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Comparison Testing Functional and Usability System Mapping Land Agriculture On Platform Web and Mobile

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Abstract

The Agricultural Land Mapping System (SPLP) is indispensable in an agricultural country where part of the population is farmers. This system has been developed by the research team since 2019 and has resulted in web and mobile based systems. The Dutatani SPLP system was developed using the Rapid Application Development (RAD) method. Before this system is further implemented in the community, this system needs to be tested in terms of functionality and usability. This research article aims to compare the functionality and reusability testing of web and mobile-based SPLP. The test was carried out using ISO / IEC 9126-4 usability metrics that focus on effectiveness and efficiency, and involve farmers and farmer groups from Gilang Harjo Village, Bantul, Yogyakarta. The results of testing the web-based and mobile-based SPLP system show that overall respondents can do all the tasks given, but it takes a long time to complete. This is influenced by internal factors of the respondents, namely the respondent's lack of experience in using mobile phones for other activities besides telephone and short messages. So that when testing, respondents need more time to adapt to the system. However, based on time on task, mobile-based SPLP testing is faster than web-based ones.

Keywords: agricultural land mapping system, functional test, usability test, web, mobile

1. Introduction

The agricultural sector is one of Indonesia's resources. Due to abundant resources and a favorable climate, most of Indonesia's population works in the agricultural sector. Agricultural land is one of the focuses of the Indonesian government in the context of development in the agricultural sector. The government strongly supports the development of technology in agriculture, one of which is for technology to produce precise agriculture. Precision agriculture is one of the capabilities to handle a variety of activities related to productivity on agricultural land and increase financial returns, reduce residual production, and minimize the impact on the environment by using data collection, and utilizing information for strategic decisions on agricultural management using information and communication technology. [1]. The use of Information and Communication Technology (ICT) in precision agriculture supports the determination, analysis and regulation of changes in agriculture for optimal benefits, sustainability and survival for agriculture [2]. This can be supported by the existence of an agricultural information system, in which the agricultural information system itself has several systems that are interrelated to help farmers in agricultural data collection, learning, land processing, and selling agricultural products.

Dutatani is one of the Agricultural Information Systems (SIP) developed by a team of developers from the Faculty of Information Technology, Duta Wacana Christian University which can be accessed through the website at the address http://dutatani.id. There are 4 (four) systems that have been developed and are ready to be implemented in the community. The first system is the Farm Portal addition. There are several systems developed, namely Agricultural Portal [3], Information System for Farmers and Farmer Groups [4], SI for Farming Activities [5], and SI for Purchasing and Selling of Agricultural Products [6]. These systems can be accessed via the website at the address http://dutatani.id. The last two systems are the web-based [7], [8] and mobile-based Agricultural Land Mapping System (SPLP) at http://dutatani.id/si_mapping and https://drive.google.com/file/d/1hWtu97W4ABJzY5irGi8K_8JNFVrxEqxe/view.The appearance of the web-based land mapping system can be seen in Figures 1 and 2, while the mobile-based ones can be seen in Figures 3 and 4.

SPLP development is carried out by applying the Rapid Application Development (RAD) method. In [9] research, RAD is a collection of methods developed to overcome the weaknesses of traditional development systems, such as the Waterfall model and its variants. Development using RAD is also capable of producing better software than development using traditional methods. Through an RAD process, organizations can reduce development and maintenance costs [10]. The use of this method is based on the suitability of the sequential and iterative or incremental characteristics of the model in the software prototype development process. This method is also used in many studies such as in [11].

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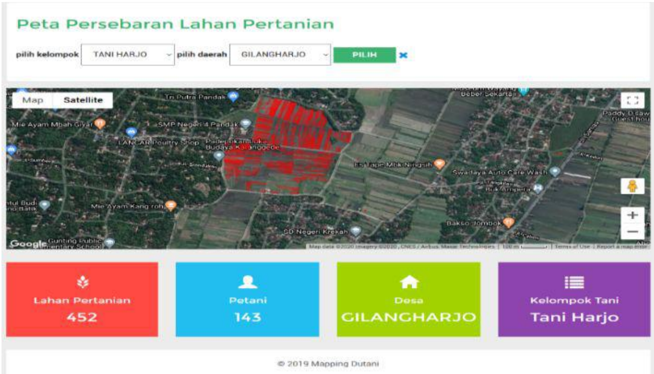

Figure 1. A map page of the distribution of agricultural land on the Web Mapping System.

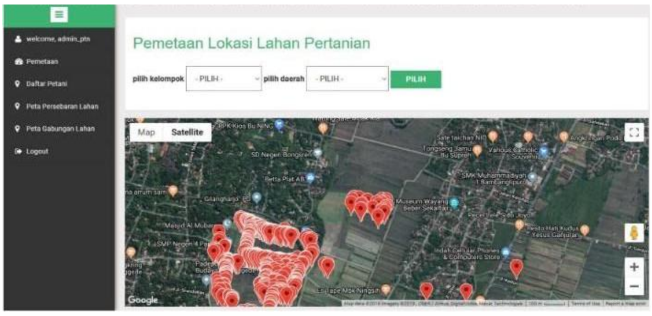

Figure 2. Mapping page of agricultural land on the Web Mapping System.

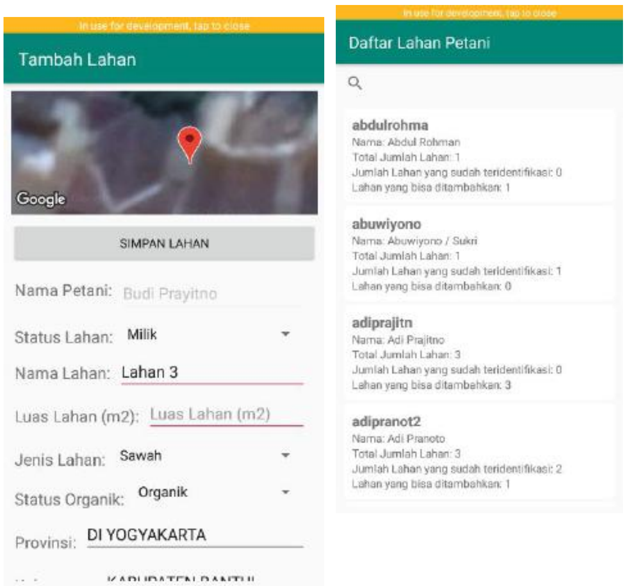

Figure 3. Interface of adding land in the Mobile Mapping System.

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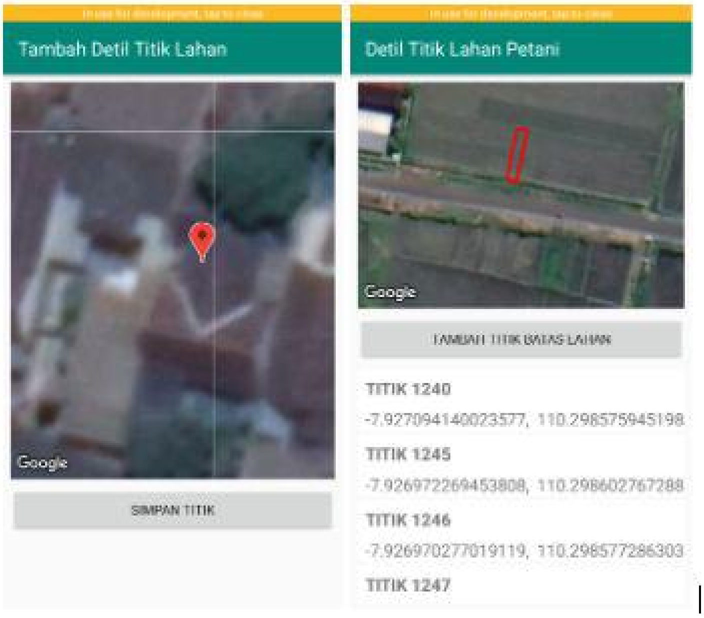

Figure 4. Detailed interface of land points in the Mobile Mapping System.

The web-based agricultural land mapping system has a dashboard feature that is connected to the Google Maps service which is used to document longitude coordinates and latitude coordinates to produce spatial information for each agricultural land. The Android based system was developed with the same data which can trace the boundaries of agricultural land automatically based on GPS. The development of this android-based system is expected to overcome difficulties in land mapping and determine the coordinates of the land found by researchers during field testing.

In this study, the research team tested the SPLP in black box from the side of task functionality and usability before it was actually implemented in farmer communities or farmer groups. Testing was conducted with research partners, namely partner farmer groups in Gilang Harjo Village, Bantul, especially Harjo and Rahayu farmer groups. The purpose of this test is to find out the functional truth of the system based on task scenarios and application usability from the user's side. Thus, the purpose of this study is how to perform functional and reusability testing for two different system platforms, but have the same functions and features.

Testing on mobile systems is not the same as testing on traditional non-mobile systems and requires special techniques [12]. Black box testing methods in the form of functional tests have been carried out in many applications such as [13], [14], the SQL vulnerability [15], even non-functional testing has also been proposed as a framework for testing mobile applications [16]. In the non-functional test mode, scenario-based tests are also used in this study. Meanwhile, usability testing has been carried out as in [17].

Usability comes from the word usable which means it can be used well. Something can be said to be useful well if failure can be eliminated or minimized and provides benefits and satisfaction to its users [18]. According to reference [19] usability has several important aspects, namely the ease (learnability), which can be measured from how quickly the user becomes proficient in using the system and the ease of using the system to do a certain task; Next is efficiency (efficiency), which can be defined as the resources spent in achieving accuracy and completeness in achieving goals; Third, the level of memorability, which is defined as how the user's ability to retain their knowledge after a certain period of time and the ability to remember from the location of something that has not changed; Next, the error rate (error), can be defined as how many errors the user makes. The error contains a discrepancy in what the user thinks with what the system actually represents. Finally, satisfaction is defined as freedom from discomfort, and a positive attitude toward product use or subjective measures as users feel about using the system. In a mobile-based system, usability can be measured by parameters of effectiveness, efficiency, satisfaction, and cognitive load [20]. Research on usability in mobile applications is still very dependent on device restriction and supporting tools.Performance metrics are one of the most widely used methods for analyzing usability. Performance metrics are used to see how well users are using a system. The aspects seen include time on task, task success, error, and efficiency [21]. Combining metrics is a technique that is quite easy to combine values on different scales by converting each value into a percentage and then taking the average value [21].

The research method used in this study will use the functional test method and usability test starting with needs analysis, preparation of task scenarios, collecting test data, and analyzing the results of test data to produce conclusions. This method will be discussed in more detail in the methodology section.

This study provides a practical contribution in the application of the functional and usability test results to a web and mobile based system. In addition, this research also provides practical contributions for experts in the field of software quality assurance related to the application of these two tests and the steps required in functional and usability testing, both for web and mobile. In addition, this study also provides theoretical contributions related to the application of comparison of test results between web and mobile based systems by looking at the results of the functional and usability tests. Where usually the two systems are developed using the same functionality. Thus, it is hoped that this comparison can become a benchmark for how to compare two systems from two different platforms. In addition, in the tests carried out, the researcher carried out a category of tasks and provided a description of the task category into several more detailed tasks. This is an extension of the reusability testing that is in the previous tests. Through this categorization, it helps the research team in knowing which tasks the respondent can or cannot do.

This article is written in the following order: the first part is in the form of an introduction which will discuss the background, problem formulation, literature review, solutions to be worked on, methods and research contributions. While the second part is continued with the Methodology section which explains in detail the research methods used, especially in terms of systems testing methods. The next section is the results and discussion of research based on the results of the research conducted. The final section of this article summarizes the results of this study, the limitations of this study, and suggestions for future research.

2. Metodologi

The stages of the research carried out by the research team can be seen in Figure 5. A detailed explanation of the method used will be explained in the following sub-chapter.

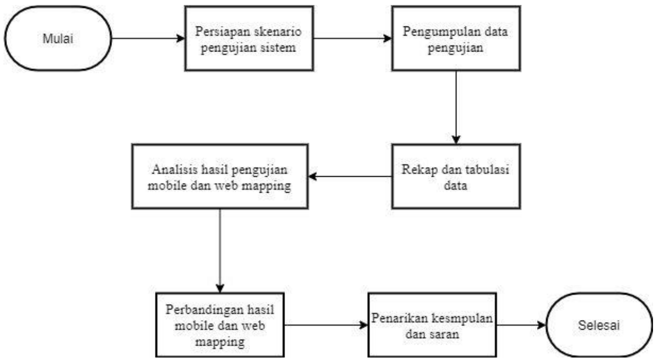

Figure 5. Research Methods

A. Preparation of System Testing Scenarios

There are 3 categories of testing this system (see Table I), namely Login, Managing Land Mapping Data, and Logout. From these 3 categories, 10 test scenarios were compiled with different codes.

Tabel 1. Skenario Pengujian

Req No	Req Desc	Test Case ID	Test Case Scenario
1	Login	TA01	Login to the Dutatani Mobile Mapping Application
2	Managing Land Mapping Data	TB01	Choose the location mapping menu
		TB02	See a list of farmers
		TB03	Search for farmer's name
		TB04	Enter the menu add farmer's land
		TB05	Increase farmer's land
		TB06	Look at the farmer's land
		TB07	Complete the farmer's land point data
		TB08	Removing land
3	Logout	TC01	Logout

The test will be carried out using the following parameters:

1. Time on task: used to measure how much time the respondent takes to use the system being tested. The less time needed to complete the task, it is assumed that the respondent's experience is good in using the system. In conducting this test, the tool used is a stopwatch located in a smartphone. The equation for calculating the time-on-task can be seen in formula (1).

$$Time - on - task = \left(\frac{Waktu\ Terlama - Waktu}{Waktu\ Terlama - Waktu\ tercepat} \right) \times 100\%$$

2. Task success is used to determine the effectiveness of respondents in using the system. In the calculation of task success, you will use binary success with the number 0 for a failed task and 1 for a successful task. The equation for calculating task success can be seen in formula (2).

$$Success = \left(\frac{Jumlah\ Success}{Jumlah\ Tugas} \right) x\ 100\%$$

3. Error, is used to calculate the number of respondents' errors in testing the system. The equation for calculating the error can be seen in formula (3).

$$Error = \left(1 - \frac{Jumlah\ Error}{Jumlah\ Error\ Max}\right) \times 100\%$$

4. Efficiency, used to measure how much effort the respondent puts in completing a given task based on the number of clicks the respondent makes. In measuring the efficiency of a system, it must be known how many clicks are needed until the assigned task is declared complete. The equation for calculating efficiency can be seen in formula (4).

$$Click = \left(\frac{Clicks\ Minimal}{Jumlah\ Click} \right) \times 100\% \quad \ldots\ldots \ (4)$$

B. Testing Data Collection

Data collection was carried out to representatives of members of the Harjo Farmer Group and Rahayu Farmers Group, Gilang Harjo, Bantul, Yogyakarta Special Region. Samples were taken randomly in collaboration with the managers of the two farmer groups. Tests carried out the preparation of scenarios that will be carried out by 20 respondents. Respondents are administrators or managers of farmer groups and several farmers in Tani Rahayu and Tani Harjo. The test data collection was carried out in July 2020 in the meeting room of Tani Harjo and Tani Rahayu farmer groups. This test was assisted by a research assistant consisting of final semester students at the Information Technology Faculty, Duta Wacana Christian University (UKDW). In this test, each respondent has to perform 13 test tasks on each platform, both mobile and web. The 10 test tasks are a compilation of several categories of test tasks described in Table I. Web-based system testing is carried out using an Asus X405UQ laptop computer with Core i5 specifications, 8 GB RAM, 1 TB HDD, and 2 GB NVIDIA VGA, while mobile-based system testing was carried out using the Xiaomi Redmi Note 7 Pro smartphone device. The list of tasks can be seen in more detail in Table II.

Table 2. List of Testing Tasks

No. Duty	Command	Deskripsi
1	Login (TA01)	Try to get into the agricultural land mapping web system using ***username*: admin_ptn** ***password*: admin123**
2	Choose a location map (TB01)	Try to select the location for mapping agricultural land by selecting **Kelompok : Taniharjo** **Daerah : Gilangharjo**
3	See a list of farmers (TB02)	Try to see all the list of farmers that are on **Kelompok : Taniharjo** **Desa Petani : Prawirodirjan**
4	Search for farmer's name (TB03)	Try to find the farmer's name with the keyword "amber"
5	Increase farmer's land (TB04) (TB05)	Try to add land to a farmer named Ambar Nur Kustinari with the following conditions: Farmer Group: Tani Harjo Name of land: TESTING AMBAR Land area: 90 Type of land: Rice fields Organic Status: Organic Province: DI Yogyakarta Regency: Bantul District: Pandak Village / Sub-district: Gilangharjo
6	Look at the farmer's land (TB06)	Try to see the land that has been made before. Name of land: TESTING AMBAR
7	Changing farmer's land data (TB07)	Try changing the AMBAR TESTING land data from a farmer named Ambar Nur Kustinari on the land to Farmer Group: Tani Harjo Land area: 120 Type of land: Tegalan
8	Increase land ownership (TB04) (TB05)	**Try adding the AMBAR TESTING land ownership to a farmer named Ambar Nur Kustinari with conditions** **Farmer: Budi Prayitno** **Starting date: 29-07-2020** **Land status: Lease**
9	Increase planting (TB07)	Try to add planting data to a farmer named Ambar Nur Kustinari by inputting Plants: Corn Seed Requirement: 2 **Kebutuhan Saprotan : 3**

		Satuan Seprotan : Kg **Bulan Tanam : Januari** **Bulan Panen : Maret** **Rata-rata Hasil Perpanen : 10**
10	Removing agricultural land (TB08)	Try removing the AMBAR TESTING field on a farmer named Ambar Nur Kustinari
11	See the distribution map of agricultural land (TB06)	Respondents see a detailed map of the distribution of agricultural land by selecting Farmer Group: Tani Harjo Area: Gilangharjo
12	View the combined land map (TB06)	Respondents view the combined map of agricultural land by selecting Combined by: Region Area: Jagalan
13	Logout (TC01)	Respondents were asked to leave the web mapping system for agricultural land

C. Recapitulation of Test Results and Tabulation of Test Data

After testing each respondent, the research team tried to enter the test results into the recapitulation and tabulation of the test data. This recapitulation was carried out in collaboration between the research team and research assistants. The research team sorted the test results and made sure that the task carried out by the respondents was correct and in accordance with what the research team wanted.

D. Analysis of Mobile Testing and Web Mapping Results

1. Time on Task data analysis

Time on task data is time data obtained from testing the test task scenarios that have been completed by the respondent. To process this, the research team recorded the time required by each respondent to complete each task. Time is recorded in seconds and presented in table form. If a task has an average time that is longer than the predetermined maximum time limit, then this will be used as an indicator that the respondent is having difficulty doing the assigned task. Given these difficulties, the research team concluded that improvements were needed for the task. Furthermore, this is also an input for researchers to evaluate the functionality of the system, especially in the intended task.

2. Task Success data analysis

Task success data is data obtained from the success of the respondent in completing a task. Researchers can find out the percentage level each task has. This percentage is used as the level of effectiveness of the respondents in completing each task. A task can be said to be successful if the percentage level has a value greater than or equal to 78%. Conversely, if the percentage value is below 78%, the task is declared a failure and the researcher needs to make improvements in that section [22].

3. Error data analysis

Error data is obtained from completing tasks performed by respondents. Researchers will analyze in the process of completing the task whether the respondent made a mistake during the process of completing the task. If the task carried out has an error rate above 20%, the task cannot be accepted by the respondent. Furthermore, the research team needs to evaluate this task and it needs improvement [23].

4. Efficiency data analysis

Efficiency data is obtained from the number of clicks made by the respondent in completing a task. To count the number of clicks, the research team calculated the number of clicks manually and recorded all test results. The number of clicks is counted for web based systems. As for the mobile-based system, the research team calculated the number of presses performed by the respondents.

E. Comparison of Mobile and Web Mapping Results

This section will compare the test results between web and mobile mapping and then carry out a comprehensive analysis.

F. Conclusion Withdrawal

In this section, conclusions will be drawn based on the analysis that has been done previously. The conclusions will also provide suggestions for further development.

3. Results and Discussion

A. Respondent Profile Analysis

The data obtained from the testing process were as many as 20 respondents who were farmers who were members of the Harjo and Rahayu Farmers groups. System testing was carried out on 22 July 2020 to 24 July 2020 in the village of Gilangharjo Bantul.

In Table III, the respondent's age, gender, recent education of the respondent, electronic devices owned by the respondent, land ownership status and types of species planted by the respondent are shown.

Table 3. Categories of Research Respondents

Variabel	Kelas	Jumlah
Age	20 – 30 Tahun	1
	31 – 40 Tahun	1
	41 – 50 Tahun	4
	50 – 60 Tahun	10
	>= 61 Tahun	4
Gender	Perempuan	0
	Laki - Laki	20
Last education	SD	8
	SMP	2
	SMA	9
	S1	1
Owned Electronic Devices	Laptop/Komputer	5
	Smartphone	6
	HP Biasa	6
	Tidak Ada	7
Experience using computers	>= 1 Tahun	1
	Tidak Pernah	19
Land Status	Milik Pribadi	14
	Sewa	8
Types of Planted Species	Padi	19
	Jagung	5
	Cabai	3
	Kacang	1

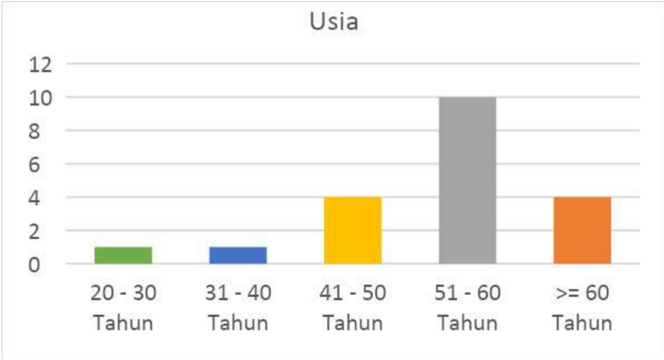

Figure 6. Age Demographics of Respondents

The test respondents were of various ages. Of the 20 respondents, there were 1 respondent aged between 20-30 years, 1 respondent aged 31-40 years, 4 respondents aged 41-50 years, 10 respondents aged 51-60 years, and as many as 4 respondents aged above. 60 years, can be seen in the demographics Figure 6.

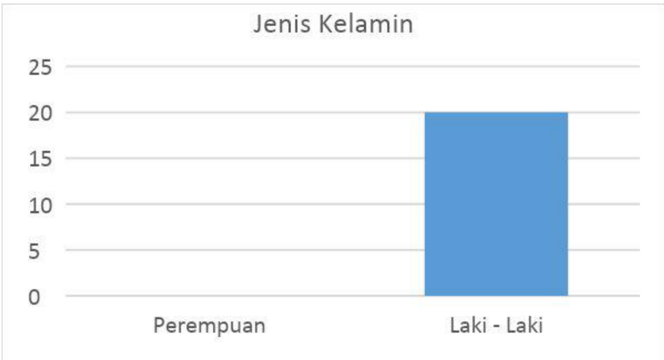

Figure 7. Demographics of Respondents Gender

Based on the demographics above, all respondents who were involved in this test were male with a total of 20, while there were no women like the demographics Figure 7.

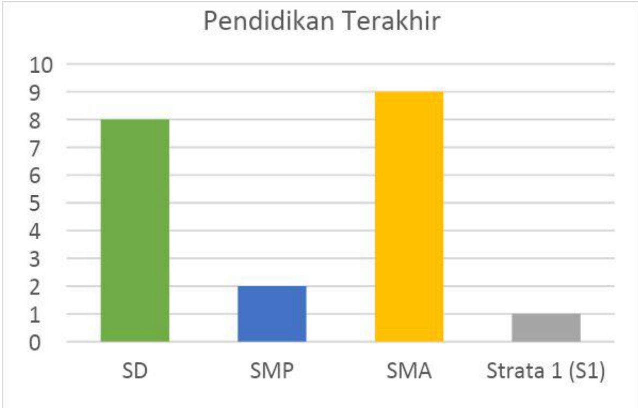

Figure 8. Respondents' Last Education Demographics

For the last education category of respondents, it was divided into 4, with the results of 8 respondents having a final elementary education, 2 respondents were junior high school, 9 respondents were SMA / SMK and 1 respondent was Strata 1 as demographics Figure 8.

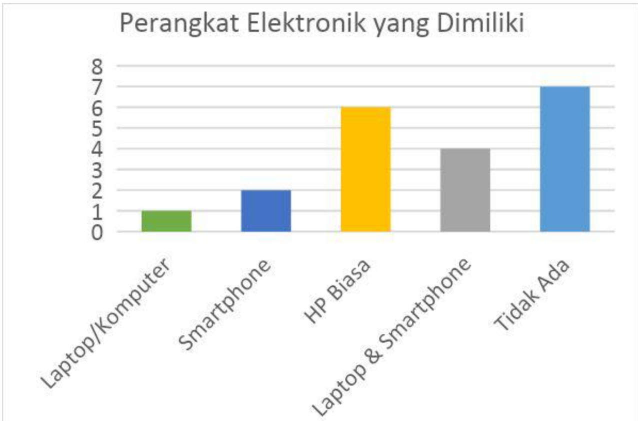

Figure 9. Demographics of Respondents' Electronic Devices

Based on demographic data in Figure 9, there is 1 respondent who owns a laptop or computer, 2 respondents have a smartphone, 6 respondents have a regular cellphone, 4 respondents have 2 electronic devices, namely a laptop and a smartphone, and 7 others do not have electronic devices.

Figure 10. Demographics of Respondents' Experience using Computers

Of the 20 respondents, 1 respondent has ever used a computer and 19 other respondents have never been like the demographics Figure 10.

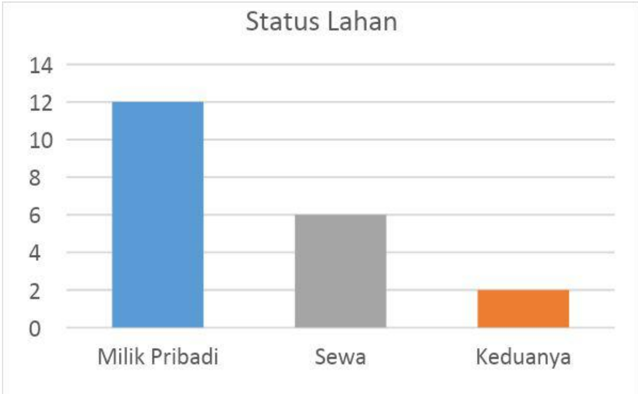

Figure 11. Demographics of Respondents Land Status

A total of 12 respondents own land with the status of being privately owned, 6 respondents own land with the status of being a tenant, and there are 2 respondents who own land with private ownership and lease as in the demographic Figure 11.

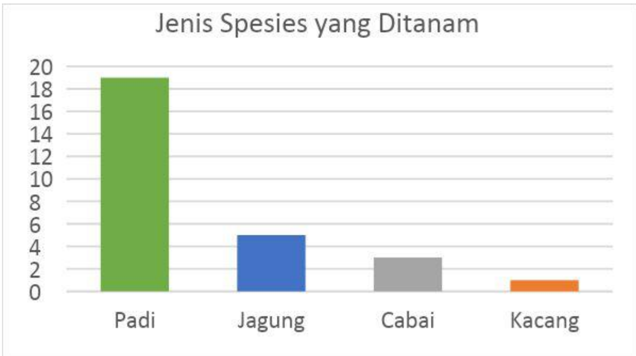

Figure 12. Types of Species planted by the Respondents

In this test, there are 4 categories of species planted, namely rice, corn, chilies and peanuts. There were 19 respondents who planted rice, 5 respondents planted corn, 3 respondents planted chilies, and 1 respondent planted beans as in the demographic Figure 12.

B. Test result

In calculating the test time on task, a benchmark test time is needed. Benchmark is used as the maximum time limit for the respondent to complete a given task. The time limit is obtained from the time it takes the researcher to complete each task, then the time is multiplied by 2 as in Table IV.

TABEL IV. BENCHMARK PENGUJIAN

Test Case ID	Waktu Peneliti (detik)	Waktu Maksimal (waktu peneliti * 2) (detik)	Minimal Klik
TA01	27	54	3
TB01	22	44	5
TB02	27	54	6
TB03	28	56	3
TB04	73	146	19
TB05	30	60	1
TB06	34	68	8
TB07	28	56	9
TB08	57	114	14
TC01	5	10	1

After testing the farmers and farmer groups, the results of the test analysis are obtained. In accordance with formula (4) to obtain the efficiency of the time needed to complete each task, the results obtained can be seen in Table V. Rounding is done to the nearest 1/1000 unit.

TABEL V. HASIL SKENARIO PENGUJIAN MOBILE MAPPING

Test Case ID	Jumlah Responden	Efisiensi Rerata Waktu (detik)	Efisiensi Rerata Waktu (menit)
TA01	20	100.357	1.673
TB01	20	7.000	0.117
TB02	20	10.857	0.181
TB03	20	19.786	0.330
TB04	20	5.214	0.087
TB05	20	193.500	3.225
TB06	20	7.357	0.123
TB07	20	41.929	0.699
TB08	20	6.071	0.101
TC01	20	7.538	0.126

Similar testing was conducted with the same respondents to test a web-based system. After recording and calculating, the research team compared the two test results on different platforms. Comparison of test results can be seen in Table VI.

TABEL VI. HASIL PERBANDINGAN PENGUJIAN MOBILE DAN WEB MAPPING

No.	Skenario	Waktu Rerata Web (s)	Waktu Rerata Mobile (s)	Kenaikan Waktu %
TA01	Melakukan Login pada Aplikasi Mobile Mapping Dutatani	100.357	99.900	-0.458
TB01	Memilih menu pemetaan lokasi	7.000	56.400	87.589

TB02	Melihat daftar petani	10.857	82.200	86.792
TB03	Mencari nama petani	19.786	49.050	59.662
TB05	Menambah lahan petani	193.500	235.550	17.852
TB06	Melihat lahan petani	7.357	51.850	85.811
TB08	Menghapus lahan	6.071	82.800	92.667
TC01	Logout	7.538	9.450	20.228

From Table VI above, the research team found that the testing time for mobile-based systems was faster than for web-based systems. There is a considerable time difference between web-based and mobile-based systems. The average speed of testing the task on time of mobile applications is 56,268% faster than the speed of testing the task on time for web-based applications. Only one task, TA01, has nearly the same timing between a mobile based system and a web based system.

To support further analysis, the research team compared it with the observation of the skills of the farming community in operating smartphones and desktops, especially the farmer groups of Tani Harjo and Tani Rahayu. This observation activity was carried out in 2019 as a first step to determine user needs. There were 36 respondents at the time of the observation. The results can be seen in Table VII.

TABEL VII. HASIL OBSERVASI KEMAMPUAN PENGOPERASIAN SMARTPHONE DAN DESKTOP

Pengujian	Jumlah Responden	%Berhasil (Desktop)	%Berhasil (Smartphone)
Menghidupkan Perangkat	36	27.78%	77.78%
Mematikan Perangkat	36	27.78%	80.56%
Menunjuk Icon 1	36	36.11%	52.78%
Menunjuk Icon 2	36	25.00%	55.56%
Menunjuk Icon 3	36	22.22%	52.78%
Membuka Halaman Web	36	30.56%	47.22%
Mengakses Email	36	16.67%	25.00%
Melakukan Diskusi Online	36	8.33%	38.89%
Melakukan Pencarian dengan Mesin Pencari Google	36	22.22%	50.00%

From the results of the observations in Table VII, it can be concluded that the user, in this case, the farmer community representatives of the Harjo and Tani Rahayu farmer groups are more accustomed to using smartphones than using desktop or laptop computers. The results in Table VII also support the findings in Table VI where the time on task testing time on mobile-based applications is faster than the time on task testing time on a web-based system.

This study has limitations for generalization in a wider population. Where in this case, the research team has not tested it on other farmer groups which of course have different characteristics. Therefore, in the next research, we can try this SPLP on representatives of other farmer groups. In addition, the visual factor is also needed in measuring the level of reusability. The researcher proposes to use the eye tracking tool in the next testing of functionality and usability. In addition, the next limitation is the respondents who are all male in this test. The researcher proposes for the next study by including female respondents in collaboration with the Women's Farmer Group for further testing.

4. Thank-you note

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Closing

From the results of testing functionality on two different platforms, it was found that the test results can be done by comparing the time on task in each task category. By making comparisons, the research team can find out how fast the respondent is in doing the assigned task.

From the test results and comparison of the test results, it is found that the time required by the user to complete a task (time on task) is faster in mobile-based applications than web-based applications. This is based on the level of use of existing computers between laptops and smartphones. Therefore, to support the usability level of using web-based applications, more support is needed, such as user training in using web-based applications. As for the success rate of system functionality testing, the test results show that all system functionality can be done well by respondents. This indicates that there is no functionality that needs fixing.

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