Usability testing of SOLAP for Indonesia agricultural commodity

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Usability testing of SOLAP for Indonesia agricultural commodity

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Abstract. Spatial Online Analytical Processing (SOLAP) for Indonesia Agricultural Commodities has successfully developed in our previous study. The application is integrated into a data warehouse that manages historical agricultural commodities data in four sectors: food crop, horticulture, plantation, and livestock. The main features of SOLAP are providing historical data as the results of roll up and drill down operation and visualization of the data in crosstab tables, graphs, and map. In order to evaluate the SOLAP implementation, this study conducted usability testing by involving respondents as potential users of SOLAP. We use the Post-Study System Usability Questionnaire (PSSUQ) which tests the system based on efficiency, effectivity, and user's satisfaction. There are three testing aspects in PSSUQ, namely system usefulness, information quality, and interface quality with the Likert scale from 1 (low) to 7 (high). The measurement was done by involving 13 respondents who are postgraduate students of Bogor Agricultural University (IPB), researchers in Agrarian Study Center IPB, data analysis and data management staff of Data and Information Center, Ministry of Agriculture Indonesia. The results show that SOLAP for Indonesia Agricultural Commodities has high usability measures which reach 5.424. The testing results of each aspect are system usefulness of 5.54, information quality of 5.258, and interface quality of 5.433. In addition to PSSUQ, this study performed usability testing based on tasks completion. The result shows that the respondents are able to complete the OLAP operations and data visualization in an acceptable time.

1. Introduction

The data on Indonesia's agricultural commodities are currently available in the Agricultural Statistics Database developed by the Ministry of Agriculture of the Republic of Indonesia. Those data include food crops, horticulture, plantations, and livestock, which can be publically accessed at https://aplikasi.pertanian.go.id/bdsp/newkom.asp. The public may retrieve the data based on some criteria and collect the results on the Microsoft Excel (xls) format. Those criteria include Subsectors, Indicators levels, Status of data, and Year. Although the Agricultural Statistics Database has been able to display data of agricultural commodities, there is no facility to analyze data easily. Data processing of Indonesian agricultural commodities can be improved by developing an application to present a summary of agricultural commodities data based on spatial and temporal aspects to users with multidimensional data analysis approach. Technologies that can be used for such purposes are data warehouse and Online Analytical Processing (OLAP).

Our previous study was successfully developed a spatial online analytical processing (SOLAP) for the agricultural commodity in Indonesia [1]. This system used spatial data that is a digital map of district border provided by Geospatial Information Agency, Indonesia and non-spatial data that are obtained from Agricultural Statistics Database provided by the Ministry of Agriculture, Republic of Indonesia. This system receives input from users and displays output in table, chart, and map. The SOLAP has not been evaluated in usability. Usability is a qualitative analysis that determines how easily a system interface is used [2]. Usability evaluation needs to be done to find out that the system can work as needed and identify the problems faced when users utilize the system.

Usability evaluation can be done by involving users to get direct information about how users use the system and problems faced with the system, especially the interface. One method of usability evaluation that involves the user is the testing method that observes one by one the user when working on the task related to the system interface and testing using a questionnaire regarding user satisfaction with the system. This study uses the PSSUQ questionnaire, which is cheap, flexible, simple, and easy to learn. From the results of the usability evaluation, this study analyzes problems found in the SOLAP system for Indonesia Agriculture Commodity, then recommendations for system improvement are made.

2. Methods

This study was carried out through several steps. The steps of study involve system preparation, instrument designation for usability testing, sampling of the respondent, system usability assessment, analysis of the result, formulation of system recommendations for future refinement.

2.1. System preparation

The first step is preparing the SOLAP system for Indonesia Agriculture Commodity, which is developed in our previous study [1]. System preparation involves analysis of functional system and determining the appropriate method for usability assessment. Furthermore, this stage also prepares a testing environment that is integration and system installation.

2.2. Instrument designation for usability testing

In this study, the measurement of usability is based on the ISO 9241-11 definition [3]. Usability measurement includes effectiveness, efficiency, and user satisfaction. Effectiveness and efficiency are measured by completed tasks by each respondent, whereas user satisfaction is measured by the post-study questionnaire. Firstly, we design test cases which contain a list of tasks, test scenario, and questionnaire. The test case is useful to guide how to use the system for respondents.

The designed tasks and scenarios are suitable for a functional system. The post-study questionnaire adopted Post-Study System Usability Questionnaire (PSSUQ) by [4] which consist of 19 items related to system usefulness, information quality, and interface quality. To facilitate the native respondent, we translate the questionnaire to the Indonesian language. Furthermore, to discover the character of the respondent, we also designed a questionnaire related to personal data and computer literacy.

2.3. Sampling of respondent

Usability testing with 5–10 respondents can be done to identify most of the problems in a system [5]. In this study, system testing was performed by 13 respondents which consist of 4 postgraduate students from Bogor Agricultural University (IPB), five researchers in Agrarian Study Center IPB, 4 data analysis and data management staff of Data and Information Center, Ministry of Agriculture Indonesia.

2.4. Usability test

In this study, we conduct usability testing for SOLAP of Indonesia agriculture commodity based on one-on-one usability testing. Before the testing, the respondents get a general explanation of the system and guidance on how to perform the task in the questionnaire. At the first stage of testing, the respondent filled personal data and computer literacy questionnaire. Then, respondents perform all tasks

corresponding to instruction in the questionnaire. After all, tasks had been completed, respondents answer questions of PSSUQ. During the test, respondents were free to give comment about the system and this activity was recorded by camera and screen capture software.

2.5. Analysis of result

We used three usability measurements that are effectiveness, efficiency, and user satisfaction. After the test, we analyze the results based on tasks completed, the number of tasks completed, and questionnaire that filled out by respondents. Effectiveness is measured by the ratio of task completion rate which is calculated using Formula 1. Efficiency is measured by the time ratio of success tasks which is formulated in Formula 2. A task is categorized to be failed if the task produces an error, respondents give up in performing a task, or completion time of a task is double from the completion time by the developer [6].

$$\text{Effectiveness} = \frac{\sum_{j=1}^{R}\sum_{i=1}^{N} n_{ij}}{NR} \times 100\% \quad (1)$$

$$\text{Efficiency} = \frac{\sum_{j=1}^{R}\sum_{i=1}^{N} n_{ij}\, t_{ij}}{\sum_{j=1}^{R}\sum_{i=1}^{N} t_{ij}} \times 100\% \quad (2)$$

where:
n_{ij} = result of task *i* completed by respondent *j*; mark as 0 if failed and 1 if succeed
t_{ij} = task *i* completed by respondent *j*
N = total tasks
R = total respondents

User satisfaction measurement is based on the PSSUQ indicator, which is measured by the Likert scale 1-7 for each indicator. A high score indicates high user satisfaction. A score of user satisfaction is calculated by the average of the answer of PSSUQ. Table 1 shows indicators of PSSUQ and related question item for each indicator.

Table 1. Indicators of PSSUQ.

Indicator	Question Item
Overall	Item 1-19
System usefulness	Item 1-8
Information quality	Item 9-15
Interface quality	Item 16-18

The question items to be addressed by the respondents in the PSSUQ are as follows

1. Overall, I am satisfied with how easy it is to use this system
2. It was simple to use this system
3. I could effectively complete the tasks and scenarios using this system
4. I was able to complete the tasks and scenarios quickly using this system
5. I was able to complete the tasks and scenarios using this system efficiently
6. I felt comfortable using this system
7. It was easy to learn to use this system
8. I believe I could become productive quickly using this system
9. The system gave error messages that clearly told me how to fix problems
10. Whenever I made a mistake using the system, I could recover easily and quickly
11. The information (such as on-line help, on-screen messages, and other documentation) provided with this system was clear

12. It was easy to find the information I needed
13. The information provided for the system was easy to understand
14. The information was effective in helping me complete the tasks and scenarios
15. The organization of information on the system screens was clear
16. The interface of this system was pleasant
17. I liked using the interface of this system
18. This system has all the functions and capabilities I expect it to have
19. Overall, I am satisfied with this system

2.6. Formulation of System Recommendation

During the test, the activities of respondents were recorded. In this stage, we analyze the activities and comments from respondents to formalize system recommendations for future refinement. The recommendations were defined to improve system usability.

3. Result and Discussion

Usability testing using PSSUQ has three usability parameters namely effectiveness, efficiency and satisfaction according to ISO 9241-11. PSSUQ questionnaire measures system usability based on satisfaction with the Likert scale 1-7. The highest PSSUQ's score indicates the best satisfaction indicator. The scales used in PSSUQ are 1 = Strongly disagree, 2 = Disagree, 3 = Rather disagree, 4 = Rather agree, 5 = Quite agree, 6 = Agree and 7 = Strongly agree.

The respondents in this testing are postgraduate students, Bogor Agricultural University (IPB), researchers in Agrarian Study Center IPB, data analysis, and data management staff of Data and Information Center, Ministry of Agriculture Indonesia. Table 2 provides the numbers of respondent and testing schedule. Respondents profile is summarized in Table 3. The activities of respondents using a computer are given in Table 4.

Table 2. A number of respondents and testing schedule.

Respondent category	Number of respondents	Date of testing	Venue of testing
Postgraduate students IPB	4	16 October 2017	Applied Computing Laboratory, Computer Science Department, IPB
Researchers in Agrarian Study Center IPB	5	18 October 2017	The meeting room at Agrarian Study Center IPB
Data analysis and data management staff of Data and Information Center, Ministry of Agriculture Indonesia	4	25 October 2017	The meeting room at the Data and Information Center, Ministry of Agriculture

Table 3. Respondents profile.

Profile		Number of respondents	
		Postgraduate students in Agriculture IPB	Researchers in Agrarian Study Center IPB
Sex	Male	1	1
	Female	4	4
Study program	Computer Science	5	0
	Horticulture	0	5

Profile		Number of respondents	
		Postgraduate students in Agriculture IPB	Researchers in Agrarian Study Center IPB
Training/Experience	Programming	3	0
	Computer Network	1	2
	Data analysis	0	1
	Data Mining	0	1
	Database	1	0
Computer skill	Reliable	1	0
	Normal	4	4
	Not reliable	0	1
Duration of using computer	1-3 Jam	1	2
	4-7 Jam	2	2
	>7 Jam	2	1

Table 4. Activities of respondents that use a computer (maximum value: 5).

Activities of respondents that use computer	Postgraduate students in Agriculture IPB	Researchers in Agrarian Study Center IPB
Making documentation of information	3.6	2.6
Accessing online information	4.4	3.8
Communicating with friends	3.8	3.8
Writing a study report	3.6	4.2
Making a computer program	2.6	1.2
Doing data processing	2.8	3.4

According to Table 4 respondent computer skills is in the fair category whereas the activity that is mostly done using a computer is accessing online information. These profiles show that respondents are representative to perform usability testing for SOLAP. The score of PSSUQ statements for each respondent is provided in Table 5. Summary of PSSUQ questionnaire is given in Table 6.

Table 5. The score of PSSUQ statements.

Respondent	A score of PSSUQ statements																		
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19
R1	6	6	6	5	6	7	6	5	0	5	6	6	6	6	6	6	6	6	7
R2	6	6	6	5	5	6	5	7	5	5	5	6	5	5	6	5	5	5	6
R3	7	6	6	7	7	6	6	7	6	7	7	7	7	7	7	6	6	7	7
R4	5	5	5	6	5	6	6	6	6	5	5	6	6	6	6	6	6	5	6
R5	5	5	5	6	6	5	5	6	6	6	6	5	5	5	4	5	5	5	5
R6	4	4	4	5	4	4	5	5	3	3	3	4	4	3	4	4	3	4	4
R7	5	5	5	5	4	4	4	5	3	4	3	5	4	4	4	5	4	4	4
R8	6	6	6	6	6	6	6	6	5	6	5	6	6	6	6	6	6	6	6
R10	5	5	5	4	6	6	6	6	4	5	5	6	6	6	7	7	6	6	6
R12	6	5	6	6	6	6	6	7	3	6	6	6	6	7	7	6	6	6	6

Note: R1, R2, and so on: Respondent 1, Respondent 2, and so on; S1, S2, and so on: Statement 1, Statement 2 and so on; R9 and R11 did not fill in the questionnaire.

Table 6. Summary of PSSUQ questionnaire.

Respondent	System Usefulness	Information Quality	Interface Quality	Overall
R1	5.88	5.00	6.00	5.63
R2	5.75	5.29	5.00	5.47
R3	6.50	6.86	6.33	6.63
R4	5.50	5.71	5.67	5.63
R5	5.38	5.29	5.00	5.26
R6	4.38	3.43	3.67	3.89
R7	4.63	3.86	4.33	4.26
R8	6.00	5.71	6.00	5.89
R10	5.38	5.57	6.33	5.63
R12	6.00	5.86	6.00	5.95
Average	5.54	5.258	5.433	5.424

Testing results in Table 5 shows that all indicators in the PSSUQ questionnaire have a value greater than the middle value (4). The average score for each aspect is system usefulness 5.54, information quality 5.258, interface quality 5.433, overall 5.424. Based on these respondents evaluation we conclude that all aspects of the PSSUQ questionnaire are important. Figure 1 illustrates the graph of PSSUQ questionnaire summary.

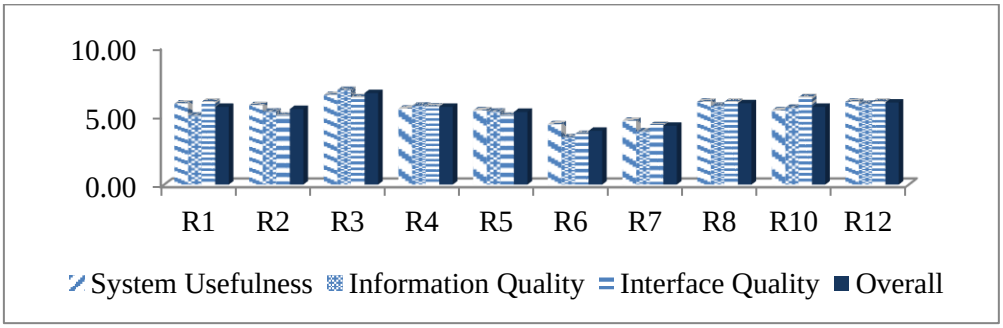

Figure 1. PSSUQ questionnaire summary.

In addition to usability testing using PSSUQ questionnaire, we conducted task-based testing of the SOLAP for Agricultural Commodities Indonesia. Respondents perform several tasks which will be evaluated based on the success of task completion. For example the tasks were performed by the respondents on data cube food crop are as follows.
Display productivity values of paddy in all districts in West Java Province, Java island.

Task 1. Display productivity values of paddy in all districts in Indonesia
Task 2. Save the results of OLAP operation at *task* T2 in Microsoft Excel format
Task 3. Display *bar chart* for productivity values of paddy in all districts in Indonesia in the period of 2004-2014
Task 4. Save the results of OLAP operation at *task* T4 in PDF file
Task 5. Display map for productivity values of paddy in all districts in West Java Province in the period of 2004-2014
Task 6. Save the results of OLAP operation at *task* T6 in file PDF.

All respondents can complete all tasks given on the data cube food crop. Some improvements recommended by the respondents are as follows

1. Provide data unit on query results in table, graph, and map for all sub-sectors.
2. Provide data source at the new page or at the footer
3. Use location code provided by Statistics of Indonesia (BPS)
4. Identification in using certain commodities to be shown

Figure 2 shows the main page of SOLAP after improvement based on the respondent's recommendation. Graph and map visualization in SOLAP are illustrated in Figure 3 and Figure 4, respectively.

Figure 2. The main page of SOLAP for Agricultural Commodities Indonesia.

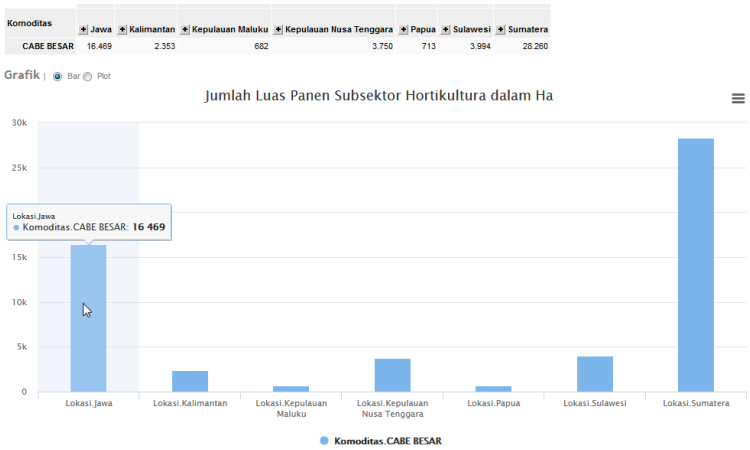

Figure 3. Graph visualization in SOLAP for Agricultural Commodities Indonesia.

Figure 4. Map visualization in SOLAP for Agricultural Commodities Indonesia.

4. Conclusion

Evaluation of usability SOLAP of for Agricultural Commodities Indonesia was successfully carried out based on the assessment of 13 respondents who were postgraduate students from Bogor Agricultural University (IPB), researchers in Agrarian Study Center IPB, data analysis and data management staff of Data and Information Center, Ministry of Agriculture Indonesia using PSSUQ. The results show a good value from aspects of the system usefulness 5.54, information quality 5,258, interface quality 5,433, overall 5.424. In addition, task-based testing shows that respondents, in general, can complete the task given. Some improvements recommended by the respondents are providing unit data on query results in crosstab tables, graphs, and maps for all sub-sectors; providing data sources at the new page or at the footer; use location code provided by Statistics of Indonesia (BPS); identification in using certain commodities to be shown.

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