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# EXPERT SYSTEM FOR INSTRUMENTS REQUIREMENT IN OPERATING ROOM

Christoforus Yohannes[1,4], Muh. Patahuddin Haspan[2,4]
Reza Maulana[3,4] and Anugrayani Bustamin[2,4]

[1]Department of Electrical Engineering
[2]Department of Informatics
[4]Artificial Intelligence and Multimedia Processing (AIMP) Research Group
Universitas Hasanuddin
Jl. Perintis Kemerdekaan Km. 10, Makassar 90245, Indonesia
{ christ.mitra; patahuddin96; anugrahyani }@gmail.com

[3]Department of Information System
Alauddin State Islamic University
Jl. Sultan Alauddin No. 36, Gowa 92113, Indonesia
reza@uin-alauddin.ac.id

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Abstract. *This study developed the expert system application of consumables for Andriod-based surgical operation. This application is intended to minimize the error determination of consumables resulting in the occurrence of waiting time and over time which can impact patient health. Data used are consumables data on the operation actions that have been performed and then stored in a database that has been hosted. The system is designed by using Apriori algorithm that will run on a server and will be executed via Android smartphone. The update process is designed by utilizing the checkbox function to make it easier for users to access the application. The output result issued by the system is in the form of consumables list that will be used in the operation and percentage of consumables usage in operation. The system output is divided into data with a percentage of above and below 60% based on the minimum support of Apriori algorithm. The process of updating the data will result in an increase and decrease in percentage due to the number of actions in the database that continues to grow.*
**Keywords:** Expert system, Consumables, Surgical operation, Smartphone, Android

1. **Introduction.** The operating room is a vital place for a hospital. The availability, efficiency and use of operating tools are crucial. The scheduling of operating room usage and operation equipment can be streamlined with the help of medical technology application.

Surgical patients are vulnerable to harm related health care where the annual volume of major surgical procedures is estimated at 234.2 million worldwide. The rate of adverse incidences for surgical patients is estimated to be between 12.5% and 20.1%, and the potentially preventable incidence ranges from 4.2% to 7.0% [1]. In Europe, postoperative mortality rates vary considerably, ranging from 1.2% in Island to 21.5% in Latavia. Of the 46,539 patients undergoing surgery, 1855 of whom (4%) died prior to discharge from the hospital, 3599 (8%) had undergone postoperative surgery in the intensive therapy unit and 1358 (73%) died without being admitted to the ICU during the postoperative therapy [2].

The study by Prasetijono in 2009 discussed about the availability information of operating room. The problem faced is the use of surgical room that is not in accordance with the schedule that should be. The problem arises because the information created cannot be obtained quickly by the relevant service units. Therefore, an information system is

designed regarding operating room scheduling (OK) [3]. The process of scheduling operations is modeled by Hu et al. in 2017 at A-A-A general hospital. The results show that medical risks, quality assurance and healthcare security are reduced [4].

Basically the manufacture of information systems will not solve all the problems that exist in operating room units, especially on the precision of scheduling operations. The study conducted by Yohannes in 2015 stated that one of the factors that could lead to an inaccurate schedule of operations is the determination of wrong consumables that would make the operating room clerk return to pick up equipment or consumables which are not provided previously [5].

Mistakes in pre-operative preparation will result in waiting time that will adversely affect the patient's health. One of the impacts that will arise is the occurrence of infection due to delay in operation. Clinical studies have shown that antibiotic administration time affects infection risk based on research conducted by Rudianto in 2012. Patzakis and Wilkins in a review of 1025 open fractures, reported that the infection rate was 4.7% (seventeen of the 364 samples) when antibiotics had started in three hours after injury and 7.4% (forty-nine of 661 samples) when antibiotics have started four hours or more after 5 injuries [6].

Many approaches of data mining have been conducted for both type of data, qualitative and quantitative. Indrabayu et al. compared statistic method and Artificial Intelligence (AI) for rainfall prediction using empirical data series in 2013. ASTAR and ARIMA methods are the statistical methods used. Genetic Algorithm-Neural Network (GA-NN) combination is chosen for AI methods [7]. In 2015, Indrabayu et al. used Radial Basis Function Network (RBFN) to predict reagents needs in teaching hospital. Data reagents are collected from the laboratory unit of the teaching hospital in Makassar for 3 years, from 2012 to 2014. The prediction result with RBFN methods reached 99% [8].

In 2015, Yohannes had built an expert system to determine PC-based consumables with a database that cannot be updated at any time. Therefore, in this study, an expert system will be designed using a database hosted as a data storage medium. Thus, data can be updated at any time and allow the use of multiple devices connected to the database. In addition, this expert system developed is based on Android so that its use is more flexible [5].

The rest of the paper is organized as follows. Section 1 presents the background of this research. Section 2 describes some of the research methods, algorithms used and design implementation. Section 3 discusses the results obtained from this study. Section 4 discusses the conclusions and suggests for further research.

## 2. **Research Method.**

### 2.1. **Data mining association rule.**

An expert system is designed to solve quite complex problems by imitating the knowledge of experts. Knowledge is processed using data mining algorithms to generate rules based on existing data. One of the data mining techniques that will be used in this research is association rule. Knowledge Discovery in Database (KDD) includes the collection, use of historical data to find the regularity of patterns or relationships in large data sets [9].

1) Data Cleaning

   Data cleaning is a process of removing noise and inconsistent data or irrelevant data. In general, the data obtained, either from a company's database or experimental results, have incomplete data such as missing data, invalid data or also just mistyping [9].

2) Data Integration

Data integration is a combination of data from various databases into a new database. Data integration is performed on attributes that identify unique entities such as name attributes, product types, customer numbers and more [10].

3) Data Selection
   The existing data in the database is often not all used; therefore, only the appropriate data to be analyzed will be retrieved from the database [9].
4) Data Transformation
   Data is altered or merged into the appropriate format for processing in data mining. Some data mining methods require special data formats before being applied [10].
5) Mining Process
   Mining process is a major process when a method is applied to finding valuable and hidden knowledge from data [9].
6) Pattern Evaluation
   In this stage, the results of data mining techniques in the form of typical patterns and predictive models are evaluated to assess whether the existing hypothesis is indeed achieved. If the results are not in accordance with the hypothesis, there are some alternatives that can be taken such as making feedback to improve the data mining process, trying other data mining methods which are more suitable or accept this result as an unexpected result that may be useful [10].

2.2. **Apriori algorithm.** Apriori algorithm is the type of association rules in data mining. In addition to apriori, which belongs to this class are the method of generalized rule induction and Hash based algorithm. The rule that states associations between multiple attributes is often called affinity analysis or market analysis. Association analysis or association rule mining is a data mining technique for finding associative rules between items combination [11]. Generally, the workings of Apriori algorithm are as follows:

1) Candidate Formation
   Formation of candidate itemset, candidate $k$-itemsets are formed from a combination of $(k-1)$-itemset obtained from the previous iteration. One characteristic of the Apriori algorithm is the pruning of candidate $k$-itemsets whose subset contains $k-1$ items not included in high frequency patterns with $k-1$ length.
2) Support Calculation
   The support calculation of each candidate $k$-itemset. Support of each candidate $k$-itemset is obtained by scanning database to calculate the total of transaction which contains all the items in the candidate $k$-itemsets. This is also a feature of the Apriori algorithm where counting is required by scanning the entire database as the longest $k$-itemset.
3) Set Frequency Pattern
   The high frequency pattern containing $k$-item or $k$-itemset is set from candidate $k$-itemsets whose support is greater than the minimum support, and then the confidence of each item combination is calculated. Iteration stops when all items have been counted until there are no more item combinations [12].

2.3. **Implementation and system design.** Based on Figure 1, the workflow of expert system of consumables determination can be seen.

1) The process of storing data on the system uses a hosted database. This allows the system to be accessed by many devices using the Internet network. In addition, Apriori algorithm is processed on the server to make the system work faster and more efficiently.
2) There are two main menus on device, namely "*Persiapkan BAHP*" to carry on expert system or core process of the system and "*Lihat Database*" to see patients' data in the form of names and registration codes and action data in the form of consumables and patients' identity in the system database.

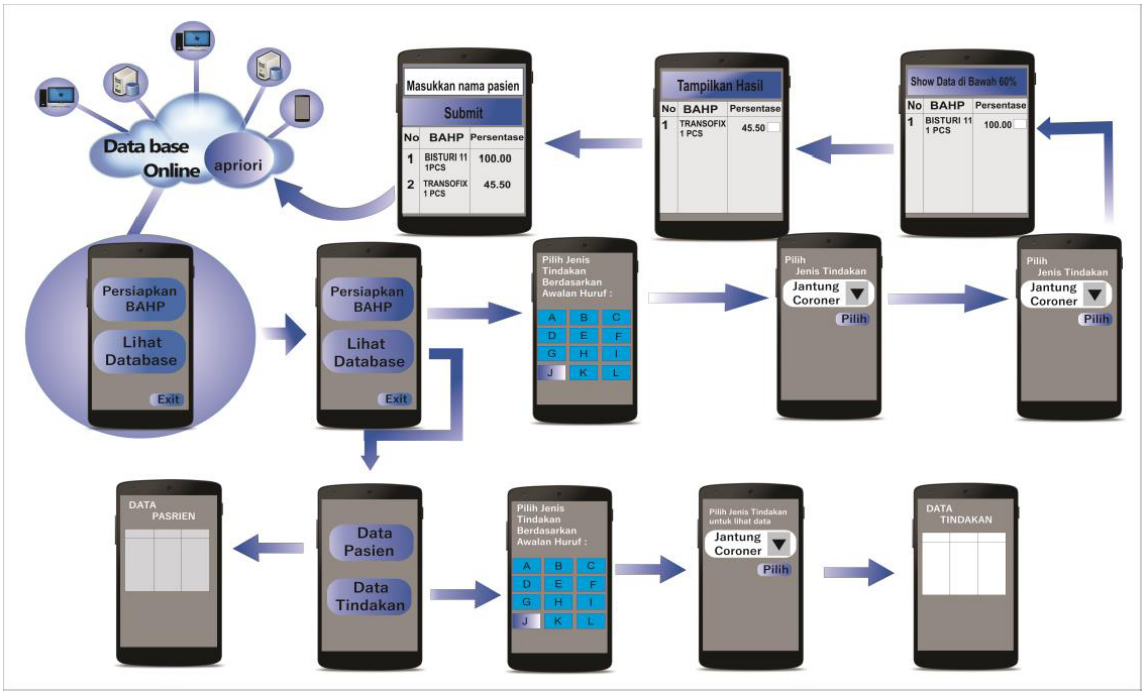


FIGURE 1. Expert system design on Android

3) The button menu "*Persiapkan BAHP*" will ask user to choose the type of operation actions performed based on the alphabet. The system will display some lists of operation types by using dropdown list. The server will process the selected operation action and the system displays the output in the form of the occurrence percentage of the tool used during operation. The information of consumables usage first shown is data above 60%. To see the percentage of consumables usage below 60%, there is "*Show Data di Bawah 60%*" button located above the percentage table. The selected consumables by clicking on the available check boxes will be displayed as a list after clicking on the "*Tampilan Akhir*" button. In the final stage, the user enters the name or patient registration ID that will be used by the system to calculate the number of actions. After clicking the "Submit" button, the data will be sent to the server to update the data.
4) On "*Lihat Database*" menu, there are two buttons, i.e., "*Data Pasien*" and "*Data Tindakan*". "*Data Pasien*" submenu displays table containing ID and patients' name while "*Data Tindakan*" submenu will ask user to enter the operation types based on the alphabet. The information will be displayed in the form of table containing ID, actions, consumables and patients' ID.

3. **Result.** This expert system can be accessed and updated at any time because it has been connected to a hosted database. In addition, the data on the system will continue to grow because the update process will occur at each time of the operation process. Therefore, the percentage output released by the system at any time will change after the data update process as shown in Figure 2.

Based on Figure 2, it can be seen that updated data will increase the percentage whereas the data that are not updated will decrease the percentage. The percentage decreased is seen with the red circle in Figure 2. Therefore, the update process will affect the percentage that will be issued by the system. When the tool percentage above 60% has decreased to below 60% due to never used in several operations, tool will move to the data list with the percentage below 60% as shown in Figure 3. Similarly, when the percentage

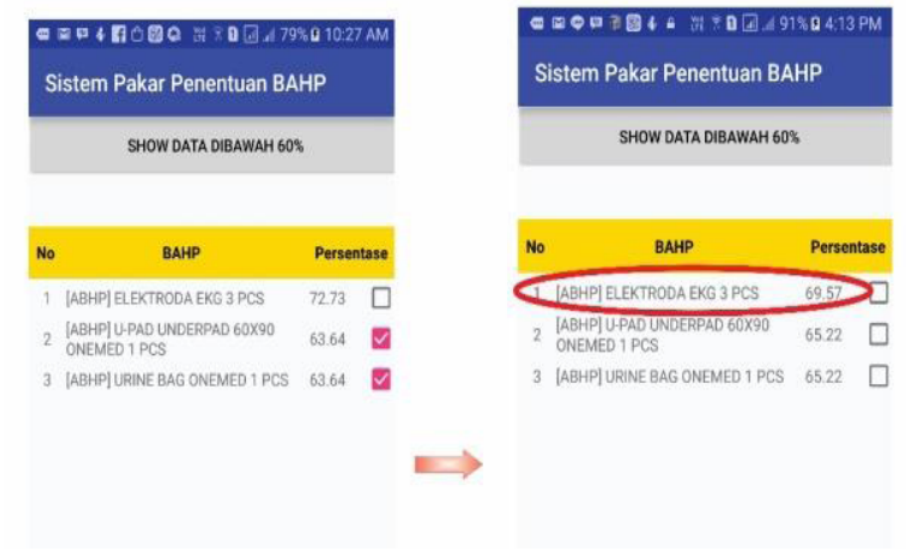


FIGURE 2. Output percentage after and before update

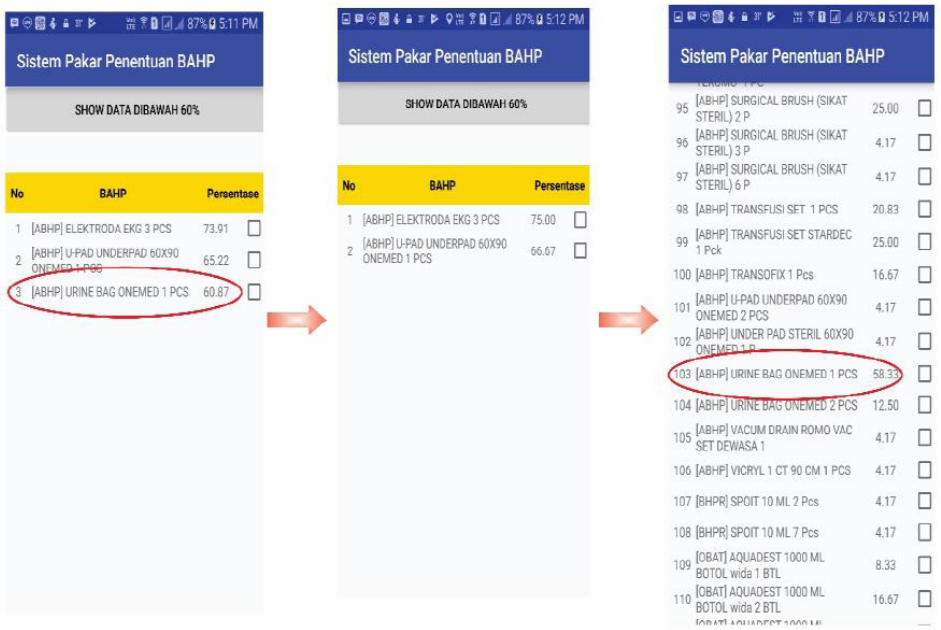


FIGURE 3. The change of data list from the percentage above 60% to below 60%

of tool below 60% has increased to above 60% due to often used in operation, the tool will move to the data list with percentage above 60% as shown in Figure 4.

The data will be declared sufficient to be processed in the system if the data or the number of actions in the database has been more than or equal to three actions. The system will automatically release the information "*Data belum cukup untuk melakukan proses pakar*" as shown in Figure 5(a) if selecting operation type based on the insufficient data. The minimum total of support on the Apriori algorithm used on the system is 60%. Therefore, to achieve a minimum percentage of 60%, the minimum total of actions in the database as many as three is used. The more the number of actions that have been done is then the more accurate the percentage of possible use of the tool in operation is.

In the system designed in this study, there is the percentage output of above 100%. It is because the use of consumables is greater than the number of actions performed. For example, if the use of urine bag in 1 operation is 2 times then the number of consumables

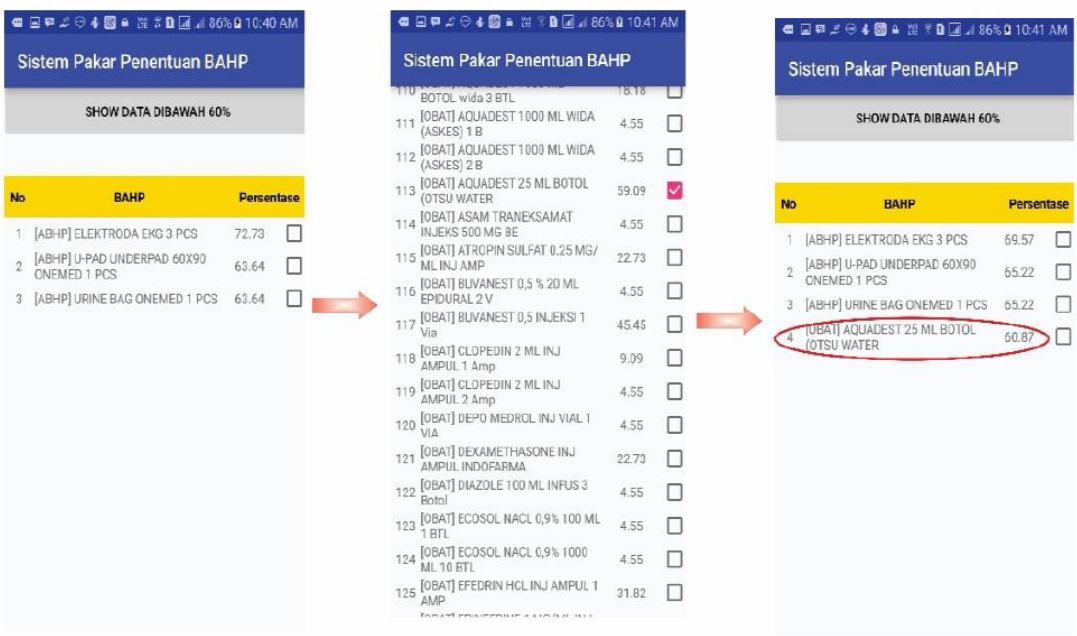


FIGURE 4. The change of data list from the percentage below 60% to above 60%


(a) (b)

FIGURE 5. (a) The system output when the data is not enough and (b) system output when the percentage is above 100%

used is divided by the number of actions $\left(\frac{2}{1} \times 100\right)$ that is equal to 200%. In the process of mathematical calculation, the percentage of data above 100% is an invalid calculation. However, consumables inputting used in the system is not a human error in data inputting resulting in double data input. Resident doctors or nurses take less consumables during surgery which results in a delay in the operation process. In addition, if the percentage of consumables data is above 100%, then the system will issue information containing


FIGURE 6. Percentage change of data above 100% when updating

"*Persentase data di atas 100%, BAHP yang digunakan lebih dari 1 kali dalam 1 tindakan*" as shown in Figure 5(b).

During the update process, especially for data percentage above 100%, the output is not erratic because the number of consumables is greater than the number of actions. Figure 6 shows the update process for data with percentages above 100%.

4. **Conclusion.** The expert system application of consumables determination used the application of Android studio, sublime text, and xampp by using the programming language of php and java. The alphabet was made in the system design to ease user in selecting the operation types that will be done. The addition of checkbox in the system design will ease user in selecting consumables as well as data update process because the new data list of consumables that will be used will be formed.

Update process done in the system was by selecting consumables output that will be used in the operation by ticking checkbox in the right side of consumables percentage. Percentage output issued by the system before and after the update was different. When the percentage of consumables used in operation is increased then the percentage of unused ones is decreased, but unlike the data with percentages above 100%, the percentage change is sometimes increased and sometimes decreased (erratically). When the action data is not enough and the system issues consumables percentage output of above 100% then the system will issue a description above the output table.

Apriori algorithm work process was done on the server and then the results of Apriori algorithm were sent to Android to be displayed. So the working process of the system in Android becomes lighter.

In the future research, the system can be developed on smartphone with different operating systems such as IOS, and Windows Phone. In addition BAHP selection is used not only in terms of expert gathering of some surgeons and the update process only. The system will be more developed if at the time of determination BAHP added parameters based on doctor's diagnosis as well.

## REFERENCES

[1] J. Bergs, J. Helling, I. Clemput, P. Simsons, O. Zurel, S. Vertriest and D. Vandijck, Surgical safety checklist: An update, *Acta Chirurgica Belgica Journal*, vol.114, no.4, pp.219-224, 2014.

[2] M. Wujtewic and M. Piechota, Mortality after surgery in Europe: A 7 cohort study, *Lancet: Anaesthesiology Intensive Therapy*, vol.380, pp.1059-1065, 2012.

[3] P. S. Prasetijono, *Design of Information Systems Operating Room Utilization Islamic Hospital Sultan Agung Semarang*, Thesis Program Pascasarjana FKM Universitas Sultan Agung Semarang, Semarang, 2009 (in Indonesian).

[4] J. Hu, Q. Su, Q. Wang and Q. Wang, A surgery scheduling model based on surgery grading management system, *International Conference on Service Systems and Service Management*, Dalian, China, 2017.

[5] C. Yohannes, Indrabayu, I. Nurtanio, R. Maulana, I. S. Areni and E. Warni, Apriori algorithm for surgical consumable material standardization, *International Organization of Scientific Research Journal*, vol.18, no.6, pp.38-42, 2015.

[6] Rudianto, The effect of surgical delay on acute infection following 554 open fractures in children, *Journal Program Pascasarjana Fakultas Kedokteran-Universitas Islam Sultan Agung Semarang*, 2012.

[7] Indrabayu, N. Harun, M. S. Pallu and A. Achmad, Statistic approach versus artificial intelligence for rainfall prediction based on data series, *International Journal of Engineering and Technology*, vol.5, no.2, pp.1962-1969, 2013.

[8] Indrabayu, B. Zaman, A. A. Ilham and I. S. Areni, Prediction of reagents needs using radial basis function in teaching hospital, *International Journal of Engineering and Technology*, vol.7, no.4, pp.1498-1504, 2015.

[9] L. Iryani, A. Wijaya and Andri, *Implementation of Datamining to Determine the Interest of Reading Students in the Library of Bina Darma University Palembang Using Clustering Method*, Universitas Bina Darma, Palembang, 2015 (in Indonesian).

[10] F. Marisa, Educational datamining (concepts and application), *Jurnal Teknologi Informasi*, vol.4, no.2, pp.90-97, 2013.

[11] H. C. Pratama, M. Bettiza and T. Matulatan, *Application of Apriori Algorithm in Finding the Relationship of Initial Data Entry of Students with Academic Achievement*, Master Thesis, Universitas Maritim Raja Ali Haji, Tanjungpinang, 2014 (in Indonesian).

[12] R. Maulana, *Expert System for Determination of the Rules of Use of Consumables in Operational Measures*, Master Thesis, Universitas Hasanuddin, Makassar, 2015 (in Indonesian).