Design of LAPAN-A2 Satellite Telemetry Data Information System Using SDLC

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Abstract—After several years of launch, the LAPAN-A2 satellite has produced a huge amount of telemetry data consisting of information on the status of the satellite's condition during orbit. The telemetry generated by the satellite is in the form of real-time telemetry and long-time telemetry. So far, telemetry data is only stored in a folder with a unique name. This method tends to be manual and makes it easier for users to analyze satellite conditions. This system was developed using the System Development Life Cycle (SDLC) approach, wherein the development process has five stages, namely planning, analysis, design, implementation, and testing. This paper will describe the design of a web-based satellite telemetry information system. The system has been tested using structural, functional, and usability tests. The evaluation results show that this information system is affordable and accepted well. The usability test results show that the LAPAN-A2 satellite, telemetry data information system, has met usability needs very well. Respondents have successfully carried out many experiments. In this case, operators and satellite analysis, with a question value of 86.22%, can be answered and 13.77% unable to be answered.

Keywords—Satellite; LAPAN-A2; Telemetry; SDLC; Ground Station

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I. INTRODUCTION

The LAPAN A2 satellite is the second microsatellite made by LAPAN, which has a research mission for surveillance and monitoring. LAPAN-A2 was launched on September 28, 2015, in a NEQO (Near Equatorial Orbit) orbit with an altitude of 650 km. An inclination is about 8º, and a period = 98 minutes. This satellite carries a matrix camera primary sensor which produces 12-bit RGB images measuring 2048 x 2048 pixels or 7km x 7km and has a spatial resolution of 5m. LAPAN A2 also carries AIS (Automatic Identification System) sensors for ship identification and radio amateurs.

Telemetry data on satellites is satellite data that contains thousands of satellite conditions in the form of temperature, the current system, battery voltage, position and speed, camera conditions, solar cell direction, etc. The sensor data loaded on the LAPAN Satellite is received by the earth station when the earth station sends a command to the satellite crossing its coverage area.

The research [1] perform catalog design, design, and build a web-based real-time LAPAN satellite image database system. This catalog database system will allow users throughout Indonesia to directly access and download LAPAN satellite imagery data. Research [2] explains the design of the web-based LAPAN image search engine system. The search engine system developed will make it easier for users in Indonesia and worldwide to access and download satellite image data generated directly from the LAPAN-A2 and LAPAN-A3 satellites. Research [3] describes responsive design's design ideas and core technologies. Responsive web design based on HTML5 and CSS3 has proven practical and effective. Research [4] describes how to involve users to develop interfaces directly. The method used in this study is a user-centered design (UCD).

The research [5] describes the design of an integrated information system for web-based lecturer workloads. REST (Representational State Transfer) service technology is used to exchange data for creating an interoperable system in designing this information system. This design is based on a functional model UML style. This paper [6] describes the design of database storage media, web-based data search, which has three functions: searching data by location name, date range of data collection, and searching for image data based on product type (image data). Camera from LAPAN-A2 or camera image data from LAPAN-A3). In making a web-based population management information system, the SDLC (Software Development Life Cycle) design technique and MySQL are used for the database [7].

The research [8] has developed a natural disaster information system. It helps the public find information on disaster mitigation policies, news and mitigation events, disaster reporting, and

investigation services. This system was also developed using the PHP, HTML, CSS, and Javascript programming languages. Research [9] has developed a new industrial area determination system in a web-based application commonly called a web-based GIS. The application prototype can facilitate planning to determine new industrial areas based on six parameters through the analytical hierarchy process method. Research [10] discusses the design and implementation of an informatics journal information system using the prototype method and uniform modeling language. Research[11] carried out the design and implementation of the Geo Image Hub system. A web-based application was deployed on the ECS Cloud running the algorithm.

Web selection is required for organizational needs, and the web is currently considered a standard platform for launching various services on the web [12]. Employee data web design has also been carried out [13] using PHP and Mysql as the database. The technology choice solution uses the example of a web-based platform developed by the Russian Academy of Education. This platform provides informational support for psychologists' activities in their research [14]. An e-commerce service information system has been developed [15]. This prototype concept requires a method for website development. The technique used is the waterfall. Website design using the Hypertext PreProcessor (PHP) programming language and MySQL database

The command software to the LAPAN satellite is currently not integrated with the database. So that the output obtained is in the form of files with .log and .txt extensions, this is quite difficult for analysts to read and analyze the telemetry data. In addition, it has not been integrated with the database, so the data organization is less efficient because the telemetry data files are still placed in folders. The problem is that the large amount of telemetry data acquired from the satellite daily will be challenging to analyze because it is still stored in a folder. Along with the increase in telemetry, a method is needed to make it easier to find the satellite health analysis required.

Based on the problems above, the solution for searching for satellite image data will be a prototype web-based LAPAN-A2 satellite telemetry data information system prototype designed. Aside from being a storage medium, a web-based system will make it easier for Centers for Research and Technology operators to conduct satellite health analysis more accurately and optimally.

II. RESEARCH METHOD

The method used in this research is the SDLC (System Development Life Cycle) method [16]. The stages of the study are presented in Figure 1.
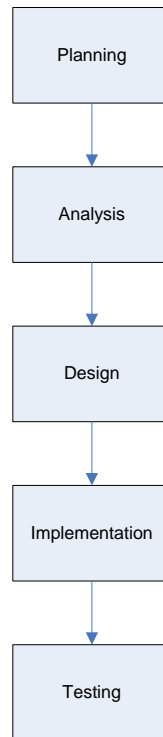
Figure 1. RESEARCH METHOD

A. Planning Stage

At this stage, the problem is defined and searched for data related to the Telemetry Data Information System for LAPAN-A2 at the Satellite Technology Center - LAPAN and looking for solutions that can solve these problems.

B. Analysis Stage

This analysis stage is used to analyse and identify problems from the LAPAN-A2 Telemetry data that has been obtained from the LAPAN Satellite Technology Center, which is ready to be processed into a database at the design stage.

C. Design Stage

The design stage is carried out in three stages, namely:

1. General System Design: Overall system design in this study was carried out using Context Diagrams, Data Flow Diagrams (DFD), system flowcharts, navigation structures, and subsequent system displays

2. Detailed System Design: Designing the forms needed to carry out a system to be

developed.

D. Implementation Stage

Implementation is the implementation stage of the designs that have been made previously. Implementation aims to produce an information system that is needed. The stage that is completed is implementing the database along with the tables that are required by the system. The database system used is MySQL and programming language used is PHP-based Code Igniter.

E. Testing Stage

Testing is done by using usability testing. This testing is an application software evaluation activity to determine how well users can use the interface when interacting with the system.

## III. RESULT AND DISCUSSION

A. Ongoing System Analysis

The analysis of the current system serves to determine the running flow after identifying the current system; the satellite operator said that the system is still managed manually by only putting files into a folder on the PC. If anyone wants to see the data, they have to look at the operator's PC and admins. The following is the analysis of the current system in Figure 2.
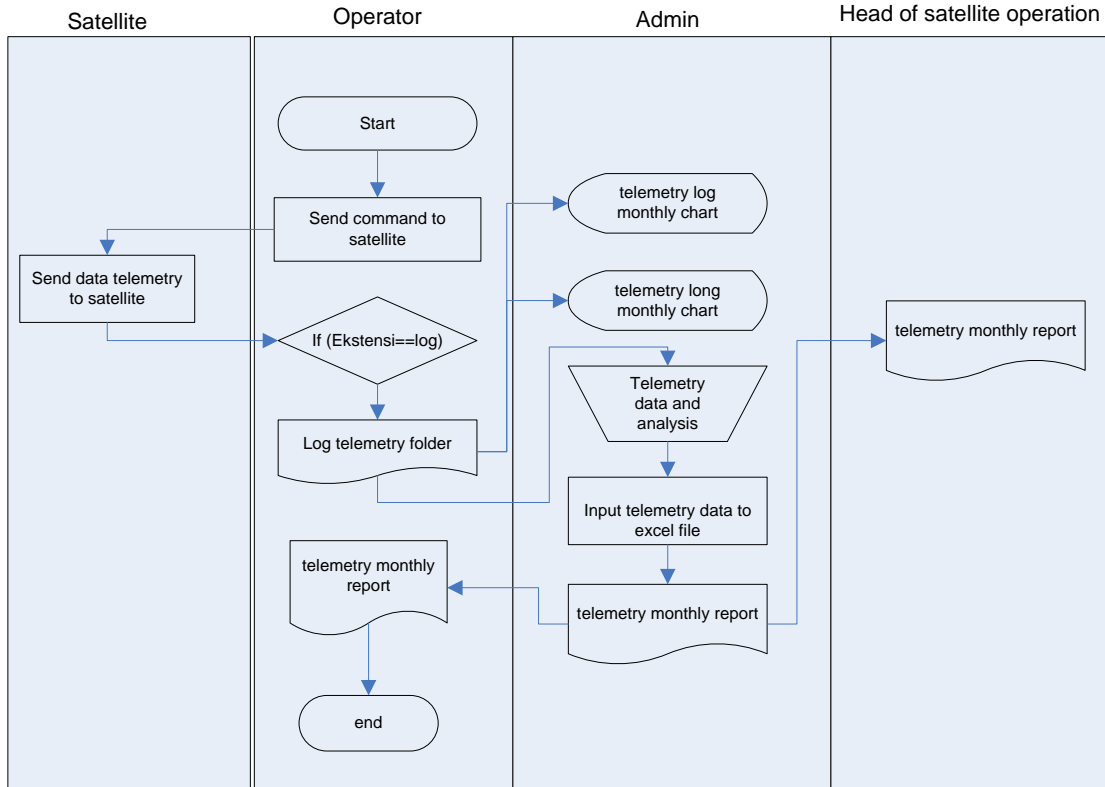
Figure 2. SYSTEM ON-GOING

B. Analysis of the Developed System

In the system analysis to be developed, several changes are made in the data acquisition process, which can be accommodated in the database, making it easier to search for data and be accessed anywhere. The following is the analysis of the system that will be developed in Figure 3.
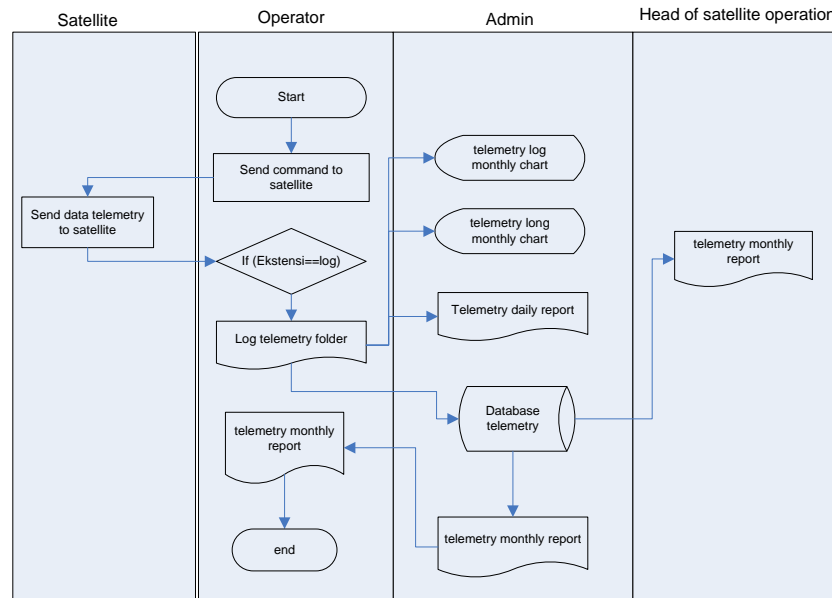
Figure 3. DEVELOPED SYSTEM

C. Design Stage

The design phase focuses on designing a web information system design that will be developed. The format must be easily accessible by the admin and web users. The stages in the system's design are the design of Data Flow Diagrams (DFD) and architectural designs. The DFD design describes the system data flow used on the LAPAN-A2 satellite telemetry data web. The DFD design is divided into context diagrams presented in Figure 4.
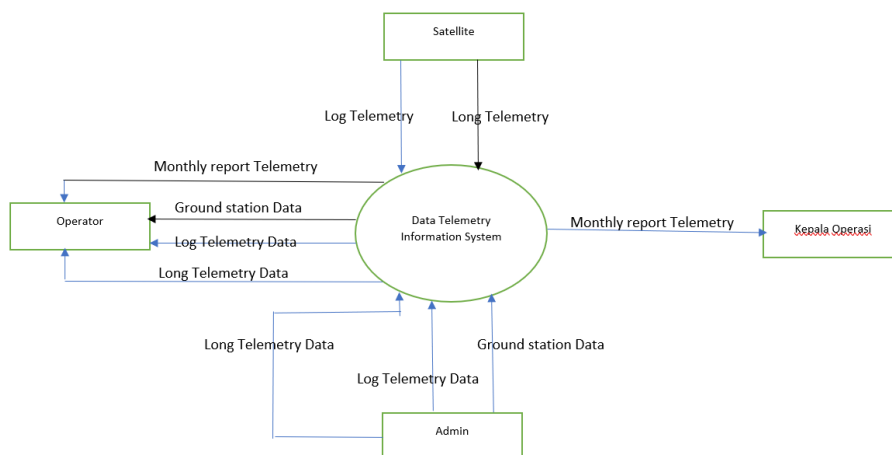

Figure 4. CONTEXT DIAGRAM

The next stage is architectural design in designing menu forms displayed on this information system. The design consists of a form design for the front end for the user side and the backend for the admin side. The form design consists of an earth station menu display design, a long telemetry data menu, and a log menu. The display design of the form is presented in Figure 5.

Figure 5. FORM DESIGN

In addition to the form design menu on the front end, the form design on the backend side is also carried out. The design consists of a dashboard that the admin will use to upload data displayed on this information system. The main admin menu form design is presented in Figure 6.
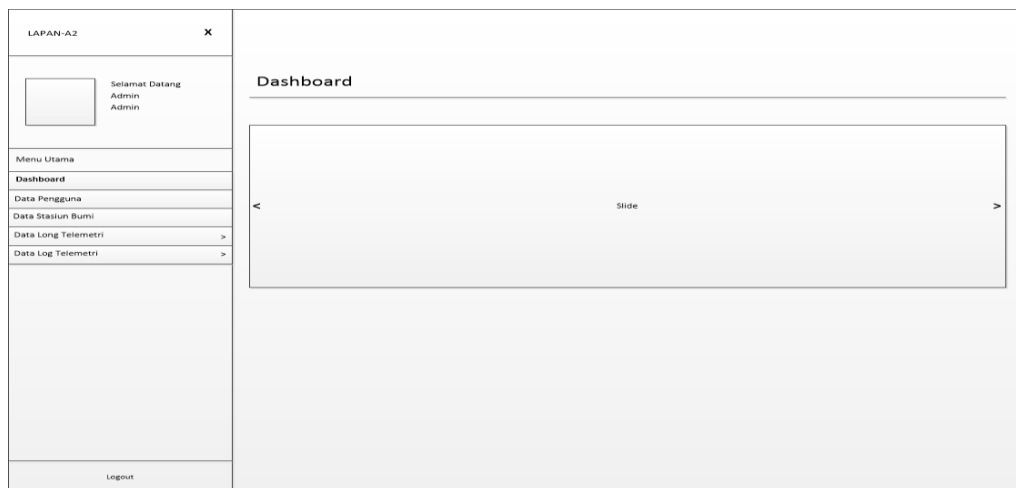
Figure 6. ADMIN FORM DESIGN

D. Implementation System

The implementation stage combines all objects in the design stage into code form in the PHP and MySQL programming languages. Implementation of database creation is presented in Figure 7.
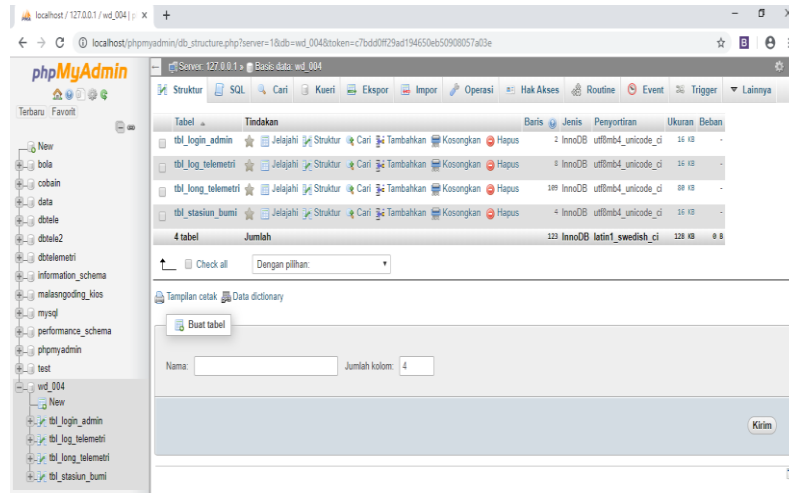

Figure 7. DATABASE IMPLEMENTATION

The main page starts when the user opens the satellite telemetry system. There is a search facility for earth station data, telemetry log data, and long telemetry data on this page. The main page display can be seen in Figure 8.

Figure 8. SYSTEM HIGHLIGHTS

The View Long Telemetry Data page can view long telemetry data from the selected long telemetry file. On this page, there is a description of many records in one file, and a menu returns to the long telemetry data page. This page displays a 24-hour history of satellite operations

described in date form. Long telemetry or LTT data is presented based on the pick-up location at the earth station that has been listed in the options. This information is essential to display to find out the history of the satellite when it is operating in orbit. The long telemetry data display is presented in Figure 9.

Figure 9. PAGE DISPLAY LONG TELEMETRY

Furthermore, after the LTT data, telemetry log data is presented to determine the value of the satellite component parameters in real-time. The data displayed is telemetry data obtained from each earth station that acquires the LAPAN-A2 satellite directly from each satellite operator at each earth station. The information displayed is in the form of parameter values from the sensors in the LAPAN-A2 satellite. The telemetry log data display is presented in Figure 10.

Figure 10. TELEMETRY DATA PAGE DISPLAY

Furthermore, this information system displays data on earth stations that acquired the LAPAN-A2 satellite. 4 earth stations have reached the Rancabungur earth station in Bogor, the Kototabang earth station in Agam Pare-Pare earth station, and the Biak earth station. Earth station data display is presented in Figure 11.

Figure 11. EARTH STATION PAGE DISPLAY
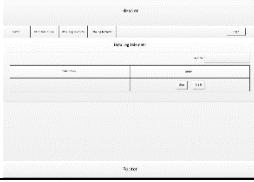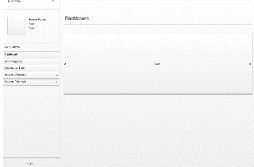
E. Testing

This structural test was carried out in 3 ways, namely structural and functional trials, to ascertain whether the program's state was correctly structured as expected. This test aims to obtain the desired results. If an error occurs or the results obtained are not as desired, the process will return. The results of the structural test are presented in Table 1.

Table 1. STRUCTURAL TESTING

No	*Main Page*	*Design*	*Implementation*	*Result*
1	Home Menu			In Accordance
2.	Ground station menu			In Accordance
3.	Long Telemetry Data			In Accordance

Table 1. STRUCTURAL TESTING [CONTINUE]

No	Main Page	Design	Implementation	Result
4.	Log Telemetry Data			In Accordance
5.	Dashboard Menu			In Accordance

After the structural test is carried out, this test will be carried out functionally. Functional testing is a test that aims to determine whether the menu that has been implemented is running well. The results of practical trials can be seen in Table 2

Table 2. FUNCTIONAL TESTING

No	Page	Function	Testing	Result
1	Admin Login	Command Login	Enter username and password, then click login. If it is valid, enter the admin home page; if it is not valid, a wrong notification will appear and repeat the login.	working
2.	User Data	Command button add, edit, and delete	Click add or edit to enter the data as filled in by the admin, and delete it if it is not needed again.	working
3.	Ground station Data	Command button add, edit, and delete	Click add or edit to enter the data as filled in by the admin, and delete it if it is not needed again.	working
4.	Long Telemetry Data	Dropdown, Add Button, View Data, View Graph, Print, Delete	Click the dropdown, then select the Earth station you aim for; the admin can add data, view data, view graphs, print graphs, and delete the desired data.	working
5.	Log telemetry data	Dropdown, Add Button, View Data, View Graph, Print, Delete	Click the dropdown, then select the Earth station you aim for; the admin can add data, view data, view graphs, print graphs, and delete the desired data.	working

In addition to the above trials, usability testing was also carried out to identify usability problems affecting the system's interaction with users on website design results. Research [17] conducted usability testing with five aspects of usability. The evaluators who become the population or object of study in this test are operators and satellite analysis. The questionnaire

was given consisting of 18 questions. Questions adequately represent the five aspects of usability. Respondents filled out questionnaires distributed based on their experiences when performing tasks. After spreading the questionnaires given to the respondents, the next step is to calculate the results of the quantitative table on the questionnaire on the usability test to measure the use of this telemetry information system website.

Based on the resulting analysis, the researchers made recommendations not found in website repairs rated from 3 from the operator team and analyzed at different levels, especially usability. For Learnability, the score is 100%, Efficiency is 77.77%, Memorability is 66.66%, the error rate is 100%, and Satisfaction is 86.66%. Meanwhile, the tasks operators and satellite analysis cannot complete; namely, Learnability is 0%, then Efficiency is 22.22%, Memorability is 33.33%, the error rate is 0%, and Satisfaction is 13.33%. So, the percentage of all tasks that can be done by operators and satellite analysis from every aspect is 86.22%, and the questions that respondents cannot complete are 13.78%.

IV. CONCLUSION

The research succeeded in designing the LAPAN-A2 satellite telemetry data information system. The system built can be easier to understand, comfortable when used, and according to user needs. The system has been tested using structural, functional, and usability tests. The evaluation results show that the information system is well understood and accepted by users quite well. The usability testing results show that the LAPAN-A2 satellite telemetry data information system has met the usability needs very well. Respondents have successfully carried out many experiments, in this case, operators and satellite analysis, with a score of 86.22% of the questions able to be answered and 13.78% of the questions answered cannot be answered. Suggestions in this research in the future can upload telemetry data automatically into the system, this information system can be developed into a mobile version, and testing is carried out using other usability and different UX testing methods to get a comparison of the results of these tests.

REFERENCES

[1]   A. Herawan and S. Salaswati, "Perancangan Basis Data Katalog Citra Satelit LAPAN," J. Inform., vol. 5, no. 2, 2018, doi: 10.31311/ji.v5i2.4029.

[2]   A. Herawan, P. R. Hakim, and B. S. Pamadi, "Perangkat Lunak Search Engine Citra Satelit LAPAN-A2 dan LAPAN-A3," J. Edukasi dan Penelit. Inform., vol. 6, no. 2, 2020, doi: 10.26418/jp.v6i2.34421.

[3]   N. Li and B. Zhang, "The design and implementation of responsive web page based on HTML5 and CSS3," 2019, doi: 10.1109/MLBDBI48998.2019.00084.

[4]   D. L. Kaligis and R. R. Fatri, "PENGEMBANGAN TAMPILAN ANTARMUKA APLIKASI SURVEI BERBASIS WEB DENGAN METODE USER CENTERED

DESIGN," JUST IT J. Sist. Informasi, Teknol. Inf. dan Komput., vol. 10, no. 2, 2020, doi: 10.24853/justit.10.2.106-114.

[5] K. D. L. Samgraha, G. A. Pradnyana, and I. M. Putrama, "Sistem Informasi Terintegrasi Penilaian Beban Kerja Dosen Berbasis Web," Int. J. Nat. Sci. Eng., vol. 3, no. 1, 2019, doi: 10.23887/ijnse.v3i1.22173.

[6] R. Kurniawan, A. Herawan, P. Rianto, and B. S. Pamadi, "Software design to search data images of satellites LAPAN-A2/Orari and LAPAN-A3/IPB," 2019, p. 136, doi: 10.1117/12.2542094.

[7] M. F. ZULKARNAEN, L. L. Putri, and H. Asyari, "SISTEM INFORMASI ADMINISTRASI KEPENDUDUKAN KELURAHAN REMBIGE BERBASIS WEB," J. Manaj. Inform. dan Sist. Inf., vol. 2, no. 1, 2019, doi: 10.36595/misi.v2i1.82.

[8] F. Muhammad, A. Hadi, and D. Irfan, "PENGEMBANGAN SISTEM INFORMASI PANDUAN MITIGASI BENCANA ALAM PROVINSI SUMATERA BARAT BERBASIS ANDROID," J. Teknol. Inf. dan Pendidik., vol. 11, no. 1, 2018, doi: 10.24036/tip.v11i1.93.

[9] E. Chumaidiyah, M. D. R. Dewantoro, and A. A. Kamil, "Design of a Participatory Web-Based Geographic Information System for Determining Industrial Zones," Appl. Comput. Intell. Soft Comput., vol. 2021, 2021, doi: 10.1155/2021/6665959.

[10] B. E. Sutrisna and A. E. Karyawati, "A Design of Web-Based Informatics Journal Information System," JELIKU (Jurnal Elektron. Ilmu Komput. Udayana), vol. 9, no. 4, 2021, doi: 10.24843/jlk.2021.v09.i04.p15.

[11] W. Wan, Z. Yang, X. Du, and X. Zhao, "Space Make the Virtual a Reality: A Web-Based Platform for Visualization and Analysis with Earth Observation Satellite Data," in International Conference on Virtual Rehabilitation, ICVR, 2021, vol. 2021-May, doi: 10.1109/ICVR51878.2021.9483848.

[12] A. W. Marashdih, Z. F. Zaaba, K. Suwais, and N. A. Mohd, "Web application security: An investigation on static analysis with other algorithms to detect cross-site scripting," in Procedia Computer Science, 2019, vol. 161, doi: 10.1016/j.procs.2019.11.230.

[13] A. Ismail, F. Sumarsono, Nuryana, and T. Kurniawan, "Perancangan Website Data Karyawan Dengan menggunakan PHP dan MYSQL," J. Sist. basis data, no. January, 2019.

[14] E. Nikulchev, D. Ilin, P. Kolyasnikov, V. Belov, I. Zakharov, and S. Malykh, "Programming technologies for the development of web-based platform for digital psychological tools," Int. J. Adv. Comput. Sci. Appl., vol. 9, no. 8, 2018, doi: 10.14569/ijacsa.2018.090806.

[15] A. T. Hidayat, A. M. D. Dewantara, and S. Saifullah, "The Development of Website on Management Information System for E-commerce and Services," J. Sisfokom (Sistem Inf. dan Komputer), vol. 9, no. 3, 2020, doi: 10.32736/sisfokom.v9i3.992.

[16] Y. Wahyudin and D. N. Rahayu, "Analisis Metode Pengembangan Sistem Informasi Berbasis Website: A Literatur Review," J. Interkom J. Publ. Ilm. Bid. Teknol. Inf. dan Komun., vol. 15, no. 3, 2020, doi: 10.35969/interkom.v15i3.74.

[17] E. Saputra, Z. Mazalisa, and R. Andryani, "Usability Testing Untuk Mengukur Penggunaan Website Inspektorat Kota Palembang," J. Tek. Inform., no. 12, 2014.