Implementation of Agile Methods in GIS Web Applications for Land Suitability Selection

by Taufiq Rizaldi

Submission date: 21-Nov-2023 02:13PM (UTC+0700)
Submission ID: 2235030538
File name: The_6th_ICoFA_camera-ready_22.docx (470.74K)
Word count: 3654
Character count: 20379

Implementation of Agile Methods in GIS Web Applications for Land Suitability Selection

Taufiq Rizaldi[1], Hermawan Arief Putranto[2], Arvita Agus Kurniasari[3]

Politeknik Negeri Jember[1,2,3]

taufiq_r@polije.ac.id[1], hermawan_arief@polije.ac.id[2], arvita@polije.ac.id[3]

Abstract. Perusahaan Daerah Perkebunan (PDP) Kahyangan is a Regional Owned Enterprise (BUMD) in Jember Regency which was formed in order to manage plantation commodities in 3 Main Plantations and 2 Subdivision Plantations. PDP's profit contribution to Jember's PAD (Pendapatan Asli Daerah) has continued to decline in recent years. With a target of PAD from plantation products in 2020 of 20 million rupiah, only 20% can be realized (4 million rupiah). Based on the 2023 PDP Kahyangan Jember Strategic Plan, one of the problems causing the opinion deficit is external factors. One of them is the suitability between the potential of the plants planted and the land conditions in a plantation area. Where land suitability, which is the carrying capacity of the land, has a significant effect on crop production. Based on the problems that have been presented, it is necessary to design a GIS-based Decision Support System (DSS), which can provide insight to researchers, practitioners and policy makers regarding the success of managing GIS data for the land suitability evaluation process so that it can increase agricultural productivity. Several stages that will be carried out include data collection, data preparation, and data processing carried out in GIS, then continued with implementation of Decision Support System. The used of agile methods to the application development process ensures that the application is built in a shorter time through the use of continuous iteration and testing thereby ensuring that the DSS implementation in the Web GIS application can run optimally.

1. Introduction

Indonesia is a country that is able to produce various types of food, horticultural and plantation crop varieties. The problems that arise depend on the planting location in the area. Land conversion, difficulty in expanding land, controlling population growth, and prolonged uncertainty of seasons and weather are some of the problems faced in the agricultural sector [1]. Land suitability analysis is one of the solutions carried out so that plant management on a land becomes effective. The Kahyangan Regional Plantation Company (PDP) is a Regional Owned Enterprise (BUMD) in Jember Regency which was formed in order to manage plantation commodities in 3 Main Plantations and 2 Subdivision Plantations. PDP's profit contribution to Jember's PAD has continued to decline in recent years with the PAD target from plantation products in 2020 amounting to 20 million rupiah and the realization only amounting to 20%, namely 4 million rupiah [2], One of the problems that causes an opinion deficit is external factors, one of which is the suitability of the potential of the plants planted to the existing land conditions in a plantation area, where the suitability of the land, which is the carrying capacity of the land, has a significant effect on crop production. The use of Geographic Information Systems (GIS) can be applied as a solution to evaluate the suitability of land for the plants to be planted [3] [4]. The use of Geographic

Information Systems (GIS) is also used to analyze a location for specific uses such as developing water sources or mapping areas [5] [6] [7].

Software development methods, in this case geographic information systems and software testing, are two things that cannot be separated. Activities to design, build, implement and maintain software or called Software Development Life Cycle (SDLC) which consists of several model phases and methodologies as a framework that controls the entire process [8] [21] formation systems developments have complexity in their processes [9] [10], so it must be ensured that the final product has a high level of integrity and durability, as well as user acceptance, where this process is a hard and tedious job, so dev[18]ment with a systematic process is important to achieve the characteristics of a successful system. [4]. Selenium is a software testing tool that is known to be stable and powerful so it can be a solution in software testing so that good quality is obtained [11] [12] [13]

2. Methodology

This research adopts the agile methodology approach, which has been recognised as a dynamic and flexible approach to project management, especially in the context of software development and related fields [11]. The agile process consists of six phases, namely requirements, design, development, testing, deployment, and review [8] [12]

2.1. Requirements

In the initial phase of the agile methodology, the needs and requirements of the current system at Perusahaan Daerah Perkebunan (PDP) are ascertained. The present case study entails a comprehensive examination by the project team of the necessity for a Decision Support System (DSS) application based on GIS to map the suitability of land for various agricultural varieties. Active participation of multiple stakeholders, including policymakers, producers, and researchers, will be sought for this analysis in order to incorporate all pertinent viewpoints. The transmission of information pertaining to the research topic is facilitated through interviews conducted with relevant stakeholders [13]. The information gathered from the interview pertained to the growth effects of food commodities and the influence of soil content, which is determined by a number of variables, including precipitation, temperature, pH, and elevation.

2.2. Design

The project team will design the user interface and system architecture of a GIS-based Decision Support System (DSS) at this juncture. The UI/UX elements, technology selection, database structure, and page layout of this design ensure that the functionality of the Decision Support System (DSS) is seamlessly integrated with the GIS. The interface of the system to be developed in accordance with the approved system design will be designed at this stage. When we launch an application for the first time, the map view of the land village in PDP Kayangan Jember Regency that is displayed on the homepage (Figures X and Y) is evident. A comprehensive view of one of the details of the land village in PDP Kahyangan Jember Regency will be displayed when one of the markers is pressed. Specifics regarding village data include information regarding the land's suitability, calculation parameters, harvest area, and output, in addition to the land's productivity.

2.3. Development

In the Development stage, the project team will implement the previously approved design. This process involves converting the design concept into a fully functional CMS application. The team will utilise best practices in software development to ensure that the codes produced meet high-quality standards [17]. In addition, the team will also integrate the CBMS application with a Geographic Information System (GIS) component to map the suitability of land with the right type of crop. During the Development stage, the project team will continuously perform unit testing and debugging to ensure that every part of the Decision Support System (DSS) application operates correctly and according to the pre-defined specifications. By utilising software development best practices, the team will ensure that the Decision Support System (DSS) application meets the needs and expectations of the users

exactly. This process also includes complete and accurate documentation of the source code and functionality of the application to facilitate maintenance and subsequent development at later stages in the project lifecycle.

2.4. Testing

During the Testing phase, guaranteeing the performance and precision of the Decision Support System (DSS) application is the primary objective. Functional, performance, and integration tests are among the many that the testing team conducts to ensure that the application adheres to the predetermined requirements. The objective of functional testing is to verify that the Decision Support System (DSS) application's critical features, such as land suitability, function as intended. This includes interactions such as completing forms, examining mapping results, and authorising GIS-based decision-making processes.

Conversely, performance testing is conducted to verify that the Decision Support System (DSS) application exhibits sufficient responsiveness. The group employs automated tools, including Selenium, to assess the performance of the application across various scenarios and validate its capacity to accommodate the expected volume of users [11] [13]. Integration testing guarantees that all elements of an application, such as database and GIS modules, are correctly interconnected and operating in concert to deliver precise outcomes. By harnessing the capabilities of Selenium, testing teams can enhance the effectiveness of functional testing pertaining to Decision Support System (DSS) applications through the automation of user interactions, thereby guaranteeing a consistent and comprehensive testing process. The outcomes of this testing phase are crucial in ensuring that Decision Support System (DSS) applications function at peak efficiency and adhere to stringent quality requirements prior to deployment in a production setting.

2.5. Deployment

This phase involves the implementation process of the approved design. The team will build a Decision Support System (DSS) application by utilising software development best practices and integrating GIS components to map land suitability. Implementation is done carefully to ensure that the application runs well in a production environment.

2.6. Review

During the Review stage, the project team will conduct a comprehensive evaluation of the project results. This evaluation encompasses various critical aspects, ensuring that the Decision Support System (DSS) application functions optimally and meets the set objectives. Firstly, the team will assess the performance of the Decision Support System (DSS) application, analysing its ability to handle the workload and ensuring that response time and overall performance align with the project requirements' standards. Additionally, user feedback will be taken into account, including inputs, suggestions, or comments from the user experience, to understand areas that require improvement or enhancement.

Furthermore, the team will verify that the land suitability generated by the application fulfils users' expectations and needs. The results obtained will be compared with the original project objectives to ensure that the app provides stakeholders with accurate and valuable information. The outcomes of this evaluation will serve as the foundation for the next step in the app's development. If improvements or enhancements are necessary, the team will take corrective action and iterate on the development or testing stages to ensure that the Decision Support System (DSS) application performs optimally and meets users' needs. This approach will enable the project to continue moving towards achieving its set goals.

3. Results and Discussion

3.1. Design and implementation

From the requirements phase, the main features that must be provided by the PDP Jember Land Suitability Selection application are obtained as presented in the following use case diagram on **Figure**

1. The first feature is to display a dashboard, which aims to display a map of the land managed by PDP Jember. The second is the user management feature, to manage application user data, and the plant data management feature. For regional management, from the results of interviews and observations it was found that the Jember PDP management area was divided into three parts, namely agriculture, subdivisions and blocks. Each subdivision can consist of several blocks and each farm with the same type of crop can be located in several blocks. To make these settings easier, there is a feature for managing agricultural data, a feature for managing afdeling data, and a feature for managing blocks. Then the features for managing parameters and managing calculation results are needed so that this application can provide the highest recommendations regarding plants that are suitable for the land in the desired area. Apart from that, there are login and logout features to limit user access to the available features.

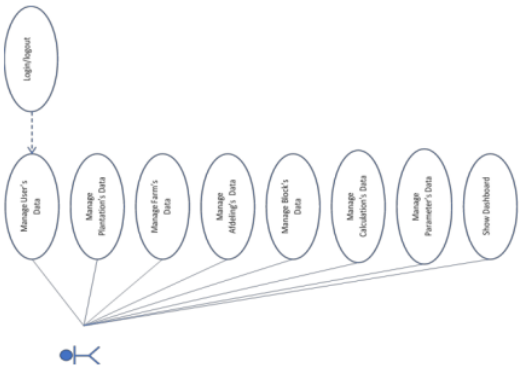

Figure 1. Use case diagram of PDP's land suitability selection application.

After formulating the main features that must be provided by the system, the next step is design and development. Before each module can be developed in parallel, a database needs to be created that will accommodate the data and information that will be managed by the application. The following is an image of the database schema created for the system.

The database created consists of 13 tables, of which there are 7 master tables and 6 transaction tables. Several tables such as the migration table, password reset, personal_access_token and failed_job function to make it easier to record changes both in the database and in the system, while the detailed criteria is a table to provide detailed information regarding land and plant criteria. After the database is created, application modules begin to be developed in the form of a product backlog.

User Access	Manage User	Manage Plant	Manage Afdeling	Manage Block	Manage Farm
•Login •Logout	•Create user •Update user •Search User •Delete User	•Insert plant's data •Update plant's data •Search plant's data •Delete plant's data	•Create Afdeling •Update Afdeling •Search Afdeling •Delete Afdeling	•Create block •Update block •Search block •Delete block	•Create farm •Update farm •Search farm •Delete farm

Figure 2. Primary Product Backlog

As shown in the **Figure 2**, the primary product backlog is related to master data management, including user interface and data management. Meanwhile, the secondary product backlog is related to land suitability calculations that support land selection applications for each plant, shown in the **Figure 3**.

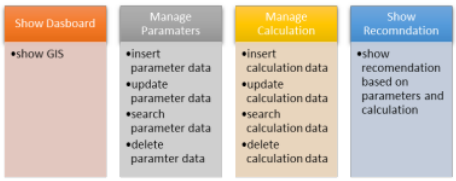

Figure 3. Secondary Product Backlog

After determining the product backlog (PB), each PB is carried out according to the specified design sprint. This design sprint shows each PB along with its tasks and it's task owners. Apart from that, it's also explains the implementation duration of each sprint and the scope of work for each product backlog. An example overview of the design sprint is shown in Table 1.

Table 1. Design sprint

No.	Product Backlog	Task	Duration (time estimation)
1.	Login	Click login	2 days
2.	Manage user's data	Add user data	1 days
3.		Edit user data	2 days
4.		Search user data	2 days
5.		Delete user data	1 days
…	……	……	……
31.	Logout	Click logout button	1 days

3.2. Testing Scenario

The next phase is software testing. Software testing is an important step in software development and is indispensable for assuring quality, identifying errors, improving security, assuring user satisfaction, reducing repair costs, meeting regulatory standards and supporting continuous development. In this test, the black box testing method was used. Black box testing is a software testing method in which testing is carried out without paying attention to or having knowledge of the internals of the source code or software implementation logic. Instead, testing is done by focusing on the software input and output. A black box testing scenario is a set of situations, conditions, or test cases that are used to test software from an external point of view, without needing to know the details of how the software works internally. The targets in this testing include Functional Testing, testing whether the software behaves in accordance with its functional specifications. It includes testing software features, use cases, and specific situations, Error Testing, identifying errors, bugs, and anomalies in the software, including functional issues, user interface appearance, and comparison of results with expectations, and Requirements Testing, ensuring that the software meets the business or user needs specified in the requirements specification.

After creating a test scenario, the next step is to choose an appropriate test method. In this research, to support agile development methods, we use black box testing methods with automated testing using selenium. Selenium is an open source automated testing tool. This tool is used for automation testing carried out on web applications in various different browsers and platforms. Selenium has 4 main

components, namely WebDriver, Selenium IDE, Selenium Grid, and Selenium Remote Control (RC). Following is an image of an automated test using selenium.

Figure 4. Automated testing using selenium on plant management page.

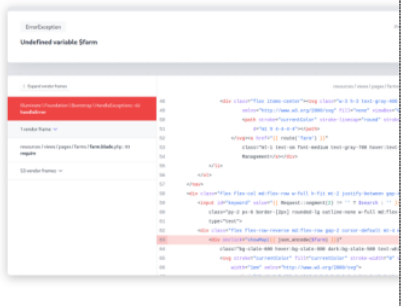

Figure 5. Automated testing using selenium on searching farm page.

Complete test results are presented in the following Table 1.

Table 1. Complete test result by Selenium

No.	Feature	Goals	Result
1.	Login	Enter main page or back to login page	Success
2.	Manage user's data	Showing add user page and add user form	Success
3.		Showing edit user data and edit user form	Success
4.		Displaying tables contain user data	Success
5.		Deleting selected user data	Success
6.	Manage plant's data	Enter main page or back to login page	Success
7.		Showing add plant's page and add plant's form	Success
8.		Showing edit plant's data and edit plant's form	Success
9.		Displaying tables contain plant's data	Success
10.	Manage farm's data	Enter main page or back to login page	Success
11.		Showing add farm's page and add farm's form	Success
12.		Showing edit farm's data and edit farm's form	Error-undefined variable $farm
13.		Displaying tables contain farm's data	Success
14.	Manage afdeling's data	Enter main page or back to login page	Success
15.		Showing add afdeling's page and add afdeling's form	Success
16.		Showing edit afdeling's data and edit afdeling's form	Error-undefined variable $afdeling
17.		Displaying tables contain afdeling's data	Success
18.	Manage block's data	Enter main page or back to login page	Success
19.		Showing add block's page and add block's form	Success
20.		Showing edit block's data and edit block's form	Error-undefined variable $block

21.		Displaying tables contain block's data	Success
22.	Manage parameter's data	Enter main page or back to login page	Success
23.		Showing add parameter's page and add parameter's form	Success
24.		Showing edit parameter's data and edit parameter's form	Success
25.		Displaying tables contain parameter's data	Success
26.	Manage calculation's data	Enter main page or back to login page	Success
27.		Showing add calculation's page and add calculation's form	Success
28.		Showing edit calculation's data and edit calculation's form	Success
29.		Displaying tables contain calculation's data	Success
30.	Dashboard	Displaying dashboard page and online maps	Success
31.	Logout	Logout form system	Success

Of the 31 test scenarios that have been carried out, there are 3 features that still do not provide appropriate output. The error message shown is that there are variables that are used but have not been previously declared. This usually happens due to errors in writing variables or inconsistent names between PHP variables and names in fields in HTML. However, if we look at the total of 28 cases that succeeded in providing appropriate output, or around 90%, it can be said that the system created has succeeded in solving the problems that have been formulated.

This also shows that the Agile method used in software development has been successfully implemented. By dividing work into smaller modules, applications can be built faster. This is because it is possible for several different modules to be worked on simultaneously by different people, so that the overall application process is faster. Using Selenium as automated testing software also helps testing more quickly and efficiently. All test logs are recorded automatically, including the cause of the error that occurred. The next step in developing the land suitability selection application is to correct errors that occur and prepare the application for the deployment process.

4. Conclusion

By using agile methods in developing software, especially the Scrum method, PDP's land suitability calculation application can run well. This is because the Scrum method has a requirements stage which allows us to determine exactly what the application needs are. Apart from that, by dividing the project into several product backlogs that can be worked on in parallel, the processing time is shorter, thereby improving the evaluation stage. Apart from that, by utilizing automated software testing Selenium, the application testing process is less time consumer and well documented, so that the deployment sphase can run smoothly.

Acknowledgments

We thank our colleagues from Information Technology Politeknik Negeri Jember and TeFa JTI Innovation who provided insight and expertise that greatly assisted the research

Commented [MOU1]: Add a word of appreciation to funding organization

References

Commented [MOU2]: adjust it to the appropriate paper template

[1] B. R and S. Y, "Climate change and its impact on Indonesia's food crop sector 1," in *In Sixth Executive Forum on Natural Resource Management: Water & Food in a Changing Environment*, Los Baños„ 2012.

[2] BPS Kabupaten Jember, "KABUPATEN JEMBER DALAM ANGKA 2021," BPS Kabupaten Jember, Jember, 2022.

[3] G. G. Acedo, "A Web-Enabled GUS Platform for Agricultural Land Use," in *International Conference on Information Technology and Digital Application*, Jaipur, 2019.

[4] T. D. Puspitasari, A. A. Kurniasari and P. S. D. Puspitasari , "Analysis and Testing Using Boundary Value Analysis Methods for Geographic Information System," in *5th International Conference on Food and Agriculture*, Jember, 2022.

[5] A. A. Othman, A. F. Al-Maamar, D. A. M. A. Al-Manmi, V. Liesenberg, S. E. Hasan, A. K. Obaid and A. M. F. Al-Quraishi, "GIS-Based Modeling for Selection of Dam Sites in the Kurdistan Region, Iraq," *International Journal of Geo-Information*, 2020.

[6] M. Tahir, A. A. Kurniasari, M. R. Mufid, A. A. Yunanto and A. Shofyan, "Geographic Information System of Fish Farmers Location in Tulungagung District Using Leaflet," in *International Conference on Applied Science and Technology on Social Science*, Bandung, 2022.

[7] M. Omidipoor, M. Jelokhani-Niaraki, A. Moeinmehr, A. Sadeghi-Niaraki and C. Soo-Mi , "A GIS-based decision support system for facilitating participatory urban renewal process".

[8] B. L. Yu , W. K. Loo, W. Y. Tham and S. F. Tan, "Software Development Life Cycle AGILE vs Traditional Approaches," in *International Conference on Information and Network Technology*, Singapore, 2012.

[9] S. A. Abraham, "Usability Problems in GI Web Applications: A lesson from Literature," in *24th AGILE Conference on Geographic Information Science*, 2021.

[10] D. Kammerhofer and J. Scholz , "An Approach to Decompose and Evaluate a Complex GIS-Application Design to a Simple, Lightweight, User-Centered App-Based Design Using User Experience Evaluation," *International Journal of Geo-Information*, 2020.

[11] F. Mobaraya and S. Ali, "Technical Analysis of Selenium and Cypress as Functional Automation Framework for Modern Web Application Testing," in *9th International Conference on Computer Science, Engineering and Applications*, Copenhagen, Denmark, 2019.

[12] O. F. , O.-A. I. and B. S. , "A Critical Analysis of Software Testing Tools," in *International Conference on Engineering for Sustainable World*, 2019.

[13] F. Mobaraya and S. Ali, "TECHNICAL ANALYSIS OF SELENIUM AND CYPRESS AS FUNCTIONAL AUTOMATION FRAMEWORK FOR MODERN WEB APPLICATION TESTING," *Computer Science & Information Technology*, pp. 27-46, 2019.

[14] S. Balaban and J. Đurašković, "AGILE PROJECT MANAGEMENT AS AN ANSWER TO CHANGING ENVIRONMENT," *European Project Management Journal*, vol. 11, no. 1, 2021.

[15] B. G. S. Grepon and N. T. Baran, "Designing and Implementing e-School Systems: An Information Systems Approach to School Management of a Community College in Northern Mindanao, Philippines," *International Journal of Computing Sciences Research*, vol. 5, no. 1, 2021.

[16] H. Bomström, "Information needs and presentation in agile software development," *Information and Software Technology*, vol. 162, 2023.

[17] M. Kalenda and P. Hyna, "Scaling agile in large organizations: Practices, challenges, and success factors," *Journal of Software: Evolution and Process*, 2018.

Implementation of Agile Methods in GIS Web Applications for Land Suitability Selection

ORIGINALITY REPORT

15%	11%	11%	7%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	doaj.org Internet Source	1%
2	www.joiv.org Internet Source	1%
3	Submitted to University of Auckland Student Paper	1%
4	T D Puspitasari, A A Kurniasari, P S D Puspitasari. "Analysis and Testing Using Boundary Value Analysis Methods for Geographic Information System", IOP Conference Series: Earth and Environmental Science, 2023 Publication	1%
5	Submitted to The University of Manchester Student Paper	1%
6	Submitted to University of Reading Student Paper	1%
7	Submitted to Ivy Tech Community College Central Office	1%

	Student Paper	
8	garuda.kemdikbud.go.id Internet Source	1 %
9	Submitted to University of Florida Student Paper	1 %
10	home.sejong.ac.kr Internet Source	1 %
11	www.researchgate.net Internet Source	1 %
12	Pramuditha Shinta Dewi Puspitasari, Arvita Agus Kurniasari, Trismayanti Dwi Puspitasari. "Geographic Information System Mapping of Plantation", Journal of Applied Science, Engineering, Technology, and Education, 2022 Publication	1 %
13	jednoducho-fele.com Internet Source	1 %
14	Submitted to Victorian Institute of Technology Student Paper	1 %
15	Fernando Kamei, Igor Wiese, Crescencio Lima, Ivanilton Polato et al. "Grey Literature in Software Engineering: A critical review", Information and Software Technology, 2021 Publication	1 %
16	e-journal.uajy.ac.id Internet Source	1 %

17	Susanna Ambondo Abraham. "Usability Problems in GI Web Applications: A lesson from Literature", AGILE: GIScience Series, 2021 Publication	<1 %
18	www.leapwork.com Internet Source	<1 %
19	Taufiq Rizaldi, Hermawan Arief Putranto, Hendra Yufit Riskiawan, Dwi Putro Sarwo Setyohadi, Jeffri Riaviandy. "Decision Support System for Land Selection to Increase Crops Productivity in Jember Regency Use Learning Vector Quantization (LVQ)", 2019 International Conference on Computer Science, Information Technology, and Electrical Engineering (ICOMITEE), 2019 Publication	<1 %
20	www.ijraset.com Internet Source	<1 %
21	Soukaina Najihi, Sakina Elhadi, Rachida Ait Abdelouahid, Abdelaziz Marzak. "Software Testing from an Agile and Traditional view", Procedia Computer Science, 2022 Publication	<1 %
22	testsigma.com Internet Source	<1 %

23	Niranjan D R, Mohana. "Jenkins Pipelines: A Novel Approach to Machine Learning Operations (MLOps)", 2022 International Conference on Edge Computing and Applications (ICECAA), 2022 Publication	<1 %
24	download.atlantis-press.com Internet Source	<1 %
25	Rida Prihatni, Indra Pahala, Ati Sumiati, Ayatulloh Michael Musyaffi. "The value relevance of accounting information moderated by earnings management: Evidence from listed companies in the developing market", Corporate and Business Strategy Review, 2023 Publication	<1 %
26	ebin.pub Internet Source	<1 %
27	ejournal.stiewidyagamalumajang.ac.id Internet Source	<1 %

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	Off		