ABSTRACT
Dr. Soetomo General Hospital (RSU Dr. Soetomo) in Surabaya has computerized their administration system based on the Indonesian Health Department standard. It calls Sistem Informasi Rumah Sakit (SIRS) and it only generates structured information. So far, SIRS cannot generate unstructured information for supporting decision making.

Due to the problem, this research focuses on developing Data Warehouse and Online Analytical Process (OLAP) Tools for supporting decision making about inpatient, payment, and surgery. The application includes a transformation process from SIRS database into OLAP Warehouse database, and processing OLAP Warehouse database into multidimensional pivot table, and generating graphics. The application was developed using Oracle 9i as the database and Net Beans 5.5 as programming language.

Keywords
data warehouse, OLAP, healthcare information, inpatient

1. INTRODUCTION
RSU Dr. Soetomo is one of the biggest hospitals in the east Indonesia. RSU Dr. Soetomo has computerized their administration system since 2002 using Oracle 9i Database and Oracle Developer. The system is standardized by the Indonesian Health Department and it calls Sistem Informasi Rumah Sakit (SIRS) [1]. SIRS supports periodic reports as structured information that is needed by the health department. The report is produced at monthly basis.

The health department or hospital director often requests inpatient, payment, and surgery unstructured information in several formats (multidimensional) to RSU Dr. Soetomo. Unstructured information is not supported by SIRS. In addition, RSU Dr. Soetomo does not have Oracle Warehouse Tools for generating the needed unstructured information. Moreover, RSU Dr. Soetomo does not have a full-time programmer to develop and maintain the application system. To fulfill the needed information, RSU Dr. Soetomo must print several structured reports that relate with the needed information and combine several information use Microsoft Excel to become another report.

Based on the problems, RSU Dr. Soetomo need an OLAP tool for generating unstructured report in multidimensional and hierarchical view.

2. MODEL, ANALYSIS, DESIGN, AND IMPLEMENTATION
2.1 Data Warehouse in Health Care
One of the key aspects for a healthcare data warehouse design is to find the right scope for different levels analysis. The analysis of healthcare outcomes is proposed to find scope studies of treatment progress for the next visit. These scopes allow the database to support multi levels analysis, which is imperative for healthcare decision making [2].

The complexity of data analysis determines the number of patients in the risk group for a particular disease. Disease risk levels must be set and adjusted on a regular basis to ensure the coverage of all patients in a care management [3].
Turning the specific clinical domain information to a Clinical Data Warehouse (CDW) can facilitate efficient storage, enhances timely analysis and increases the quality of real-time decision making processes [4].

There are six steps for building a medical data warehouse [5].

- Identify the requirement for the building of the data warehouse
  The developers should be able to convince the stakeholders that they have a sound solution for this critical requirement.

- Quality and scope of the sources
  Identify the quality and scope of each data source and also the rate of updating (depend on the dynamics of the entities to which the data refers).

- Identify what data is needed by the stakeholders
  Match the potentially collectible data with the results that are desired by the stakeholders and the decision makers.

- Build an ontology
  In distributed environments, the denominators for data attributes and values can be different.

- How to update the central repository
  Establish the update policy for each local source and estimate the costs involved.

- Enact exception handling protocols
  The sources should be analyzed with the simplest methods and after the data collected should be analyzed immediately with the same methods to detect anomalies that are induced by the data gathering process.

A star schema is consisted of fact tables and dimension tables. The fact tables describe business fact during a period of time. The dimension tables describe details information for supporting information of fact tables [6].

### 2.3 System Analysis
The needed SIRS Data to be included into data warehouse are:

- Inpatient room records include roomID and type.
- Room type records include roomType, roomClass, roomRate, and numberOfBed.
- Patient records include patientName, patientAddress, diseaseType, checkInDate, inpatientTime, and roomID.
- Diagnose records include diagnoseType and symptoms.
- Service records include serviceID and serviceName.

OLAP tool is needed for processing warehouse database using pivot table. OLAP tool is built on analysis the purpose [2]. Several unstructured information example often request by the Indonesia Health Department or hospital director are:

- Revenue analysis based on inpatient room, surgery type, room type, and inpatient time. For instance, analyst hospital revenue during a period time.
- Inpatient room utilize based on inpatient room, patient, and time. For instance, analyst the most used room in period time.

### 2.4 Data Warehouse Star Schema
The conceptual frame work of our research work is shown in Figure 1. There are two main processes, i.e. Create Star Schema and Transformation SIRS OLTP database into OLAP Warehouse database as a preparation and cleansing data and Pivot Table Process as a process to generate multidimensional table and graphic. The first process will discuss in this sub section and the second process will discuss in next section.

Firstly, create or modify the OLAP Warehouse meta schema. A user design or modify a star schema by select tables and fields from the SIRS OLTP meta schema into OLAP Warehouse meta schema as a mapping process. Secondly, transform SIRS OLTP database into OLAP Warehouse along with cleansing data process as shown in Figure 2. Users can transform all data or periodically data.

![Figure 1. The research conceptual frame](image-url)
The relation between dimension and fact tables is generally one to many with minimum cardinality optional in fact table. The purpose every dimension table is:

- Time dimension is used for recording the event of inpatient, payment, and surgical. It prepared for multidimensional hierarchical information, e.g. weekly, monthly, quarterly, annually.
- Patient dimension is used for recording the detail patients data who are inpatient and or surgical and pay their medical expenses.
- Facilitates dimension is used for recording the facilities for supporting medical care patient, such as Astek, Askes, Jamsostek.
- Room type dimension to record type of room
- Class type dimension to record class of room
- Surgery lists dimension to record list of surgeries

3. THE DESIGN PROCESS

The pivot table process algorithm is shown in Figure 6. The user can set up new parameter or using the saved parameter to process data into multidimensional information as a table or a graphic. The user can select a fact table and several related dimensional tables follow with set attribute to row, column, and data. Furthermore, the user can set the value in the distinct value in the attribute to be included in pivot process. In addition, the user can set the start and end date data to be processed by default is current date. At last, the user can choose the operation process, i.e. count, sum, max, min, and average. The default operation process is count.
4. RESULTS
In this section, we demonstrate the developed application system. Pivot table about count of patient based on education vs. room name on February 1–May 1, 2005 is shown in Figure 7. Based on RSU Dr. Soetomo requirement analysis, they also want to know the detail information from the pivot table easily. Therefore, we design a pivot popup to zoom out the cell pivot table detail information. For example, the zoom out of pendidikan Tamat SMTP nama ruang Anak Kelas 1 is shown in Figure 8.

Figure 7. Pivot table count operation in periods

Figure 8. Pivot table zoom out

Furthermore we demonstrate the multi dimensional table as the main RSU Dr. Soetomo requirement. Figure 12 shows a pivot table with two dimensions on row (education and facilitates name) and one dimension on column (room name). Figure 13...
shows pivot table with one dimension on row (education) and two dimensions on column (room name and facilitates name). Figure 14 shows pivot table with two dimension on row (education and facilitates name) and two dimension on column (room name and room class).

5. CONCLUSION AND DISCUSSION

The developed OLAP tools can be used for generating multidimensional as a pivot table and graphic for inpatient, payment, and surgery. The OLAP tool outcomes are used for supporting decision making and to fulfill the Indonesian Health Department requirements that do not support by SIRS.

This application needed to be improved for run time process, computer memory efficiency, and view of pivot table to be more users friendly.

6. ACKNOWLEDGMENTS

This research is supported by Direktorat Jendral Pendidikan Tinggi, Departemen Pendidikan Nasional (110/SP2H/PP/DP2M/IV/2009) with title "Design and Development of Medical Record Data Warehouse Application System for Supporting RSU Dr. Soetomo Strategic Decisions".

7. REFERENCES


