Management Information Systems Development for Veterinary Hospital Patient Registration Using First In First Out Algorithm

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***Abstract*— Registration system is one of the most important elements in an organization or institution that involves the presence of customers and one by one services. Nowadays, with the development of technology, services process in an institution become more effective and efficient. One of the institutions that require the development of this technology, in the form of hospital information management system, is the veterinary hospital. The conventional system has many shortcomings include allowing an error in writing the patient data also the patient registration recaps is less effective and more time consuming. Therefore, a prototype of RSH management information system was made as an ilustration in the design of hospital information management system. The focus of this study is the patient registration system which use *First In First Out* (FIFO) algorithms where the patient who came first to the hospital is the one who enrolled first.**

Keywords—information systems; algorithms; queue system; FIFO; veterinary hospital; registration system

I. INTRODUCTION

Nowadays, information technology is a common thing for everyone. Information technology is believed to provide many benefits in daily life, one of them is for a company or institution. The utilization of information technology can increase the performance of various institutions in an effort to improves the quality of human resources and facilitate people in managing data and provides a quality, effective, and efficient information [1]. Beside that, this technology has capability to filter and process the data into information also store the data with more capacity than the manual way. With the support of information technology, data processing activity in a conventional way can be replaced by computerized information system.

Hospital is a very complex system with various activities in the health and business management fields [2]. The hospital requires a system that can organize and manage all of activities in the hospital well. Therefore, with the development of technology there is an integrated system that can simplify the process of managing hospital data, which called hospital information system. Hospital information system is a wide integrated electronic system, which is designed to regulate administrative, financial, and various aspects of the clinics in hospitals and healthcare facilities. With the use of information systems in a hospital, it's expected to provide faster service and minimize the waiting time for the patients [3]. One thing that is very important in a hospital information system is patients queue system.

RSH Prof. Soeparwi is one of the complex healthcare institutions. Recently, patient registration services at the RSH Prof. Soeparwi still done manually, where all the datas about the patient were recorded in the books of hospital records and it was recapitulated as a report. The system has many lacks, included allowing an error in the writing of the patient data, the longer time to search patient data, and the recapitulation data for patient registration is less effective. Therefore, a prototype of RSH management information system was made as an ilustration in the design of hospital information management system.

The focus of this study is in the patient registration system. This registration system is certainly required an algorithms that suitable with the service workflow in RSH Prof. Soeparwi. Based on the interviews with administration of RSH Prof. Soeparwi, patients entered the clinic based on their registration order at the hospital. Proceedings of the national conference on research and PKM health, has explained that the line model which can increase effectiveness and reduce the waiting time at the counter is a queue theory with First In First Out (FIFO) pricipal, where the first line queue will receive the service first [4]. It is also described in a study of a queue theory that FIFO queue theory is one of the best to be used, although some of them are joining with a priority class [5]. Each process in the queue system will changes anytime when there is a priority which goes into the queue [6]. Based on this problem, the authors choose to use an algorithm First In First Out (FIFO) on the establishment of registration information system where the patient who came first to the hospital is the one who enrolled first.

II. FIRST IN FIRST OUT ALGORITHM

A. *Queueing System Theory*

The queueing system is one of the options that are used in business decision-making to meet a certain service system for resources requirements [6]. Queueing systems theory begins from the study by Agner Krarup Erlang which made a telephone information exchanged model in Copenhagen [7]. However, on the progress the queueing system has been used for numerous application in the telecommunications, traffic engineering, computational techniques, and some industrial businesses such as shops, offices, and hospitals.

Queueing theory has been used very successfully by various types of industry services. L.L. Bean, one of the largest telemarketer and messenger catalogs for the best quality of sport equipments, has been used this theory in optimizing their sales and service settings, so that they receive a decent turnover. There are also several models of queueing system which can calculate the predictions of queues lenght and waiting time [7].

Queue is a waiting line of customers who require services from one or more facilities. In general, the queue system can be classified into different systems where the queue theory and simulation is often applied broadly to predicte the queue length and waiting time.

B. *FIFO Algorithm*

FIFO algorithms is the most simple algorithm. The principle of this algorithm is like the principle of a queue (queue non-priority), the patient who arrives first will be sered first well. A queue is a linear data structure that also serves as a collection of elements. Both ends of a queue are accessible for performing operations on the elements and are typically called head and tail. Elements may be inserted at any time, but only the longest element in the queue that can be removed. There are two principal operations can be performed on a queue; enqueue and dequeue [8]. The elements that are inserted from behind (enqueued) and removed from the front (dequeued) is describedd in Fig 1.

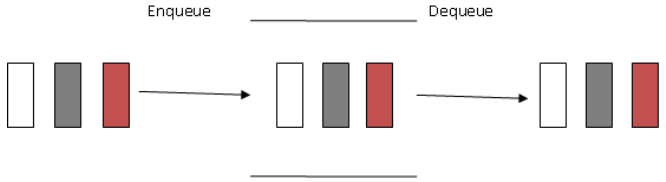

Fig 1. The theory of FIFO algorithm [8]

When an element is enqueued, it is added to the tail of the queue. Performing dequeue operation will remove an element from the front. Since the enqueued elements are always dequeued in the same order as they were enqueued. The types of queues may differ on how enqueueing and dequeueing operations are performed on elements. Circular queue, priority queue, and double-ended queue are the special types of queues. Using arrays and linked lists, queues can be efficiently implemented in high-level programe languages.

III. METHOD

A. *Research Flowchart*

This research using the waterfall method to implement the five implementation stages that illustrated in Fig 2, they are literature study, system requirements analysis, system design, system implementation, also system evaluation and improvement.

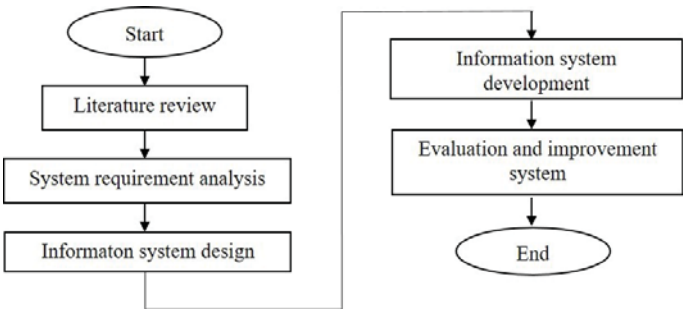

Fig 2. Research flowchart

B. *Requirement System Analysis*

Registration system at RSH Prof. Soeparwi initially uses conventional system by writing the examination results into the form and it will be recapitulated to the digital files of Microsoft Excel. Therefore, a prototype of RSH management information system was made as an ilustration in the design of hospital information management system.

Information system will be designed in three phases, there are input, process, and output. As it can be seen in Fig 3, administrator as primary user from registration system will input patient registration that divided into two type, there are outpatient and inpatient registration. The input results is processed using information systems and implemented as a list of patient visits that display a queue list, patient visit history table, also inpatients list who displays a table of entry and inpatients exit. Lastly, the output is taken out in the form of recap reports that are useful for administration utilities of RSH Prof. Soeparwi.

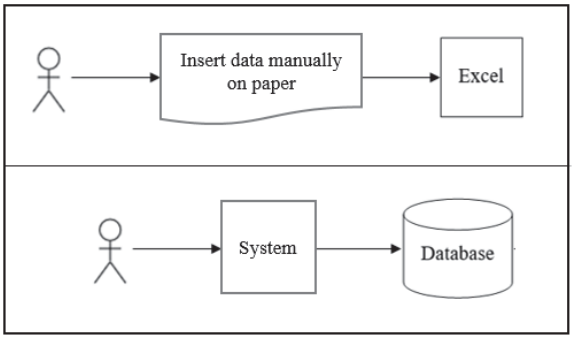

Fig 3. Conventional system (up) and implementation system (down)

The system is created in a web-based information systems. It is because the registration system that has been built on this research will be integrated with another sub-systems, there are medical record systems, pharmacy, and billing that requiring multiple devices at different rooms in one location. Moreover, it is also the hospital requirement to be able managing online system that can be accessed outside the hospital, for example, a doctor can charge the medical records of hospitalized patients from wherever they are, through the devices which they have.

1) Use Case Diagram: From a describe conceptual model, it can be made an use case as illustrated in Fig 3 above. In this system there is one person who can manage everything and it is registration officer. The system has eight main functions as shown in Fig 4, there are login, list of queueing patients, form to add queueing patients, form to add a new patient, list of patient, form to add inpatients, list of inpatients, list of history patient visits, and report.

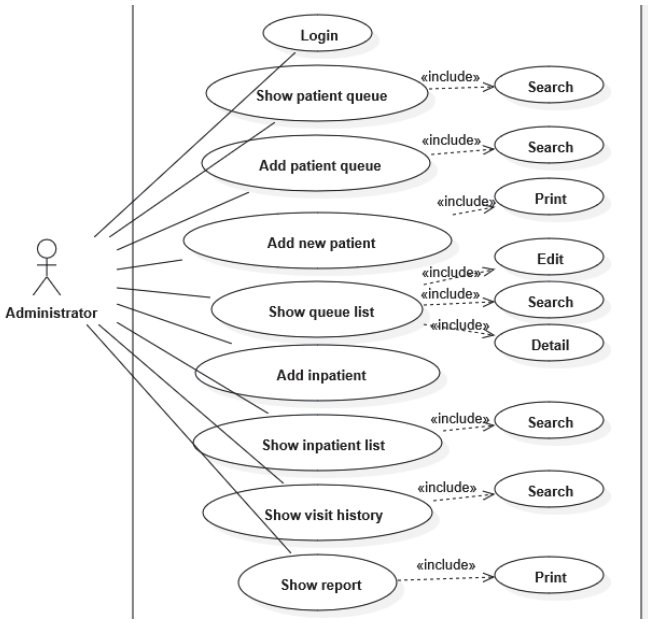

Fig 4. Use case diagram

2) Relational Diagram: Database design is a process to determine the content and arrangement of data required to support a various of system designs. Relational diagram used to represent logical relationships between the entities that involved in a database system in the data models. In this case, there is five tables that is related one another in Fig 5.

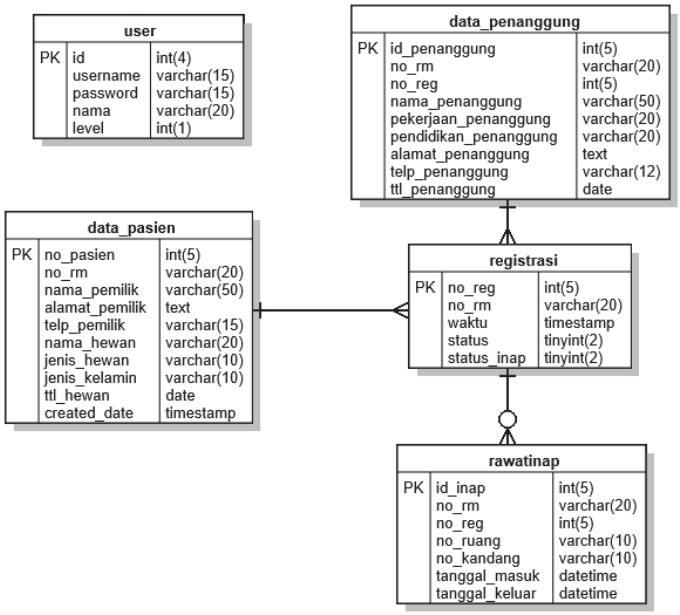

Fig 5. Relational diagram

C. *FIFO Algoritm Design in Queueing System*

The program that are built in this queue system uses FIFO algorithm. FIFO algorithm was applied in a single line that will put the latest line and will take out the first line. This algorithm consists of two operations, they are enqueue and dequeue process. Enqueue is the process of entering data into the last row of the queue while dequeue is processing data at the earliest row.

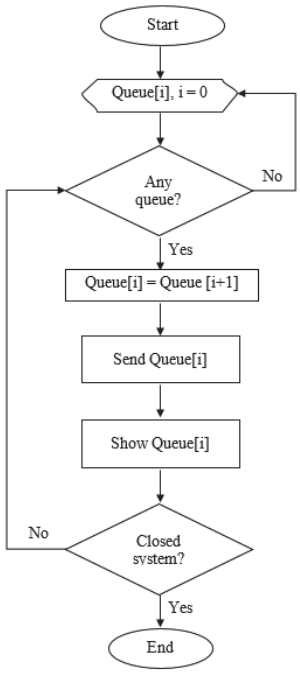

Fig 6. Enqueue process of queue system with FIFO algorithm

In Fig 6 shows enqueue process that the queue will be initiated first, which for the early initiation there is no data in the queue [i] or i determine as 0. Furthermore, if there is a new incoming queue and it will be placed in the queue to-i (the last line) and data in Queue [i] will increase. Queue [i] will be displayed if there is no new line, the service will be terminated, but if there are new incoming queue, then the process will be repeated from a conditioning test line. Patients which are entered into the queue list will be placed behind the existing line and the line number will increase again.

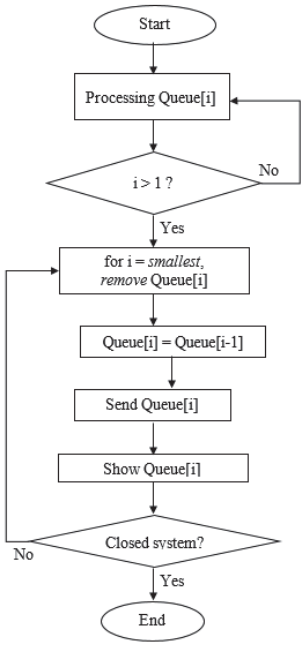

Fig 7. Dequeue process of queue system with FIFO algorithm

Dequeue process described in Fig 7. The system will be checking the queue on the system. If there is a queue the system will select Queue [i] with the value of i is the smallest or the first line. Furthermore, the data on the i queue or queue [i] will be removed and the value of the data in the queue [i] will be reduced. The dequeue process will be end if the data in the queue [i] is up or i = 0.

IV. Result and Analysis

A. FIFO Algorithm Analysis in Registration Queueing System

Patients service will be carried out sequentially in accordance with the queue number of each patients. In addition, the data that displayed in the queue list is the patients queue in one day, so the queue list for the next day will be reset back to 0. The use of the code line can be seen in Fig 8 as follows.

```
$no = 1;
$enable = true;
foreach($datapas_aktif as $row){
  echo "<tr>";
  echo '<td>'.$no.'</td>';
  echo "<td>".$row->waktu."</td>";
  echo "<td>".$row->no_reg."</td>";
  echo "<td>".$row->no_rm."</td>";
  echo "<td>".$row->nama_pemilik."</td>";
  echo "<td>".$row->nama_hewan."</td>";
  echo "<td>".$row->jenis_hewan."</td>";
  if ($row->status == '0' && $enable){
    echo '<td><a href="inputpemeriksaan?no_reg='.$row->no_reg.'"
    class="btn btn-default"><span class="glyphicon glyphicon-plus"></span> Pemeriksaan</a></td>';
    $enable = false;
  }
  else if ($row->status == '0' && !$enable){
    echo '<td><a href="inputpemeriksaan?no_reg='.$row->no_reg.'"
    class="btn btn-default disabled"><span class="glyphicon glyphicon-plus"></span> Pemeriksaan</a></td>';
  }
  else if ($row->status == '1'){
    echo '<td>Pemeriksaan</td>';
  }
  elseif ($row->status == '2'){
    echo '<td>Apotek</td>';
  }
  elseif ($row->status == '3'){
    echo '<td>Pembayaran</td>';
  }
  else{
    '<td>Selesai</td>';
  }
```

Fig 8. Code of Queue System

On the list displayed, the queue line will begin with the sequence number 1. When there are new incoming queue, it will be sorted with the appropriate number of data input. Each new incoming queue iteration will be checked $ enable variable. For the first iteration $ enable variable is set to "true", where line with the $ enable variable "true" is the line that will be removed first from the system when marked button is active, and the variable $ enable will change to the value "false". When the line is already removed from the list then the iteration will be checked again from the beginning by looking into the status_antrean, if the status_antrean worth "0" and the $ enable variable is "true" so that queue at this iteration active to be removed from the list and the $ enable variable will be set again to the value "false". This iteration will be repeated until the last iteration of data input.

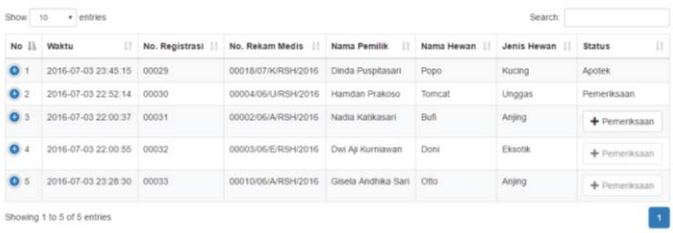

Fig 9. Implemetation of Queue System

The results of the implementation of the line system code above can be seen in Fig 9. Every patient who register will be entered into the queue on the top. Patients with the first queue number will have an active distribution status, whereas patients with the next number can not be distributed before the patient on the first line was distributed into the medical record system. If the patient who called is not in place, then their will be removed from the queue and have to do the registration queue from the beginning. The principle of this queue is compatible with the principle of FIFO algorithm, which first incoming data will be processed first.

B. FIFO Algorithm with Patient Distribution

The application of the algorithm FIFO method also can be can be applied in dealing the patients distribution. This system will display the status of patient services flow that consist of five conditions, there are:

1) Button '+ Inspection': is the default status after the patient register on the registration section. This status means that the patient has not been served or are waiting for examination.

2) Examination: a status when the patient goes into the doctor room or the patient is being examined by a doctor. Status changed to "1" when the administrator of medical records has added an action for the patient from the list so the queue status at the registration table will be updated.

3) Pharmacy: where the patient has completed the examination process and should take medication to the pharmacies. Status will change to "2" after the administrator at the pharmacy take an action on the patient

4) Payment: means that the patient has made a series of treatment and is expected to make a payment at the cashier for the examination and treatment costs. The line statis will change to "3" after the administrator cashier take an action on the patients.

5) Finish: means the patient has completed the hospital services and the status will change to "4".

C. System Evaluation

Testing is the final part of the system establishment stage and it is done to ensure the quality of a system. The results of this test is the possibility of errors / bugs in the system so that it can be a correction for the future. The testing process will be dealing directly with the stakeholders that are associated with the system, they are the front office personnel. The system testing will uses black box methods which is based on what is seen, also just focus on functionality and output. The test is aimed for the design of system wether already compliant and produce a reaction when there is bugs/vulnerabilities in the system.

In this aspect, the method used is checklist (questionnaire) and black-box testing approach. This system is still limited protoype which is expected to run based on the functions that is required by active users of the RSH Prof. Soeparwi patient registration system, so testing was conducted on three active users RSH. The results of the questionnaire method were present in Table 1.

TABLE I
THE RESULT OF EVALUATION SYSTEM

No	User 1	User 2	User 3
Total	110	81	80
Persentage	91.67%	67.50%	66.67%
Average of Persentage	**75.28%**		

Based on descriptive analysis and calculation of the percentage obtained 75.28% of the functionality testing. Of the scores given by the third users show that they agree that the information system has been run in accordance with the functionality.

In addition, the result from black box testing show that all functions on information systems work well and no found errors in the form of functions that are incorrect or missing in information systems. It can be concluded that the quality of information systems in terms of functionality has good judgment. So it can be concluded that the prototype of management information system RSH has met the minimum requirements of intended initial needs RSH Prof. Soeparwi.

D. Advantages and Disadvantages of the Information System

This information system has several advantages. As the transition from conventional to digital systems, this information systems is considered very helpful which is they can reduce the time when processing th patient data. Moreover, data storage can be validated properly and reduce the use of paper that can decrease the expenses of RSH Prof. Soeparwi. The information system flow is assessed clear and easy to learn. With the simple function/menu in this system, it can help the operation in collecting patient data more effective and efficiently.

But there are also some drawbacks where the sub-system registration information still unable to give priority to patients with emergency cases. Moreover, the current system is still a localhost information so it can not be accessed online. Then, in terms of displays, the information systems not cover properly the groove and placement functions of User Experience yet so that the registrar still has a bit of confusion when first tested.

V. CONCLUSION AND FUTURE WORK

From this study, it can be concluded as follows:

1. Preparation of conceptual models have described the design of functionality and non-functionality prototype development of information systems RSH Prof. Soeparwi sub-system of registration patient.
2. The patient registration information system prototype using the FIFO algorithm that has been made can help the operator in performing patient data charging and management.
3. Based on the method of black box testing, all of the functions that contained in the registration information system have been functioning well.
4. From the test results, it shows quality of software has been approved and meet the minimum requirement of registration system in RSH Prof. Soeparwi with the total votes are 75.28%.

However, registration system are still use the pure FIFO algorithm in which the actual implementation in the hospital queue system is much more complex than just a pure FIFO, so its needs an additional algorithm that are more appropriate with the queue for RSH Prof. Soeparwi patient registration system.

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Proceedings of

The 1st 2016 International Conference on Biomedical Engineering

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