Management Information System Design Hospital Health Services Using Scrum

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Abstract The standard of health services for health providers is to provide maximum service to patients. Based on the Ministry of Health Number: 129 / Menkes / SK / II / 2008 the waiting time of patients is approximately 60 minutes so we can assume that the management of the average time in the field is 15 minutes the process of retrieving queue numbers, 40 minutes waiting time and checking patients and 25 minutes time prescription retrieval at the pharmacy, with the translation of the allocation time we can develop an Agile development system with Scrum framework. Development using Scrum framework itself is used to overcome the problems of development time and human resources so that the results obtained can be evaluated to determine the level of functionality and effectiveness of the system in terms of user satisfaction and increase the quality of service providers and medical personnel.

***Keywords*—health services, medical providers, medical personnel, patient, agile, scrum.**

I. INTRODUCTION

Health service standards for health providers in this case health centers, hospitals, clinics and polyclinics, and health workers in this case (doctors, nurses, midwives), are service standards based on the authority that has been submitted and must be carried out by the organizers and health workers themselves. To improve the quality of services in terms of queuing time, and health workers for the quality of workers and health providers that have an impact on increasing economic efficiency in terms of outpatients and increased financial management and health workers.

Waiting time is the distance and time the patient uses to get health services from the place of registration, the selection of medical personnel (doctor) to the doctor's examination room. Distance and waiting time of patients is one of the potential components of causing dissatisfaction. The length of time the patient waits reflects how the health provider manages the components of the service tailored to the patient's situation and expectations [1].

Waiting times and check times that are expected to be satisfactory or unsatisfactory for patients include when patients come from registering to counters, queuing and waiting for calls to public clinics to be examined by doctors, nurses or midwives for more than 90 minutes (category long time), 30 - 60 minutes (medium category) and ≤ 30 minutes (fast category) [2] . Waiting time in Indonesia is determined by the Ministry of Health (Kemenkes) through minimum service standards. Every hospital must follow a minimum service standard about this waiting time. Minimum service standards in outpatient-based on Ministry of Health Number: 129/Menkes/SK/II /2008 are less than or equal to 60 minutes [2].

Based on the Ministry of Health Number: 129 / Menkes / SK / II / 2008, we find assumptions about the management of the average time in the field, 15 minutes for queuing number, 40 minutes for waiting time and patient examination and 25 minutes for taking prescription at the pharmacy, assuming the time that has been described can cut the distance of ticket pick-up time and waiting time for patient examination by developing a system using the Agile development approach with Scrum framework. Development using Scrum framework itself is used to overcome the problems of development time and human resources so that the results obtained can be evaluated to determine the level of functionality and effectiveness of the system in terms of user satisfaction.

II. LITERATURE REVIEW

A. Agile

1. Agile development methods are defined in four values commonly called the Agile Alliance's Manifesto, including [3]:

a) **Interaction and personnel** are more important than processes and tools, in agile interactions between team members are very important, because without good interaction the software

manufacturing process will not run according to plan.

b) **Functional software** more important than complete documentation, when performing a demonstration process with clients, software that works properly will be more useful than complete documentation.

c) **Collaboration with clients** more important than contract negotiations, one characteristic of agile is that clients are part of the software development team. Good collaboration with clients during the software manufacturing process is very important when using agile. Because the functions of the software developed must be continuously discussed and improvised according to the wishes of the client.

d) **Response to changes** more important than following the plan, agile development methods focus on the speed of the team's response when the client wants changes during the process of making software.

B. Scrum

Scrum is one of the agile development frameworks. Scrum can overcome adaptive problems complex, by increasing the productivity and creativity of each stakeholder involved. Scrum is not a process or technique for building a product. Instead, Scrum is a framework that can be using various processes and techniques [4] [5].

Scrum is suitable for the development of Agile Business Intelligence at Puti Bungsu Hospital because of Scrum using empirical methods or in other words, each stage involves inspection and adaptation. The thing it indicates that Scrum avoids more risk at the end of the project which means saving money project. Scrum can also adapt quickly to technical / business changes, which are very important considering the hospital does not have an IT department, so the technical / business needs are in the system will be built prone to change [5].

Another thing is because the Puti Bungsu hospital has a limited amount of funds, time and stakeholders which are available. Scrum is suitable for system development projects consisting of 3-5 people. Scrum too including the nature of agile which means the time needed for the project is relatively short, so it is automatic save funds and stakeholders [5].

C. User Acceptance Testing (UAT)

User Acceptance Testing (UAT) is a testing methodology in which all users/clients are involved in testing system to validate their system according to their needs. The intended needs are adjusted with technical, design, business and management parameters [6]. UAT is also often known as "last stage of testing" to ensure that user needs are met or not [6].

In the case of a hospital, UAT is used in the analysis of chapter 5 where all users are includes directors, administrators, doctors and patients, operatives involved in testing. Output from UAT process this is testing the needs of the Puti Bungsu hospital, whether it has been fulfilled or not. Method used is a test case.

Test case is a set of conditions or variables where the tester will determine whether a system is the tested meets the requirements or works correctly [6]. A test case is a document, which has a test data set, prerequisites, expected results and postconditions, were developed for a particular test scenario to verify compliance with certain requirements. The Test Case acts as a starting point for test execution, and after applying a set of input values, the application has definitive results and leave the system at some endpoint or also known as execution postcondition[6]. Test case on generally in the form of a table containing things to be tested, test scenarios, outputs, expected results and validation the (already appropriate or not).

D. PSSUQ (Post-Study System Usability Questionnaire)

PSSUQ (Post-Study System Usability Questionnaire) is a package of questionnaire questions containing as many as 16 up to 19 questions. This question questionnaire package has the purpose of assessing user satisfaction with system tested. Questions 1-16 state Overall (whole), questions 1-6 discuss System Quality, questions 7-12 discuss Information Quality, questions 13-16 discuss Interface Quality [7].

III. METHODOLOGY

A. Data Collection

This research is an observational epidemiological approach, namely by using the Cross-Sectional research method. Cross-Sectional is a research design using measurements or observations at the same time (once in a while) between risk or exposure [8]. The tool used in this study is a questionnaire in which respondents just fill it with answers that are in accordance with what is felt by the respondents.

In this study, the sampling technique used is random sampling, which means the technique of determining the sample with certain considerations. The sampling method uses odd numbers or respondent numbers, for example from numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, only numbers, 1, 3, 5, 7, and number 9 are only taken to make it easier to give questionnaires every day, in one day the researchers gave questionnaires to respondents around ± 14 to 15 respondents with an effective day 24 days. The process of data collection began when the study was planned for September 2 in the Hospital of Ganesha Polyclinic by means of researchers coming and giving queue numbers to respondents who came for treatment who were waiting for a call to enter the doctor's examination room, in the middle of the queue waiting for researchers to give questionnaires to respondents to be filled in according to the respondent's answer.

B. Observation Data

Subject characteristics in this study include: touch time and waiting time. Can be seen in the following table:

1. Characteristics of Subjects

Table 1 Frequency distribution of patient waiting

times for the level of satisfaction at the Hospital Poyclinic on 15 January to 07 February 2018.

TABLE I
FREQUENCY DISTRIBUTION OF PATIENT WAITING TIEMS FOR THE LEVEL OF SATISFACTION

#	Criteria	Frequency	Percentage
1	Quick	12	3,4%
2	Medium	189	53,2%
3	Slow	154	43,3%
	Total	**355**	**100%**

Based on Table I, it can be seen that there were 12 respondents (3.4%) with satisfaction categories stating that the waiting time was fast and only 154 respondents (43.3%) stated that the waiting time used to wait in the queue was long.

Table 2 Frequency distribution of patient touch time to level of satisfaction at the Hospital Polyclinic on 15 January to 07 February 2018.

TABLE II
FREQUENCY DISTRIBUTION OF PATIENT TOUCH TIME TO LEVEL OF SATISFICATION

#	Criteria	Frequency	Percentage
1	Quick	12	3,4%
2	Medium	189	53,2%
3	Slow	154	43,3%
	Total	**355**	**100%**

Based on Table II it can be seen that there were 12 respondents (3.4%) stating that the services provided were very fast, and as many as 154 respondents (43.3%) said the services of the old medical officers.

Table 3 Frequency distribution of satisfaction levels at the Hospital Polyclinic on January to 07 February 2018.

TABLE III
FREQUENCY DISTRIBUTION OF SATISFICATION LEVELS

#	Criteria	Frequency	Percentage
1	Very satisfactory	0	0%
2	Good enough	13	3,7%
3	Less satisfactory	179	50,4%
4	Not satisfactory	163	40,9%
	Total	**355**	**100%**

Based on Table III, it can be seen that there are 0 respondents (0%) who stated that they were very satisfied with the service of waiting time and touch time provided by medical officers, while 163 respondents (40.9%) stated they were not satisfied with the services provided by the Hospital Polyclinic.

Based on the results of patient waiting for time distribution, patient touch time distribution, and patient satisfaction level distribution, the results required the development of a patient queuing system to reduce waiting time, touch time and patient satisfaction with medical personnel at the Hospital Polyclinic.

C. System Planning

System Design discusses research methodology from the beginning - the end of the study. There are 4 stages main, but the stage is broken down again into 6 stages. For more details, fig. 1. Research Methodology Outline.

D. Product Backlog

This Product Backlog is a fraction of the process that will be carried out based on the needs analysis functionality in the previous step. Based on the steps in needs analysis, this product backlog divided into 7 users with their respective roles/tasks that match their priorities.

The priority determines the length of the sprint (number of days) be carried out in the next step. The higher the priority, the longer the sprint length (number of days). Sprint priority and length (the number of days) determined by an agreement between the director (Product Master) and the design team leader (Project Manager). The technical parameters that become the reference are the complexity of the program in terms of design and functionality. The higher the level of complexity, the longer the number of days. Priority refers in the Hansoft Project Scrum Management software, which is divided into 4 categories:

a) Very High Priority: sprint length 12-14 days
b) High Priority: 10-12 days sprint length
c) Medium Priority: sprint length 7-9 days
d) Low Priority: sprint length 4-6 days

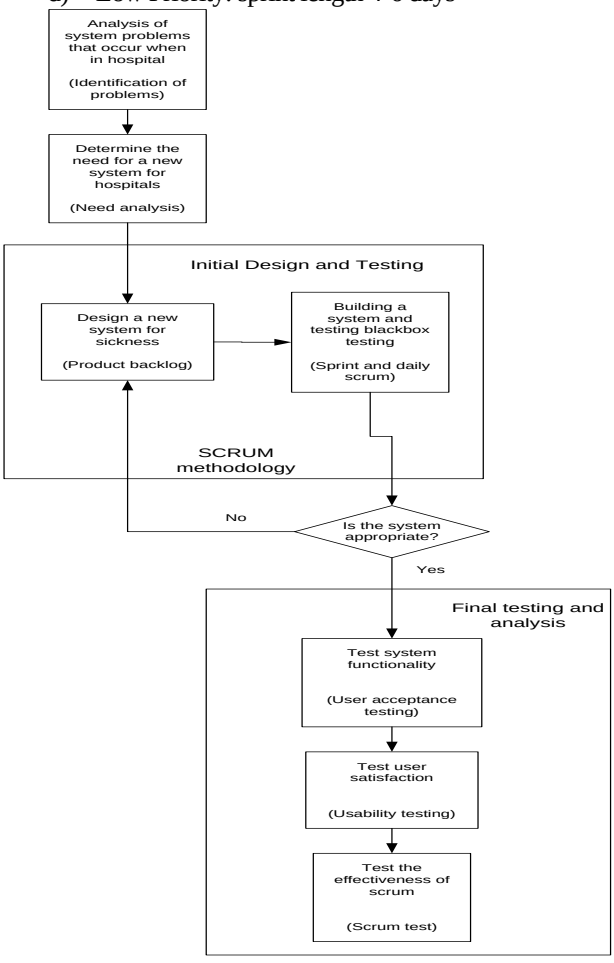

Fig 1. Research Methodology Outline

TABLE IV
EARLY PRODUCT BACKLOG

#	Product Backlog	Status	Priorty	Note
1	Administrator	Not done	Very High Priority	
	Home page / login	Not done	Very High Priority	

	Admin Dashboard	Not done	Very High Priority	
2	Doctor	Not done	Medium Priority	
	Doctor's dashboard	Not done	Medium Priority	
	Looking at the patient's medical record data	Not done	Medium Priority	
	CRUD resep obat pasien	Not done	Medium Priority	
3	Operator	Not done	High Priority	
	Operator Dashboard	Not done	High Priority	
	CRUD patient medical record data	Not done	High Priority	
	Looking at the patient's medical record data	Not done	High Priority	
	CRUD patient registration Street	Not done	High Priority	
	Sequence number of the patient's queue Street	Not done	High Priority	
4	Patient	Not done	Very High Priority	
	looking for hospital data, doctors and reviewing doctor's performance	Not done	Very High Priority	
	registration and retrieval of queue numbers	Not done	Very High Priority	
5	Director	Not done	High Priority	
	Director's Dashboard	Not done	High Priority	
	Related decision making hospital evaluation	Not done	High Priority	

E. Sprint

Sprint and daily Scrum are divided into 4 stages:

a) Sprint and daily Scrum administrator panel
b) Sprint and daily Scrum opertor panel
c) Sprint and daily Scrum doctor panel
d) Sprint and daily Scrum panel directors

For each stage, there are at least 3 processes, namely Sprint at the time of status in progress, sprint at the time status completed and daily Scrum. Sprints are carried out by stakeholders including Project Manager, programmer 1 and programmer 2. While during the daily Scrum process testing blackbox testing involving all stakeholders including the hospital director. That is because the hospital director has the authority to stop/continue the sprint, and so that the project can be completed faster.

Blackbox testing will produce an answer whether the system functionality is appropriate or not. If the system functionality is appropriate and the hospital director is satisfied, it will continue to the sprint next. If not, then the 2nd, 3rd, Scrum daily will be carried out, and so the system functionality is really appropriate.

F. Questionnaire Design

TABLE V
QUESTIONNAIRE DESIGN

#	Question	Likert Scale				
		1	**2**	**3**	**4**	**5**
1	Overall, I am satisfied with how much easy to use this system.					
2	Easy to use system					
3	I can complete assignments and scenario using this system					
4	I feel comfortable using the system this.					
5	Easy system to learn					
6	I believe in a short time can be productive using this system.					
7	The system gives an error message tell me how to fix the error.					
8	When I make a mistake using the system this, easily and quickly I can return to normal system.					
9	Information on this system is clearly presented.					
10	I can easily find information which are desired.					
11	Information presented effectively can help complete tasks and use scenarios this system.					
12	The organization of information displayed on screen, clearly presented.					
13	The interface presented feels comfortable and fun.					
14	I like to use the interface on this system.					
15	The system has the functions and capabilities that I have expect it.					
16	Overall, I am satisfied to use this system.					

IV. RESULTS AND DISCUSSION

A. SWOT Analysis

Strategic planning method for evaluating factors that influence business attainment of goals, namely strengths, weaknesses, opportunities, and threats, both short and long-term goals.

1. Strength: With the data that has been distributed, all patient data queue recording can be accessed anywhere at any time by patients or medical personnel, thereby reducing patient waiting time.
2. Weakness: In terms of medical personnel, it is expected to register patients in full and according to procedures,

while from the patient's side to dare to try this application, in the future, it may be expected that there are regulations that regulate medical record data and information and the obligation to use health facilities using this system.

3. Opportunities: Going forward with this system can minimize the incidence of malpractice or wrong diagnosis, with a set number of diseases and drugs can provide references to diseases in an area where there is no cure.
4. Threats: Medical information can be seen by medical personnel in a medical facility, confidentiality of patient disease data can be seen by medical personnel who handle and use information wisely, but this returns to the oath of medical staff and regulating regulations.

B. PIECES Model

According to Wukil Ragil, the PIECES method is an analytical method as a basis for obtaining more specific issues. In analyzing a system, it will usually be carried out on several aspects including performance, information, economy, application security, efficiency and customer service. This analysis is called PIECES Analysis (Performance, Information, Economy, Control, Efficiency, and Service).

TABLE VI
PIECES MODEL

Indicator	Current System	System Usage
PERFORMANCE	Using the current manual documentation system is not optimal in terms of service, data storage, because the queue data is still stored manually and varies according to health facilities.	With a smartphone & web-based queue-based data storage system this service and data processing will be faster.
INFORMATION	Data on medical services are still manually written and stored either in cabinets or file racks, if it is already computerized it is only limited to one scope of the health facility.	Distributed system-based health service systems will provide convenience and speed in finding patient information, and with distributed systems patient information can be seen/known throughout the health facilities, so that patient information becomes centralized and complete.
ECONOMIC	The number of people who need health services is always increasing and increasing, this, in the long run, will have the effect of manually storing data, both in terms of storage and maintenance, which consumes funds and enough space.	The health care system that has been computerized and stored on a server that can be accessed by all health facilities, so that server maintenance costs can be as minimal as possible because it is borne by all related health facilities.
CONTROL	Data on health services stored manually will be difficult to control, especially with a very large amount of data, so the possibility of errors in data retrieval or damage is very likely to occur.	The health care system will facilitate the control of medical personnel so that the possibility of data errors can be minimized and file damage will not occur.
EFICIENCY	The manual system is very inefficient, taking the waiting number is taken manually.	Very efficient taking patient waiting for numbers through smartphones and operators using web-based.
SERVICE	Service to patients with manual methods is very time to consume because everything is done manually so it requires a lot of time and effort.	Service to patients will be faster and the doctor's diagnosis is faster and more precise because the patient's waiting time has been managed in the system so that the process of calling data/information can be done quickly.

C. User Acceptance Testing (UAT)

In the Administrator Panel, there are three product backlogs that will be tested, namely the front page / login, CRUD for all admin users and dashboards. UAT results show technically that 100% of the output is in accordance with which are expected. For more details, please see the following table:

TABLE VII
USER ACCEPTANCE TESTING (UAT)

#	Product Backlog	Scenario	Expected output	Validation
1	Home page / login	The user entered the username and password correctly	The page will move to dashboard	OK
		The user enters a username and password wrong	A username and password warning will appear incorrectly	OK

2	CRUD for all users	Test the create function for operator accounts, doctor, patient, director	The create account function runs well. All accounts can increase	OK
		The user fills out the operator update form, doctor, patient, director then change the data	Account data the selected changes	OK
		Users search for hospital data, doctors, appointment lists based on names in the search box	User search results will appear	OK
		User deletes data	Data will be deleted	OK
3	Admin Dashboard	After logging in, go to the dashboard page		OK

Every functionality of the Director Panel runs well and is technically in accordance with the wishes of the user.

D. Usability Testing

After getting the results of the average value of each question. The next step is to calculate each average question. Questions 1-6 cover the aspects of System Quality, questions 7-12 cover the Information aspect Quality, questions 13-16 include the Interface Quality aspect. Then the value of each aspect returns to the average to get the overall value (Overall). The following is table 4-10 which shows the average of each aspect:

TABLE VIII
THE AVERAGE OF EACH ASPECT

Aspect	Score
System Quality	4.43
Information Quality	3.57
Interface Quality	3.82
Overall	3.94

Based on the results above, the lowest average score is 3.57, namely the Information Quality aspect. Aspect Information Quality gets the lowest score due to several factors, including information displayed ineffective and the organization of information displayed is unclear. This causes the user difficulty in getting the information needed. However, the Information Quality score is still above the value middle 2.5, it shows that the Information Quality produced is still relatively good and the value of 3.57 is not so influential. The highest average score is 4.43 which is in the aspect of System Quality. That matter shows that the system is easy to use and the system is useful for the user in supporting his work. Interface Quality aspects get an average score of 3.82.

Overall (overall) the system gets an average score (mean) of 3.94 which shows above the value middle 2.5. This shows that the average user is satisfied with the system as a whole.

TABLE IX
RESULTS OF RESPONDENT'S ANSWER

Aspect	Score (%)
System Quality	88.75
Information Quality	71.45
Interface Quality	76.56
Overall	78.92

Based on the results in Table User Application Testing (UAT), it is explained that System Quality scores 88.75% of users have agreed with the quality of the system that is owned, Information Quality gets the lowest score of 71.45% but still in the agreed / good category, Quality Interface gets a score of 76.56% and overall the system has a score of 78.92% which according to the Likert scale results table goes into the Agree, Good, or Like category.

E. Scrum analysis is based on the results of project development

This timeline analysis aims to calculate the total time of the entire project from the beginning. Based on project time requirements analysis. In reality, the time to develop this system takes 150 days. Broadly speaking, time is divided into two, namely the design time which is divided into 5 sessions and time daily Scrum (evaluation). The details are as follows:

a) Panel Admin: 14 days (02-01-2018 to 13-01-2018)
b) Panel Operator: 14 days (17-01-2018 to 31-01-2018)
c) Doctor Panel: 10 days (01-02-2018 to 10-02-2018).
d) Panel Director: 10 days (14-02-2018 to 24-02-2018)
e) Panel Patient: 20 days (27-02-2018 to 19-03-2018)
f) Total Time of Design: 68 days
g) Daily Scrum Total Time: 58 days
h) Total Project Time from the beginning: 150 days (02-01-2018 to 31-05-2018)

V. CONCLUSION AND FUTURE WORK

Evaluation has been carried out using User Acceptance Testing (UAT) to test system functionality and Usability Testing to test user satisfaction. The test results of User Acceptance Testing (UAT) using the test case method show that 100% of the product backlog testing scenario produces a valid output. This shows that the system functionality has been running as desired by the user. The results of Usability Testing with the questionnaire method show the average value. overall (overall) system is 3.94 (above the mean 2.5) and the satisfaction value shows 78.92% of users agree. Based on the Likert scale table, it shows that broadly the user is satisfied with the system that has been built. An evaluation has been carried out to measure the effectiveness of Scrum. The evaluation includes analysis based on the timeline, analysis based on expenditure and analysis based on system improvements. The evaluation results show Scrum can meet limited design requirements in terms of time, this is indicated by the design time that is below the target time. The results of the evaluation based on the expenditure of funds indicate that Scrum can save on expenditure because payment is made every sprint count which means the funds are managed well. Evaluation results based on system improvements show

Scrum is fast for changes made and Scrum is static, meaning that if there is a change in product backlog it will not affect other product backlogs. From the three analyzes above, it shows that Scrum has fulfilled the design aspects of the information management system and the design of hospital health services which are limited in terms of funding, time and human resources. The development of information management systems and the design of hospital health services using Scrum is expected to improve the quality of health services in terms of patient waiting time and the performance of medical personnel.

Add analysis to measure Scrum effectiveness. With the growth of the system and future data, several features can be developed, including processing of data mining and machine learning in medical records.

REFERENCES

[1] A. E. P, Y. Puspitasari, and A. Rusmawati, "Pengaruh Waktu Tunggu Dan Waktu Sentuh Pasien Terhadap Tingkat Kepuasan Pasien Poli Umum Di Puskesmas Sukorame Kota Kediri," pp. 1–8, 2013.

[2] Anonim, "Keputusan Menteri Kesehatan Republik Indonesia Nomor 129 tentang Standar Pelayanan Minimal Rumah Sakit." Kemenkes RI, Jakarta, 2008.

[3] R. Wulan, "Pengembangan Konfigurasi Model Analisis Arsitektur AgilePada Perusahaan Bisnis IT Online (Studi kasus Lazada dan Bhineka . com)," vol. 9, no. 2, pp. 166–177, 2016.

[4] J. Sutherland, A. Viktorov, J. Blount, and N. Puntikov, "Distributed scrum: Agile project management with outsourced development teams," *Proceedings of the Annual Hawaii International Conference on System Sciences*, pp. 1–10, 2007.

[5] K. Schwaber and J. Sutherland, "The Scrum Guide - The Definitive Guide to Scrum: The Rules of the Game," 2011.

[6] M. Bolton, "User Acceptance Testing – A Context-Driven Perspective User Acceptance Testing in Context," pp. 1–13, 2007.

[7] A. Frughling and S. Lee, "Assessing the Reliability, Validity and Adaptability of PSSUQ," *AMCIS 2005: Proceedings of the 11th Americas Conference on Information Systems*, pp. 2394–2402, 2005.

[8] S. Nursalam, Pariani, *Pendekatan Praktek Metodologi Research Keperawatan.* Jakarta : Sagung Sentosa, 2001.