Original Article

Visualization Development of Health Data Reporting with Business Intelligence Techniques

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Objective: To develop a format for reporting, summarizing, and presenting research data using business intelligence [BI] software and the Datazen program, with powerful dashboards based on users' needs.

Materials and Methods: This study was part of the Routine to Research program.Raw data were drawn from the Royal Charitable Project of Professor Dr. Her Royal Highness [HRH] Princess Chulabhorn. The database was maintained by the Chulabhorn Hospital Data Management Unit. Data were reported, summarized, and presented via dashboards using BI and the Datazen program. User satisfaction with the system and content was evaluated.

Results: BI dashboards for health data were developed using a research data report, summary, and presentation format. Most users (80%) reported the highest level of overall satisfaction. In particular; users were highly satisfied (96.67%) with the system's operational benefits.

Conclusion: The format for research data reporting, summary, and presentation using BI techniques and the Datazen program creates dashboards for health data. This format interacts with users in a visualization of multidimensional data, can improve operational efficiency, and results in a high level of user satisfaction. The format can be adjusted as needed and used with data in other units of HRH Princess Chulabhorn College of Medical Science.

Keywords: Business Intelligence, BI, Datazen, Dashboard

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Business Intelligence [BI] software brings together existing data to produce reports in various formats. The BI function of retrieving data from a database means many types of reports are available to suit the view of analysis and needs of users. Data analysis is performed in multidimensional models, which enables viewing of drill-down data(1).

Today, organizations need to collect a large amount of data. Public health organizations also use information technology [IT] to help manage large amounts of stored data and improve operating efficiency and clinical quality(2). BI has a role in bringing data from various systems to be managed in different ways. Key features of BI include reporting, analysis, monitoring, and prediction of results, and it has additional advantages of being user-friendly and not requiring database knowledge. BI can easily function with the required data filter, and the resulting report can be changed to any format without the need for new data. It also can interact with users in a range of data views to increase operational efficiency and support rapid, accurate decision making(3,4). Acquisition of various BI features is based on the Datazen program,

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which is software that was used to help create BI dashboards with graphical data display. These dashboards can be accessed by multiple devices (e.g., computers, smart-phones, and tablets) via an application or browser. BI dashboards are controlled by the person who operates the system; data can be adjusted and customized into various presentation formats as needed. In addition, users' rights to access the system can be set for permission[5].

For research data management at Chulabhorn Hospital, data storing involves a system of databases of varying sizes. Data quality assurance and quality control must be accurate and complete for data to be used in research. However, it takes considerable personnel and time to manage the diverse and complicated formats needed for data reporting, summaries, and presentations according to the context of different research projects. Sometimes, available formats do not cover users' needs in terms of using their data for research.

This study aimed to develop a format for data reports, summaries, and presentations using the BI software and Datazen program to create dashboards for reliable and effective health data based onusers' needs.

Materials and Methods

This study was approved by the Ethics Committee of Human Research, Chulabhorn Research Institute (Project code 014/2560). It was part of the Routine to Researchof an observational descriptive study[6]. Raw data, questionnaires, and data from case record forms were collected from the database for seven projects under the royal charitable project of Professor Dr. Her Royal Highness [HRH] Princess Chulabhorn, during the auspicious occasion of HRH's birthday anniversary on July 4 in 2009 to 2015, and from two projects conducted in cooperation with other institutions. Data were managed by the Chulabhorn Hospital Data Management Unit. BI dashboards for medical information were developed, as shown in Figure 1.

BI dashboards were assigned to users with access rights in different groups, classified by research project and satisfaction with the system/content after complete use was evaluated. Descriptive statistics with frequency and percentages were used for data analysis with Microsoft Excel.

The protocol of this research was reviewed and approved by the Human Research Ethics Committee, Chulabhorn Research institute No. 014/2560.

Results

In this study, three main types of BI dashboards were developed: 1) dashboards for the number of participants and cancer cases in each project, 2) dashboards for demographics data in each project, and 3) dashboards for physical examination (case record forms) for important variables in each project. Users can access the dashboards through log-in via application or web browser by entering their username and password according to the access privileges of various research projects in Datazen login screen (Figure 2).

The key feature of BI dashboards in this study includes data visualization, reporting, analysis and monitoring. To illustrate, there are dashboard reporting for number of project participants and cancer cases (Figure 3). Namely, the dashboard for visualization of demographics data consists of the map of Thailand showing the distribution of sample population in research projects by using a template of bubble map. The sizes and colors of the bubble are varied to indicate the difference in population by province, etc. (Figure 4). Besides, users can view the drill-thought data by clicking on data items in the parent dashboard and be taken into entirely different dashboard (Figure 5). Another feature of dashboard reporting is the ability to analyze the relationship between variables in multidimensional views. This can

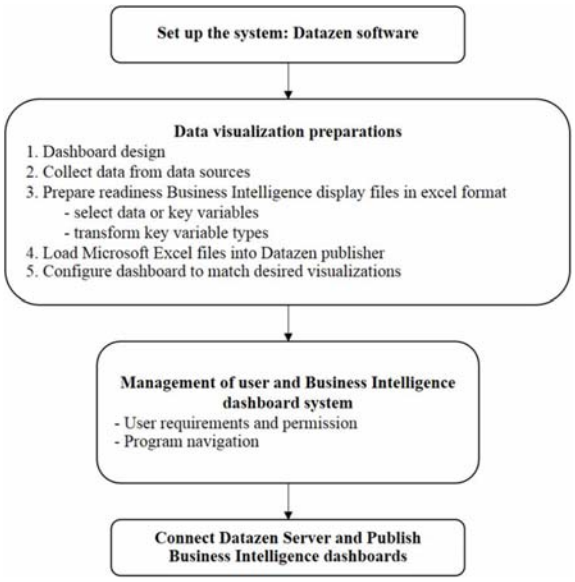

Figure 1. Flow diagram of implementing data visualization.

Figure 2. Datazen login screen to access the system according to rights permission.

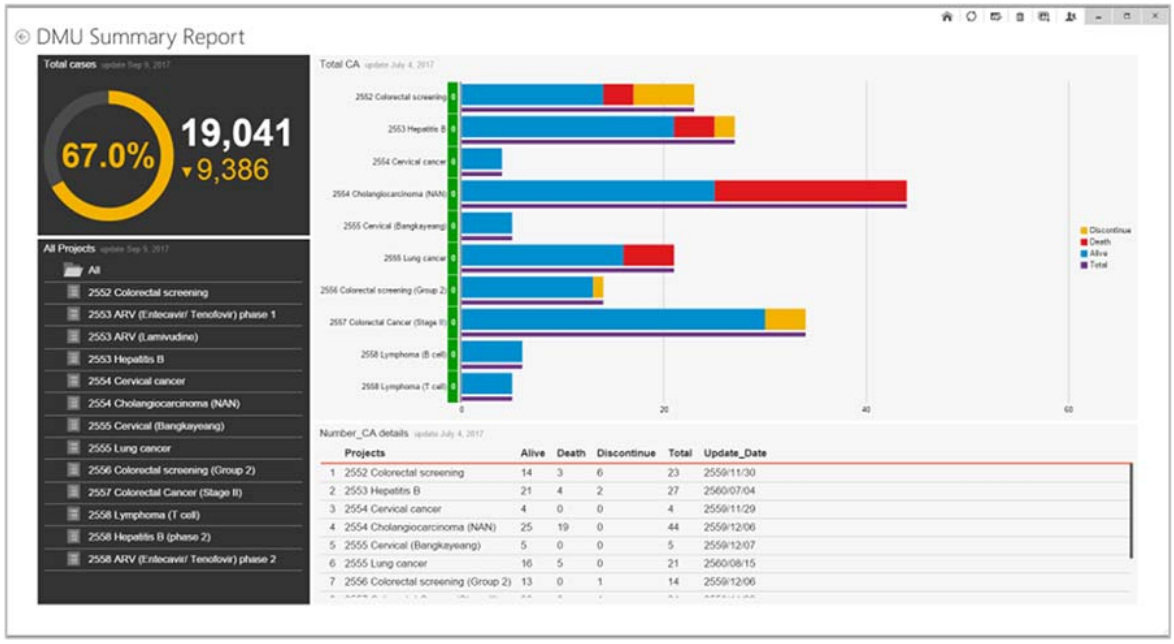

Figure 3. Dashboard for number of project participants and cancer cases.

be done by clicking on the variables to show the relationship. The dashboard will immediately report the result of relationship analysis between those variables (Figure 6).

Following a survey of 30 healthcare professionals for their satisfaction on the use of BI dashboards in term of systems and contents, it was found that most users showed the highest level of satisfaction (90%). Users also reported the highest level of satisfaction for system stability (76.67%), system's operational benefits (96.67%), and overall satisfaction (80%) (Table 1).

Discussion

This study focused on data from research projects managed by the Chulabhorn Hospital Data Management Unit. Data for each cohort study were collected by questionnaires and case record forms. However, the data collection process took considerable time, particularly given thelarge amount of data and complicated context of each project.

We identified a need for data collection, analysis, and access technology to ensure the most effective reporting of research results. This included the ability to view data in multidimensional models for

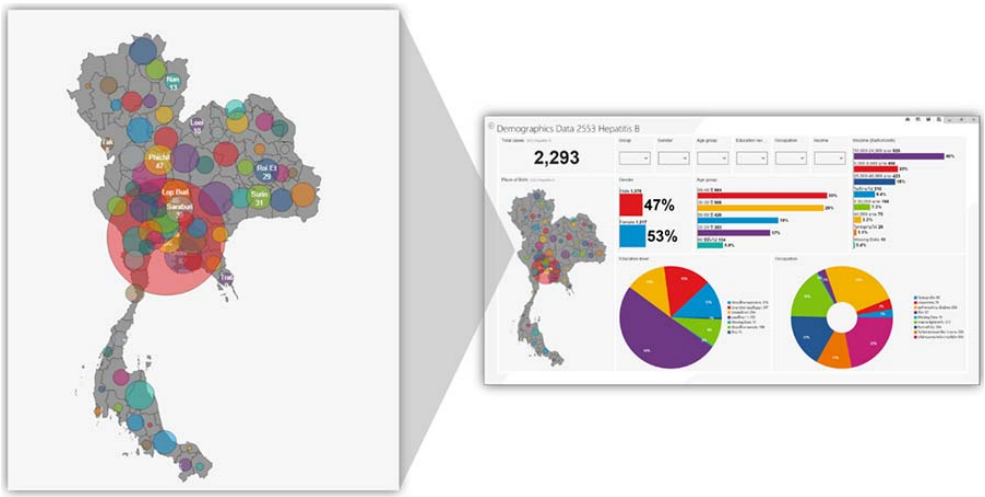

Figure 4. Dashboard for visualization of demographics data.

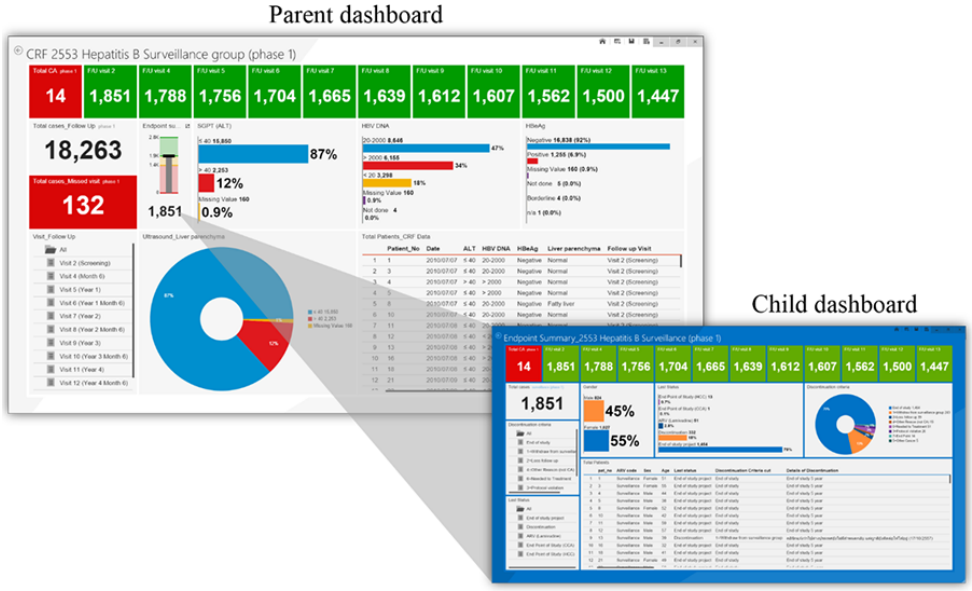

Figure 5. Dashboard Drill-thought to child dashboard for showing more data on a different parent dashboard.

each project using BI techniques such as data visualization, data mining, reporting, time-series analysis, online analytical processing, and statistical analysis[7]. The Datazen program was used to make the format of data reporting, summaries, and presentations more interesting and effective.

Evaluation of user satisfaction with the BI dashboards showed that overall users were highly satisfied with the system (80%). In particular, users were highly satisfied with the operational benefits of the system (96.67%), which included increased operational efficiency and new options for data reporting, summary, and presentation. A study by Jones et al[8] on a business analytics tool for monitoring and predicting radiology through put performance found that business analytics software improved operational efficiencies and management of radiology resources; users could receive rapid and accurate data reports, with analysis and relationships of variables in multidimensional views. In addition, users were able to

Figure 6. Dashboard reporting for analysis and relationships of variables in multidimensional views.

Table 1. Satisfaction with Business Intelligence dashboards: system and content (n = 30)

Items	Level of satisfaction				
	Highest	High	Moderate	Low	Lowest
Design of the system	27 (90.00)	3 (10.00)	0 (0.00)	0 (0.00)	0 (0.00)
Stability of the system	23 (76.67)	7 (23.33)	0 (0.00)	0 (0.00)	0 (0.00)
Operational benefits of the system	29 (96.67)	1 (3.33)	0 (0.00)	0 (0.00)	0 (0.00)
Overall satisfaction	24 (80.00)	6 (20.00)	0 (0.00)	0 (0.00)	0 (0.00)

better adjust the data for further research development, which previously required time and personnel to prepare and analyze new data or create a one-dimensional view of the data. Similar results were reported by McIntosh et al[9], who investigated the use of BI to monitor, report, and analyze academic biomedical informatics. Another study by Al Hazme et al[10] on developing and implementing a clinical and BI system for a health data warehouse showed that using dashboards significantly shortened the time required to analyze data for decision-making processes. Therefore, BI dashboards may enhance more accurate and effective reporting, summary, and presentation of health data in accordance with the distinctive features and operational functions of BI[2].

Conclusion

BI dashboards can improve the efficiency of reporting, summarizing, and presenting medical research data accurately and quickly according to the needs of users. This includes reporting of statistics, data analysis, and monitoring of data for use in further research. This format can be adjusted for other types of health data, such as number of patients at outpatient department and inpatient department, and hospital bed occupancy rates over time.

What is already known on this topic?

BI software helps to collect, analyze, and predict data on the performance or operating results of business organizations. BI techniques were used in previous studies to manage data in organizations such as healthcare departments, radiology departments, and biomedical informatics. This study showed that BI can be used to collect and store health data in research projects managed by the Chulabhorn Hospital Data

Management Unit. It also enhanced the development of more effective formats for reporting, summarizing, and presenting research data.

What this study adds?

Given the high level of user satisfaction, BI dashboards should be used for various hospital health data, such as number of service receivers and patients, rate of bed occupancy, and standard health data reports. This will help to optimize the operational performance of the hospital and various medical units.

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Potential conflicts of interest

None.

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