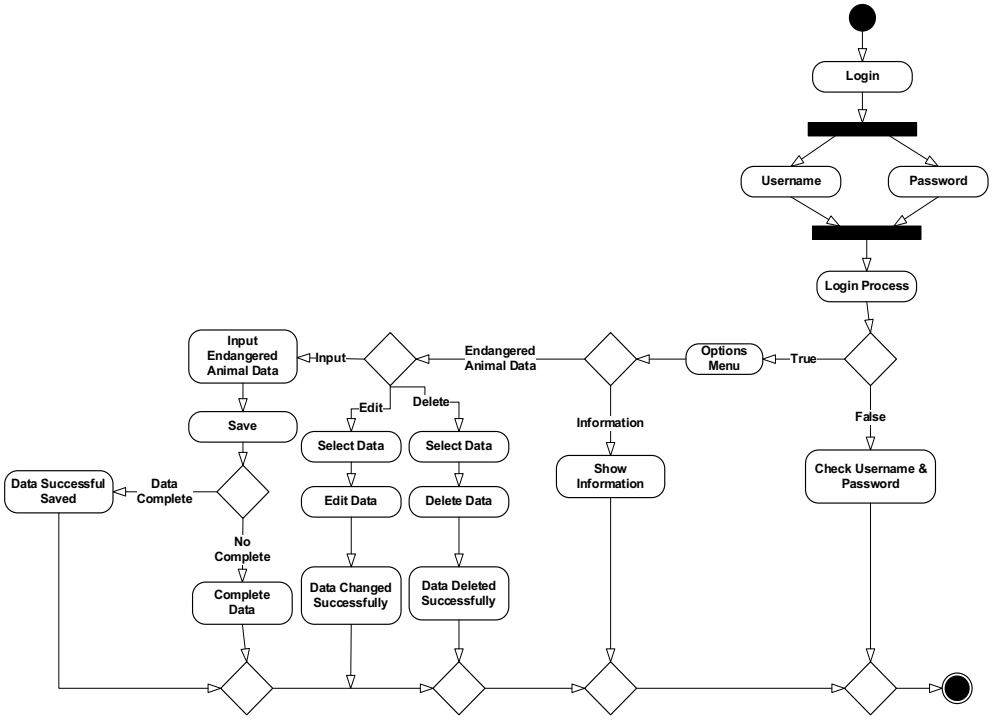

Figure 4. Activity Diagram

Class Diagram

A Class Diagram is a visual representation that shows the structure of a system by defining the classes that will be used in its development. This diagram functions to model relationships between classes, including the attributes (data or properties) and operations (methods or functions) that each class has [20].

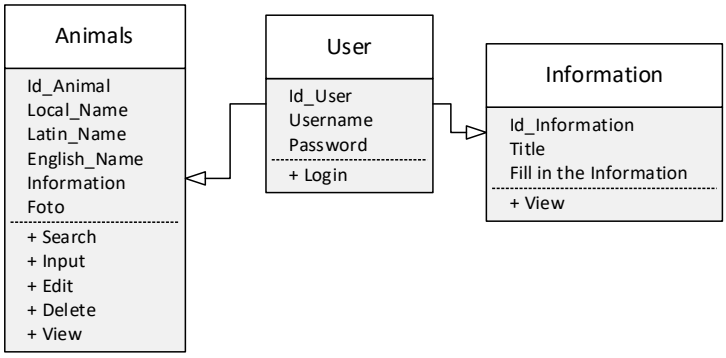

Figure 5. Class Diagram

3.3. Implementation

The process of translating a design based on test results into a specific programming language and deploying a functioning system in an actual environment is known as stepped system implementation [21]. The system is built using Kodular and Firebase database. Kodular interacts with Firebase through available extensions and components. For CRUD (Create, Read, Update, Delete) operations, you can use the Firebase Database or Cloud Firestore components, depending on your project needs. Kodular provides a visual interface for setting up connections to Firebase and performing data operations [22]. Firebase offers several types of features that can be used in application development. The two main types that are often mentioned are Firebase Realtime Database and Cloud Firestore, both of which are cloud-based NoSQL databases. In addition, Firebase also provides other services such as Firebase Authentication, Cloud Messaging, Cloud Storage, and Firebase Hosting, each of which has a specific function in application development [23]. The firebase features used in the endangered animal information system are the firebase realtime database and cloud store. The following is a display of the step animal information system. Firebase is a real-time database that can be accessed online using an internet network. In accessing firebase, users need a stable internet network. An unstable internet network is one of the obstacles in retrieving data on firebase. In addition, the animal data entered into the system is relatively large and equipped with image data types, so it takes relatively more time to enter data. The appearance of the information system consists of displaying a login page, information page, animal list page, and animal data page.

Login Page

The administrator must log in on the login page using a username and password before he can access the animal information system. The page can be shown in Figure 6.

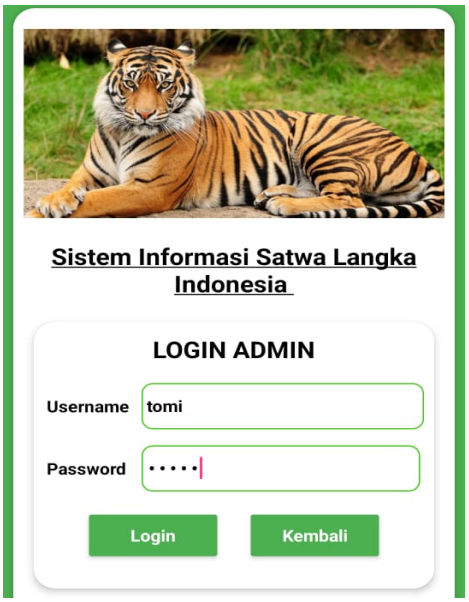

Figure 6. Login Page

Information Page

On this page, users can see available information regarding endangered animals in Indonesia. The page can be shown in Figure 7.

Figure 7. Information Page

Animal List Page

On this page, users can see a list of rare animals that have been processed. The page can be shown in Figure 8.

Figure 8. Animal List Page

Animal Data Page

On this page, admins can add, change and delete data on endangered animals. The page can be shown in Figure 9.

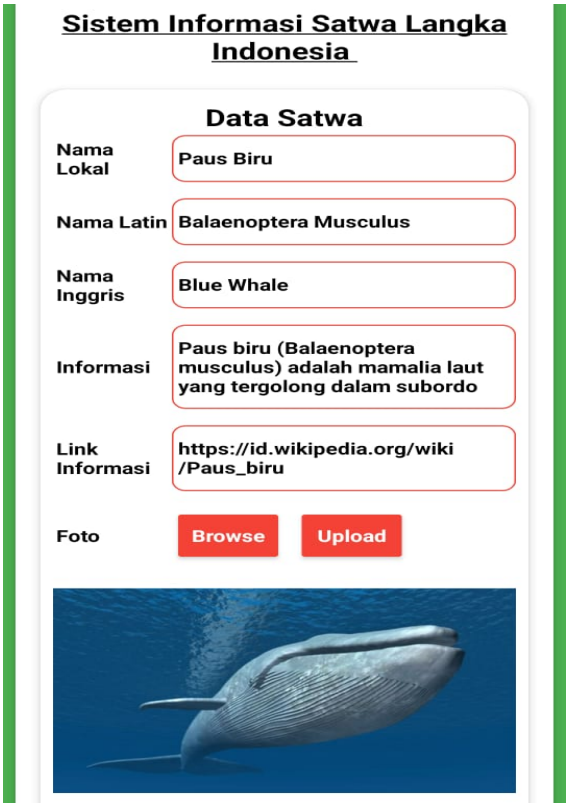

Figure 9. Animal Data Page

Testing

Information system testing is carried out to check the functionality of the information system being developed and look for deficiencies or errors. The black box method was used in testing this research. Black box testing is a type of testing based on information system specifications [24] consisting of the user interface or external display of the program, process performance, input, processing and output produced by the information system, and how to use information system features in the user's environment, followed by validation testing [25]. The black box testing results can be seen in Table 1.

Table 2. Application Testing Table

Testing Module	Testing Procedure	Input	Output	Result	Problem Handling
Login	- Open the information system - Enter the username "tomi" and password "admin" - Click Login	Username "tomi" and password "admin"	Admin can enter the information system	Succeed	-
Login	- Open the information system - Enter the username "xxx" and password "xxx" - Click Login	Username "xxx" and password "xxx"	Login failed, incorrect username or password	Failed	Please double check the username and password you entered.
Animal Data	- Open the information system - Login - Enter complete animal data - Click input	Complete animal data	Animal data added successfully	Succeed	-
Animal Data	- Open the information system - Login	Incomplete animal data	Failed to add animal data	Failed	Complete animal data

	- Clear one of the animal data - Click input				
Animal List	- Open the information system - Select animal list	Animal List Display	Animal list	Succeed	-
Animal List	- Open the information system - Select animal list	Animal List Display	Animal list not showing	Failed	Check internet network

After testing is done, the next step is to create a questionnaire to get the evaluation results of the use of the system that has been built. The questionnaire was given to the community with a sample of 15 people. The questionnaire instrument is related to the Ease of Use of the System, Attractive and Easy to Understand Design, and the System Provides Complete Information with answer choices of very good, good, sufficient and less. The results of the questionnaire can be seen in Figure 10, Figure 11 and Figure 12.

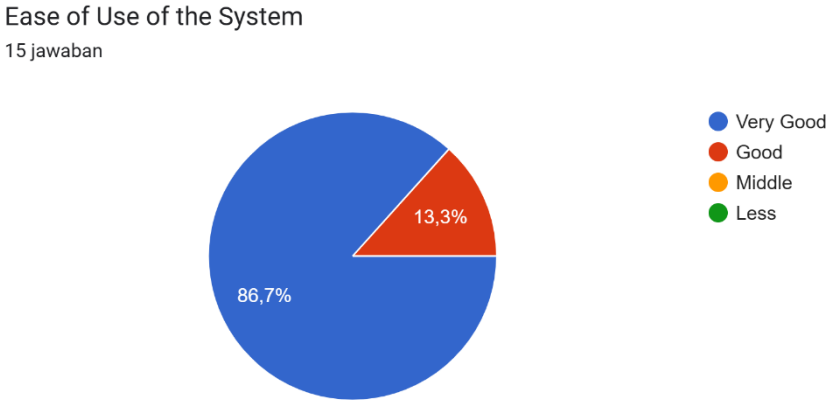

Figure 10. System Usage Survey Results

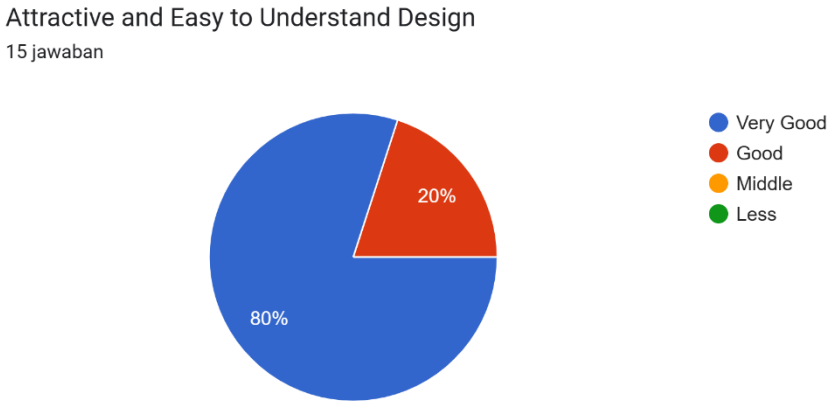

Figure 11. System Design Survey Results

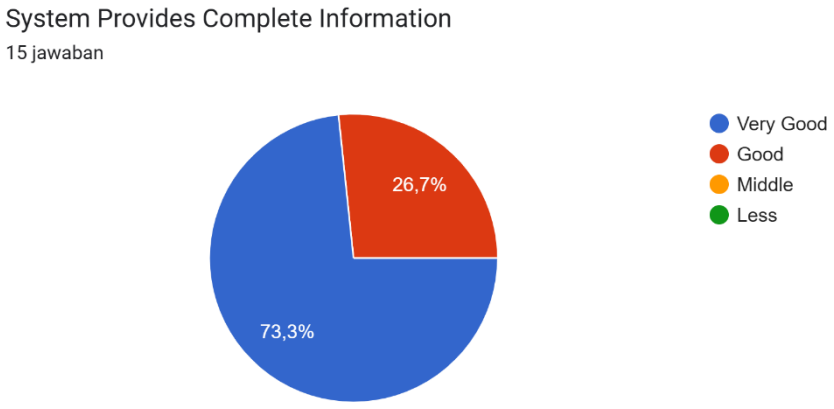

Figure 12. System Benefits Survey Results

Table 3. Survey Results Table

Survey Instruments	Number of Correspondents	Answer Options			
		Very Good	Good	Middle	Less
Ease of Use of the System	15 Correspondents	13 (86,7 %) Correspondents	2 (13,3 %) Correspondents	-	-
Attractive and Easy to Understand Design	15 Correspondents	12 (80,0 %) Correspondents	3 (20,0 %) Correspondents	-	-
System Provides Complete Information	15 Correspondents	11 (73,3 %) Correspondents	4 (26,7 %) Correspondents	-	-

4. CONCLUSION

The conclusion that can be drawn regarding the development of an android-based endangered animal information system that has been built after conducting this research is based on the stages contained in the RAD method. The study of its utilization resulted in an information system that functions well according to user needs. Based on the results of the questionnaire from fifteen respondents who filled out the questionnaire, 86.7% answered very well for ease of use of the system, and 13.3% answered good for ease of use of the system. As many as 80% of respondents answered very well regarding the appearance of the system, and 20% of respondents answered good regarding the appearance of the system. As many as 73.3% of respondents answered that the benefits of the system are very good in displaying information, and as many as 26.7% of respondents answered that the benefits of the system are good in displaying information. So it can be concluded that as many as 80% of respondents answered very well about the system that was built in terms of ease of use, appearance, and benefits for displaying information, so that it can overcome problems that occur related to information and knowledge of endangered animals in Indonesia. In addition, the research that has been conducted can be a reference for further research by developing several features that are not yet available, such as the location of rare animals, the distribution of rare animals and other features that can make it easier for users to search for complex information.

5. REFERENCES

[1] C. Husna, R. Firdaus, E. Wardani, and S. R. Jannah, "Disaster preparedness among disaster management agency officers: a study from rural and urban areas in Aceh, Indonesia," *Int J Disaster Resil Built Environ*, vol. 13, no. 4, pp. 484–497, Aug. 2022, doi: 10.1108/IJDRBE-02-2021-0015.

[2] S. Protschky, "Disaster in Indonesia: Along the Fault Line toward New Approaches," *GeoHumanities*, vol. 7, no. 2, pp. 647–655, 2022, doi: 10.1080/2373566X.2021.1896373.

[3] A. Fadhillah, M. Glorino, R. Pandin, and T. Koesbardiati, "Analyzing Forest and Land Fire Disaster Prevention Programs in Riau, Indonesia," *Qubahan Academic Journal (QAJ)*, vol. Vol.3, no. No.4, 2023, doi: 10.58429/Issn.2709-8206.

[4] W. Wicaksono, I. Desportes, and J. Sopaheluwakan, "Disaster cultures and the Indonesia Tsunami Early Warning System: (mis) alignments revealed by the 2018 non-tectonic tsunami in Labuan," *Australian Journal of Emergency Management*, vol. 39, no. 1, pp. 34–40, 2024, doi: 10.47389/39.1.34.

[5] H. I. Qadriina, H. Herdis, and B. Aryo, "Social capital of disaster-affected communities in post-disaster conditions: A case study of the Cianjur Earthquake, West Java, Indonesia, 2022," *Disaster Advances*, vol. 17, no. 5, pp. 1–8, May 2024, doi: 10.25303/175da0108.

[6] A. Purwanto, Rustam, Eviliyanto, and D. Andrasmoro, "Flood Risk Mapping Using GIS and Multi-Criteria Analysis at Nanga Pinoh West Kalimantan Area," Oct. 13, 2022, *Gadjah Mada University*. doi: 10.22146/IJG.69879.

[7] J. Zhang, "Blended insurance scheme: A synergistic conventional-index insurance mixture," *Insur Math Econ*, vol. 119, pp. 93–105, Nov. 2024, doi: 10.1016/j.insmatheco.2024.08.002.

[8] R. Feng, M. Liu, and N. Zhang, "A unified theory of decentralized insurance," *Insur Math Econ*, vol. 119, pp. 157–178, Nov. 2024, doi: 10.1016/j.insmatheco.2024.08.008.

[9] H. H. A. Aboul Ela, "A Novel Hybrid ANFIS-NARX and NARX-ANN Models to Predict the Profitability of Egyptian Insurance Companies," *Statistics, Optimization and Information Computing*, vol. 12, no. 6, pp. 1934–1955, Nov. 2024, doi: 10.19139/soic-2310-5070-2104.

[10] S. Sukono *et al.*, "Determination of the natural disaster insurance premiums by considering the mitigation fund reserve decisions: An application of collective risk model," *Decision Science Letters*, pp. 211–222, 2022, doi: 10.5267/j.dsl.2022.4.002.

[11] M. Feofilovs, A. J. Pagano, E. Vannucci, M. Spiotta, and F. Romagnoli, "Climate Change-Related Disaster Risk Mitigation through Innovative Insurance Mechanism: A System Dynamics Model Application for a Case Study in Latvia," *Risks*, vol. 12, no. 3, Mar. 2024, doi: 10.3390/risks12030043.

[12] J. M. Mol, W. J. W. Botzen, and J. E. Blasch, "Risk reduction in compulsory disaster insurance: Experimental evidence on moral hazard and financial incentives," *Journal of Behavioral and Experimental Economics*, vol. 84, Feb. 2020, doi: 10.1016/j.socec.2019.101500.

[13] K. Ohori, "Ruin probability on storm and flood disaster risk finance in multiple railway businesses," *Journal of Japan Society of Civil Engineers*, vol. 7, no. 1, pp. 150–165, 2019, doi: 10.2208/JOURNALOFJSCE.7.1_150.

[14] Kalfin, Sukono, S. Supian, and M. Mamat, "Model for Determining Insurance Premiums Taking into Account the Rate of Economic Growth and Cross-Subsidies in Providing Natural Disaster Management Funds in Indonesia," *Sustainability (Switzerland)*, vol. 15, no. 24, Dec. 2023, doi: 10.3390/su152416655.

[15] A. Pothon, P. Gueguen, S. Buisine, and P.-Y. Bard, "California earthquake insurance unpopularity: The issue is the price, not the risk perception," *Natural Hazards and Earth System Sciences*, vol. 19, no. 8, pp. 1909–1924, 2019, doi: 10.5194/nhess-19-1909-2019.

[16] S. Ma and J. Jiang, "Discrete dynamical Pareto optimization model in the risk portfolio for natural disaster insurance in China," *Natural Hazards*, vol. 90, no. 1, pp. 445–460, 2018, doi: 10.1007/s11069-017-3053-6.

[17] H. Reed, "Actuarial Ruin Theory," 2022. United States: University of Puget Sound.

[18] I. Hamidah, Sriyono, and Hudha Muhammad Nur, "A Bibliometric Analysis of Covid-19 Research Using Vosviewer," *Indonesian Journal of Science & Technology*, vol. 5, no. 2, pp. 209–216, 2020.

[19] A. Thakuria and I. Chakraborty, "A Bibliometric review on Information Seeking Behaviour research literature in Library and Information Science using HistCite and VOSviewer," 2021. [Online]. Available: https://digitalcommons.unl.edu/libphilprac

[20] S. H. H. Shah, S. Lei, M. Ali, D. Doronin, and S. T. Hussain, "Prosumption: bibliometric analysis using HistCite and VOSviewer," *Kybernetes*, vol. 49, no. 3, pp. 1020–1045, Feb. 2020, doi: 10.1108/K-12-2018-0696.

[21] M. Dubyna, O. Popelo, N. Kholiavko, A. Zhavoronok, M. Fedyshyn, and I. Yakushko, "Mapping the Literature on Financial Behavior: a Bibliometric Analysis Using the VOSviewer Program WSEAS TRANSACTIONS on BUSINESS and ECONOMICS," *Wseas Transactions on Business and Econimic*, vol. Volume 19, 2022.

[22] B. V. Nurdin, S. S. Hutagalung, Yulianto, R. C. Kurniawan, and D. Hermawan, "Bibliometric Analysis on Governance Index Topics Using Scopus Database and Vosviewer," in *Journal of Physics: Conference Series*, IOP Publishing Ltd, Jun. 2021. doi: 10.1088/1742-6596/1933/1/012047.
[23] S. Yayu Ninglasari, "Mapping the Cash Waqf Literature Based on Web of Science and VOSviewer: A Bibliometric and Visualization," 2021. [Online]. Available: https://digitalcommons.unl.edu/libphilprac
[24] H. Soegoto, E. S. Soegoto, S. Luckyardi, and A. A. Rafdhi, "A Bibliometric Analysis of Management Bioenergy Research Using Vosviewer Application E I N F O Soegoto et al., A Bibliometric Analysis of Management Bioenergy Research Using... | 90," *Indonesian Journal of Science & Technology*, vol. 7, no. 1, pp. 89–104, 2022, doi: 10.17509/ijost.v7i1.
[25] A. Kirby, "Exploratory Bibliometrics: Using VOSviewer as a Preliminary Research Tool," *Publications*, vol. 11, no. 1, Mar. 2023, doi: 10.3390/publications11010010.
[26] D. Moher, A. Liberati, J. Tetzlaff, and D. G. Altman, "Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement," *International Journal of Surgery*, vol. 8, no. 5, pp. 336–341, 2010, doi: 10.1016/j.ijsu.2010.02.007.
[27] E. Stovold, D. Beecher, R. Foxlee, and A. Noel-Storr, "Study flow diagrams in Cochrane systematic review updates: An adapted PRISMA flow diagram," 2014, *BioMed Central Ltd.* doi: 10.1186/2046-4053-3-54.
[28] F. Firdaniza, B. N. Ruchjana, D. Chaerani, and J. Radianti, "Information Diffusion Model in Twitter: A Systematic Literature Review," *Information (Switzerland)*, vol. 13, no. 1, Jan. 2022, doi: 10.3390/info13010013.
[29] M. J. Page *et al.*, "The PRISMA 2020 statement: An updated guideline for reporting systematic reviews," Mar. 29, 2021, *BMJ Publishing Group*. doi: 10.1136/bmj.n71.
[30] O. Ellegaard and J. A. Wallin, "The bibliometric analysis of scholarly production: How great is the impact?," *Scientometrics*, vol. 105, no. 3, pp. 1809–1831, Dec. 2015, doi: 10.1007/s11192-015-1645-z.
[31] N. Jan van Eck and L. Waltman, "VOSviewer Manual version 1.6. 15," 2020. Universiteit Leinden.
[32] Riaman, Sukono, S. Supian, and N. Ismail, "Mapping in the Topic of Mathematical Model in Paddy Agricultural Insurance Based on Bibliometric Analysis: A Systematic Review Approach," Apr. 01, 2022, *MDPI*. doi: 10.3390/computation10040050.
[33] T. Purwandari, Y. Hidayat, and R. A. Ibrahim, "Development of the Black–Scholes Model for Determining Insurance Premiums to Mitigate the Risk of Disaster Losses Using the Principles of Mutual Cooperation and Regional Economic Growth," *Risks*, vol. 12, no. 7, 2024, doi: 10.3390/risks12070110.
[34] Z. Bleemer and W. van der Klaauw, "Long-run net distributionary effects of federal disaster insurance: The case of Hurricane Katrina," *J Urban Econ*, vol. 110, pp. 70–88, Mar. 2019, doi: 10.1016/j.jue.2019.01.005.
[35] A. Bhattacharyya and M. Hastak, "Empirical causal analysis of flood risk factors on U.S. flood insurance payouts: Implications for solvency and risk reduction," *J Environ Manage*, vol. 352, 2024, doi: 10.1016/j.jenvman.2024.120075.
[36] K. French and C. Kousky, "The effect of disaster insurance on community resilience: a research agenda for local policy," *Climate Policy*, vol. 23, no. 5, pp. 662–670, 2023, doi: 10.1080/14693062.2023.2170313.
[37] A. Duqi, D. McGowan, E. Onali, and G. Torluccio, "Natural disasters and economic growth: The role of banking market structure," *Journal of Corporate Finance*, vol. 71, 2021, doi: 10.1016/j.jcorpfin.2021.102101.
[38] Z. Bleemer and W. van der Klaauw, "Long-run net distributionary effects of federal disaster insurance: The case of Hurricane Katrina," *J Urban Econ*, vol. 110, pp. 70–88, 2019, doi: https://doi.org/10.1016/j.jue.2019.01.005.