Analysis and information system designs of surveillance infection control system in the hospital

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Abstract. Almost of infection diseases transmitted in a hospital by medical divides. Until now there is no surveillance system that can store data about system infections in hospitals. This study aims to analyse and identify the design of information systems in hospitals. The method used is using Rapid Application Development (RAD). The results of this study consist of the duties and functions of health workers in the surveillance system as well as data that needs to be known when conducting surveillance. Conclusion in this study was identifying the duty of health workers as users and data that needs to be taken in conducting surveillance.

1. Introduction

Recently, a Healthcare associated infection (HAIs) becomes a huge issue. Regarding the number of diseases increases in a hospital. For the two last decades, HAIs becomes the main problem about safety services in hospital [1]. Based on WHO (2009) [2] estimated that more than 1.4 million peoples in the world suffering from an infection which acquired from the hospital. In a modern hospital, 5-10% of peoples acquired one or more infection and reached 25% in developing countries [2]. Healthcare associated infection or nosocomial infection was the infection which received from more than 72 hours hospitality wherever the patients did not show the sign and symptom of infection when they were admitted in hospital [3]. The infection acquired from the hospital can be transmitted by cross infection or autoinfection.

In the case of HAIs, the majority of acquired infection transmitted by cross infection. Cross infection enters the body by port de entry. Port de entries were the entrance of germ by body mucosa or open wound. In HAIs, port de entry identification by Intra Venous line (IV line), catheter line, Central Venous Catheter (CVC) [4] and Endotracheal Tube (ETT) tract [5]. These pathways have the potential as a port the entry for germs which called nosocomial infections. This line increased the incidence of HAIs.

In the last decade, the hospital quality assessed by the number of HAIs. The high rate of HAIs in a hospital indicated to decrease the quality of hospital services, especially regarding patient safety. Recently, surveillance infection control system according to HAIs in Indonesia nothing appropriate yet. Then, the numbers of HAIs were not yet appropriately seen. However, the incident of HAIs is still growing. Therefore, be required for the surveillance system to control the infection.

A surveillance system is a collection, analysis, and interpretation of data for planning, implementing and evaluating system [6]. Recently, the development of information technology serves opportunities for both manufacturing and company as one of the competitive strategies including hospitals. Therefore, the applications of technology in hospital management provide an effective and efficient impact. Within
a management information system, the employee does not have to enter data and analyse manually [7]. From these reasons above, for developing of surveillance infection control system in a hospital need analysis and information system design before build the surveillance infection control system itself.

2. Literature
2.1. Information system
The system can be defined as a collection of elements from components that are interconnected with one another and form a unity to achieve certain goals. The role of the information system is to process data into information. Data processed through a model will produce information, the recipient of information will make a decision and take an action, which means that it will make some data back. The data will be captured as input, reprocessed through a model and so on to form a cycle. This cycle can be shown on figure 1 is called the information cycle [8].

![Figure 1. Information cycle.](image1)

![Figure 2. RAD Phase.](image2)

Rapid Application Development (RAD) is a method of developing object-oriented information systems [9]. With this development method the development of information systems can run shorter. When RAD is implemented, users can be part of the development of the whole process and are capable of being decision makers at each stage of development. Stages in RAD can be shown on figure 2 [9].

2.2. Health-care associated infections (HAIs)
According to the World Health Organization [2], healthcare associated infections (HAIs) are infections that occur in patients during the treatment process in hospitals or other health facilities, before being treated these patients did not have similar symptoms and were not in the incubation period. The Ministry of Health revitalizes infection prevention and control programs in hospitals that aim to improve patient safety and reduce the risk of infection acquired and disseminated among patients, staff, health professionals, contract workers, volunteers, students and visitors [10].

Health care facilities are a very risky environment for infection, infected people and people who are at increased risk of infection gather there. Other factors that increase the risk of spreading infection include the condition of a crowded hospital, frequent patient transfers from one unit to another, and patients with a high risk of infection in the same place. Infection can also be caused by contaminated objects, such as medical equipment, and other materials that can be touched by many patients [11]. Ninety percent of the causes of HAIs are caused by bacteria, while the rest are caused by micro bacterial, viral, fungal and protozoa [11]. The spread of this infection can occur through 3 main things, namely [12]: Contact (direct or indirect), droplet transmission and Air bone transmission.

HAIs do not occur spontaneously, they are the result of a number of steps in the process that allow an organism to colonize and / infect vulnerable hosts. These steps are related and are often referred to as the "Transmission Chain". Transmission of infectious agents requires three elements [13].
A Source (source of infection) Sources of infection include: patients, health workers, visitors, the environment and equipment.

Means/ mode of transportation the way organisms are picked up and taken to the host, namely through (contact, droplet and air).

A Susceptible host Infection is the result of a complex link between potential hosts and infectious agents. Most factors that influence the occurrence of infection and the severity of the disease are related to the host.

3. Methods
3.1. Research Design
These studies using Rapid Application Development (RAD) plan to develop information system design. Rapid Application Development was the information system development methods with a subject point of view and faster development [14]. Based on Kendall & Kendall [9] the phase of RAD divide into three steps. They were planning, workshop and implementing. In this study use two stages of RAD to analysis the information system design. They were planning and workshop.

3.2. Research Framework
The research framework divided into two steps based on RAD. The first step was planning. The planning step including identification of the problem. To including identification of the problem, this study used two collection methods. They were primary data and secondary data. Primary data collected by interviewed and Focus Group Discussion (FGD) with the user based on Whitten et al. [15] by two steps. First step, System initiation has identified the problem; system analysis by analysing and understand the problem, identify solution requirements or expectations. These concepts were a combination of RAD and Whitten et al. [10] theory. The subject of this study was health worker especially nurse in a hospital. Secondary data collected with the literature review. The literature was searching on internet based which appropriate with this study. The keywords were used to search process including RAD, HAIs, nosocomial infection.

The second step was RAD and design workshop. In this step, the user and researcher work together to design the system then develop the system by analysis and identification the design of surveillance infection control system in the hospital. In this stage, the analyst designed the information system based on output from planned needs that have been prepared. Users and analyst will work together, and users advise analyst works. It called Group Decision Support System (GDSS). This is the ideal steps because the user and analyst can make the agreement of the design and develop to be a prototype. After the GDSS finished, then system development tools and technique were developed. In this study, flow diagram, activity diagram, and use case diagram were used to create the system.

4. Result
The aim of this study is to Analysis and Identification the Information System Designs of Surveillance Infection Control System in the Hospital. To get the result, this study needs to do some activity. There are identification needs, architecture design, process design, activity diagram, and display design.

4.1. Identification of needs.
There is some point which a part of identification needs. There were functional requirements analysis, input requirements analysis, process requirements analysis, and “use case diagram” output requirements analysis.

At the functional requirements analysis stage, the authors conducted theoretical studies, interviews, and FGDs. Academic research is an attempt to harmonize studies that have been undertaken by researchers previously related to surveillance systems. At the interview and FGD stages, the author tries to dig up information related to the needs of the system in the institution. The results of the identification are as follows: data on intravenous line installation and release, data about urine catheter installation and release, data about central venous catheter installation and release, data about endotracheal tube installation and release, data on the occurrence of infection in each medical device installation, bacterial data that causes infection and antibiotic drug classes given.
At input requirements analysis steps, an application required the data input and followed by data processing until produce output by the expected goals. The input system in this system is in the form of input data from the health officer on duty. In information systems that are designed, there are several data input requirements. There are installation data input, release data input, Input infection data and antibiotic drug classes given. The input design used is designed to facilitate users where the date of installation and release use the "drop down" system. With the drop-down system, a list will be provided for all data input. Each health worker has an account for data input. This feature is provided to track who enters data into the system, moreover the track record of health workers can be traced.

At this process requirement analysis, the author designed a process that is by the expected goals. From existing theoretical studies, the author developed a process that is tailored to the needs of this system. The conclusion of process requirements analysis was the system will store input data in the form of infection events that occur in a ward, the system will display data in the form of graphs and the results of data processing.

At the output requirements analysis, output data from this system will be used as a basis in the preparing reports and as a basis for developing management strategies to overcome the level of infection that occurs. The output including the length of installation the medical devices, the system will record when the infection occurred in the installation of medical devices each days and showed in table in months, types of bacteria that cause infection, the group of antibiotic drugs, which used.

The results of the system show the bacterial profile which is often the cause of infection, from the culture results will get the results of the types of bacteria that infect patients. By getting the types of bacteria that infect it will be easier to determine the type of antibiotic that is resistant or sensitive.

4.2. Use case diagram
To be able to describe the interaction between users and the system and provide a narrative description of how the system will be used using a use case diagram. The use cases that are designed showed in Table 1 and figure 4.
Table 1. Use case diagram surveillance infection control system in hospital.

| Actor    | Use Case       | Information                                                                 | Pre-condition                |
|----------|----------------|-----------------------------------------------------------------------------|------------------------------|
| Administrator | System access | Admin is the officer who has the right to create an account for all users | Login to enter to the system |
| Health worker  | System access | Input data, see the results of the recapitulation                           | Login to enter the system    |
| Chief       | System access | Input data, see the results of the recapitulation                           | Login for entering to the system |
| Manager     | System access | Input data, see the results of the recapitulation                           | Login for entering to the system |

4.3. Activity Diagram

The modeling of the activity diagram carried out to explain the activities contained in the system. Activity diagrams can be used to describe use case scenarios in graphical notation using flowcharts. The activity diagram modeling that has been made can be seen as follows on figure 5.

![Use case diagram](image)

**Figure 5.** Use case diagram.

**Figure 6.** Activity diagram.

4.4. Process design

The design of the system surveillance process is modeled with data flow diagrams (DFD). Based on the needs analysis, the process design of the system reliability can be described as follow:

![Context diagram](image)

**Figure 7.** Context diagram.
5. Conclusion
Surveillance is a way to identify, and clarify quality issues, understand the causes and then identify actions to bring about improvements, the design of this information system can be identified as the need to support surveillance infection control systems as follows the health worker as the user and the system which contained as follow: a) data on intravenous line installation and release, b) data on the installation and release of urine catheter, c) data on central venous catheter installation and release, d) data about the installation and release of endotracheal tube e) data on the occurrence of infection in each installation of medical devices, f) bacteria data that causes infection and the class of antibiotic drugs given. The results of the system data processing are presented in graphical and tabular reports of the type of infection, the number of infections of which type is recorded every day to get accurate data.

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