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Development of the Health Information Analytics Dashboard Using Big Data Analytics

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ABSTRACT

The development of digital technology has the impact on healthcare facilities in Indonesia, one of which is the digitization of medical records. This will generate abundant clinical data from various sources including electronic medical records. Therefore, a large infrastructure is needed to store data from various sources that can facilitate the process of data aggregation to then be processed into information. Health Information Analytics Dashboard is the solution to get accurate, complete, and real-time insight from big data in healthcare. Data collection is carried out from various sources of health service facilities in Indonesia that are integrated into the system. With a user-friendly display, the analytic dashboard can be used to create monitoring reports with just one click. The method of this study uses big data analytics. The data analysis results are visualized through display charts/graphs that make it easier for users to understand the data analysis results and interpretation. This dashboard is useful to facilitate decision making so that stakeholders can find out more quickly to be able to respond appropriately and also improve the quality of health services so as to improve the degree of public health.

Keywords: *Health Information, Analytics Dashboard, Big Data, Big Data Analytics*

I. INTRODUCTION

In the latest global health index, according to the 2019 report of The Legatum Prosperity Index, Indonesia is 97th out of 167 countries. The index is based on physical, mental health, health infrastructure and cares to prevent various outbreaks or diseases. Based on comparisons from 2017, Indonesia experienced an increase from 101 in 149 countries [1]. This increase can be triggered by improving the quality of health facilities in Indonesia which are getting better.

Based on the Minister of Health Regulation No. 71 of 2013, health facilities are health service facilities that are used to carry out individual health service efforts, both promotive, preventive, curative and rehabilitative carried out by the Government, Regional Governments, and/or Communities[2]. In health facilities, each health professional is responsible for various types of information, both medical and administrative information. With the development of digital technology, health facilities in Indonesia began to adopt the digitization of medical records. The digitization has begun to be implemented in all units, from inpatient, outpatient, emergency, laboratory, coding, disease, filing, distribution, assembling, financial, guarantee, insurance, and other units.

Increased adoption of electronic health records in recent years has substantially increased the amount of readily accessible digital data for use in clinical and business decision making; however, the current methodologies used for database analysis in healthcare have been inefficient[3]. Data is being created around us at an increased rate, in a multitude of forms and types. Most of the advances in all the scientific disciplines that have occurred over the last decade have been based on the extraction, management and assessment of information to provide cutting-edge intelligence. This, in turn, has accelerated the need, as well as the production of large amounts of data, otherwise referred to as big data. Due to the diverse nature of big data, there is a constant need to develop, test and apply theoretical concepts, techniques and tools, to successfully combine multidisciplinary approaches to address such a challenge. As such, theory is continuously evolving to provide

the necessary tools to enable the extraction of relevant and accurate information, to facilitate a fuller management and assessment of big data[4].

The data needs to be collected, cleaned, curated and stored in a way that information retrieval and analysis for business intelligence becomes easy[5]. Therefore, in health facilities that have adopted digitization of medical records, a large data infrastructure is needed to store data from various sources so that it can facilitate the process of data aggregation to then be processed into information.

II. METHOD

The method of this study uses big data analytics. Data collection is carried out from various sources of health service facilities that are integrated into the system Infrastructure data in the Health Information Analytics Dashboard includes Data Acquisition, Data Management, and Data Usage.

Data acquisition is the collection of data from medical records in various health facilities, both from manual and electronic medical records. Data sources obtained from manual medical records are first inputted to the computer so that the data used is medical record data that is ready to use. The data then enters the data management stage, namely medical record data from various units entering the data center. In this case, the data center can be more than one because each division in the health facility has its own server. The data that enters the data center is cleaned up to be able to enter the final stage, ie data usage. The process from data management to data usage uses big data analytics so that it can display a health information analytics dashboard.

The medical record data was taken from one of private hospital in Kebumen Regency, Central Java, Indonesia. Medical record data for this study were taken from 22nd June 2018 until 6th June 2019. The medical record database is stored in an Oracle database.

The health information analytics dashboard is made using the R programming language. The library used for this dashboard is *shiny*.

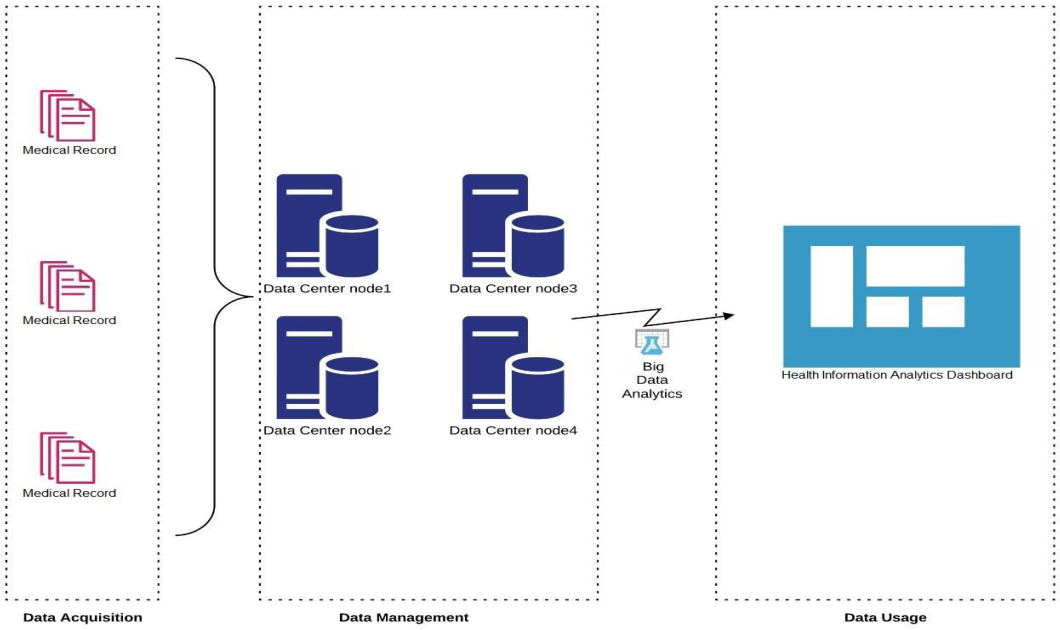

Fig. 1. Data Infrastructure of Health Information Analytics Dashboard

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Shiny is an R library that makes it easy to build interactive web apps straight from R. Shiny will automatically convert programming code from R language to HTML and CSS languages, so the dashboard can be displayed interactively in the form of web pages.

There are three steps to create a health information analytics dashboard using the R programming language. The first step is data acquisition. Digital medical record data that has been previously stored in Oracle Database, is called into environment R to be stored in the form of data frames. Shiny will create a dashboard with data sources from data frames converted from Oracle Database. To do this database conversion process, use the RJDBC library. The RJDBC library allows R to connect directly into Oracle databases to store and retrieve data. The second step is data management. Data taken from the previous stage is preprocessed, e.g. checking for outliers, missing values, or incompatible data types. The following are the features contained in the medical record database:

1. ID
2. Patient's Name
3. Username
4. Time of Occurrence
5. Time of Arrival
6. Check time
7. Reason to Come
8. Follow Up
9. Reason for Exit
10. How to Exit
11. Officer
12. Doctor Take Care
13. Guard Nurse
14. Shift
15. ICD10

The third stage is data usage. The medical record database that has gone through the data management stage is then visualized as the main output in the dashboard. There are four types of data visualization used in the health information analytics dashboard: line chart, heatmap, pie chart, column chart, bar chart, and treemap. Further explanation is in III. Result and Discussion.

III. RESULT AND DISCUSSION

Dashboards are data-driven clinical decision support- tools used to analyze data from multiple databases using easy-to-read, color-coded graphical displays, much like the dashboards of automobiles. Dashboards can be used to promote data-driven decision making. Using dashboards to perform automated analytical reviews of clinical data will prove more efficient when data elements stored in electronic health records become standardized. The increased use of electronic documentation in healthcare settings will provide a wealth of data, and dashboards will play a pivotal role in converting these data into actionable knowledge[3].

In this case, the dashboard uses visual analytics which is the science of analytical reasoning facilitated by interactive visual interfaces, and has been utilized to enhance the evaluation of large, complex data sets within healthcare fields. It is compatible with health information analytics dashboard, where the abundant clinical data from various sources exist. The future of healthcare analytics will consist of an ever-increasing demand for and application of sophisticated analytics methods and tools (e.g. visual analytics dashboards) to explore and analyze data with the goals of improving patient care, increasing efficiency, optimizing resource utilization and allocation, and enhancing decision-making at both the clinical and enterprise levels[6].

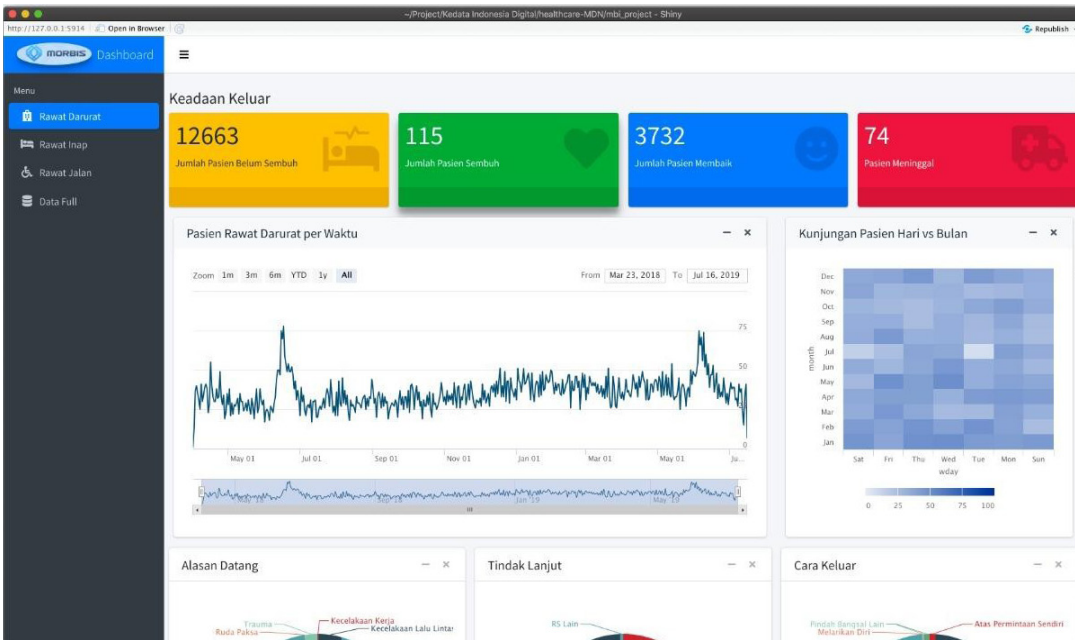

Fig. 2. A screenshot of Health Information Analytics Dashboard that enables to user to explore discharge condition of patients, emergency patients per time and patient visits in days and months

In this health information analytics dashboard display, there are variety of information, including discharge condition of patients, emergency patients per time and patient visits in days and months as in Fig.2. In the condition of the patient out, there is information on the number of patients who have not healed, have healed, improved, and died. Through this information, it can be seen the quality of services provided. The number of emergency patients per time can be used to see the trend of the highest number of patients, for example, during the holiday, Eid. Information as in Fig. 2. is useful for preparing the needs of both human resources and logistical needs on certain days.

The use of line chart in this visualization is to make comparisons, show distributions, find out deviations or values that deviate from what they should, display trends in data over time, and understand relationships between one another[7]. While the use of heatmap on patient visits in days and months with the goal to show the presence of possibly anomalous deviations in the stuff personal movement[8]. The heatmap element shows the counts or average values for groups of observations using a color intensity scale[9].

Next display as in Fig. 3. includes reasons for coming, follow-up, ways out, doctor on duty, the nurse on duty, and shift nurses. The use of pie charts in this visualization is to make comparisons and explain part of the whole[7]. Reason information comes in handy to find out the highest reason people go to the hospital either from illness/complaints, work accidents, traffic accidents, trauma and forced rendering or other reasons. This can provide information to hospitals to convey to the relevant agencies, for example, related to traffic accidents related to the Department of Transportation and work accidents related to the Department of Manpower. Through this information will facilitate the relevant agencies to handle and prepare preventive measures to suppress the incident.

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Further information on the follow-up pie chart makes it easy for health service facilities to find out the patient's follow-up after treatment is given, including hospitalization, discharge, or referred to another hospital. Inpatient follow- up information is useful for health care facilities to prepare beds and inpatient facilities. The return follow-up information shows that the treatment provided has been effective, while the follow-up referred to other hospitals shows that the referral health care facility is still inadequate so that it can be used as a control material to improve facilities and better services.

On the next pie chart that is the way out provides information on the way outdone by the patient. In the graph, the information shows the highest way out is by hospitalization. This is the basis for hospitals to provide inpatient facilities both in terms of room availability and better services.

As for the information of the attending physician, the nurse on duty, and the nurse shift in Fig. 3. it is useful to find out the performance of each of these resources in the health care facility. This can help the human resources division in healthcare facilities in terms of monitoring performance while helping in human resource planning. The use of column chart in the visualization of the attending physician, the nurse on duty is to make comparisons, show distribution, explain parts of the whole, show trends over time, and find out the deviations or values that deviate from the supposed use of the bar. The chart on the visualization of nurse shift is almost the same as the column chart, which is to make comparisons, explain parts of the whole, and find out deviations[7].

In the largest types of diseases as in Fig. 4. provide information on the types of diseases from the largest to the smallest. This makes it easy for health service facilities to predict outbreaks and other health-related events, increase preventive measures, provide warning signs to the public in the event of an outbreak, provide appropriate drug facilities and needs, implement and increase the use of the latest technology to help the diagnosis and treatment process, and estimating revenue to be able to detect fraud, abuse, or other violations. The use of treemap in this visualization is

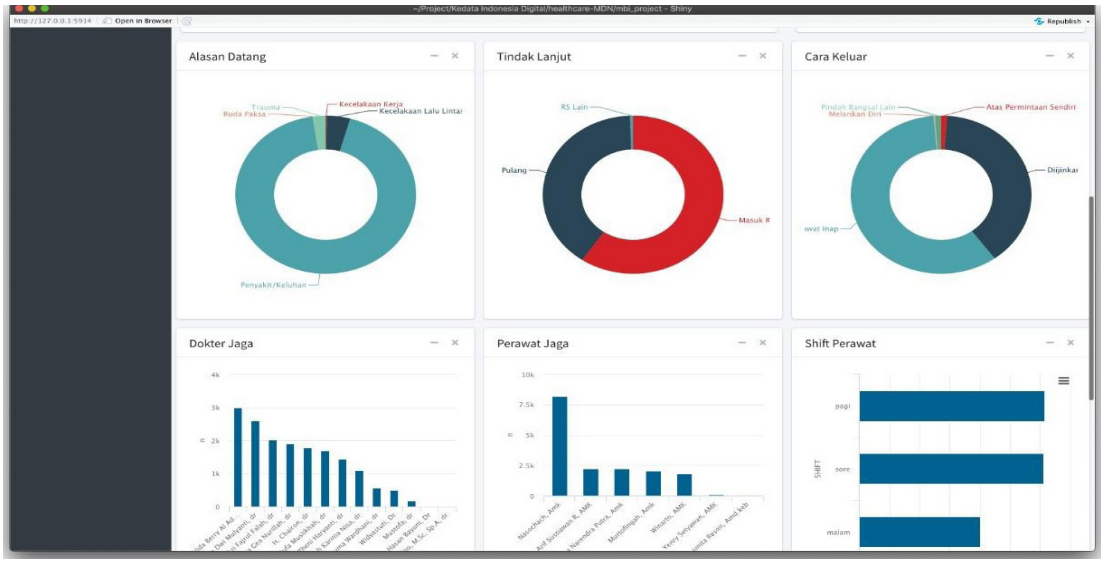

Fig. 3. A screenshot of Health Information Analytics Dashboard that enables to user to explore reasons for coming, follow-up, ways out, doctor on duty, the nurse on duty, and shift nurses

Fig. 4. A screenshoot of Health Information Analytics Dashboard that enables to user to explore the largest types of diseases

to display data in nested rectangles. The dimensions to define the structure of the treemap, and measures to define the size or color of the individual rectangles. Treemaps are a relatively simple data visualization that can provide insight in a visually attractive format [10].

Previous research on health information analytics dashboard has been done by Simpao, AF, etc. by focusing on Anesthesia and Healthcare patients. In the study, integration of big data and analytics within anaesthesia and health care will increase demand for anaesthesia professionals who are well versed in both the medical and the information sciences. Analytics methods offer promising tools to leverage big data to improve patient care, quality assessment, financial management, and other areas of health care [11].

The existence of this health information analytic dashboard can reduce the existence of human error so as to facilitate the decision-making process appropriately. Therefore, health service facilities and stakeholders can find out more quickly and respond appropriately.

IV. CONCLUSION

Health Information Analytics Dashboard can improve the ability of health service facilities and stakeholders to predict disease epidemics and health-related events, prevent human errors, improve early preventive care, provide warning signs to the public, facilitate evaluation of programs and related policies health, and facilitate decision making to find out faster and respond appropriately.

V. ACKNOWLEDGMENT

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