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Business Analytics Components for Public Health Institution - Nursing Decision Area

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Abstract

In the health area, the use of Information Technologies is becoming increasingly indispensable, since they allow the assistance of health professionals by contributing to better health care practices. Thus, the Information Systems, allows to provide information and make it available faster and more accurately to assist health professionals in the decision-making process. The nursing area, in a hospital context, presents some complexities due to the volume and difficulty of data recording. Thus, Business Intelligence (BI) technology allows to be the solution to get around this. BI allows you to integrate data from different sources, offering quality information, that allows healthcare professionals to make more intuitive and effective decisions. This article presents a solution of a BI system developed for the University Hospital Center of Porto (CHUP) in order to allow health professionals, the extraction of knowledge through data analysis from the nursing area, serving as support in the decision-making process. To obtain the solution, it was necessary to perform all the tasks associated with Business Analytics (BA) projects, to create dashboards in the area of efficiency and quality indicators for nursing practice.

Keywords: Decision Support System; Business Intelligence; Business Analytics; Nursing

1. Introduction

Currently, the use of information technologies (IT) in the health area is increasingly central. It is noteworthy that technological developments, in terms of health, are a constant and allows to assist professionals in this sector.

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Since the amount of information available in this area has increased exponentially, it is necessary to have information systems (SI) for better data organization. In the health area, the IS allow you to facilitate and transmit information in a fast, effective and safe way, which allows health professionals to have uninterrupted access to information, thus facilitating their work process.

IS in health provide a mechanism for receiving, processing, analyzing and transmitting fundamental information, so that it is accessible and useful for those who should use it [1]. These systems allow professionals in this area to have easier and faster access to information, in a more effective and efficient way, which becomes a strategy to achieve the quality of healthcare and thus help to make better decisions.

In line with project and, looking at a nursing area, this in a hospital context, entails some complexities in regard to the extraction of knowledge through data analysis, taking into account the volume and complexity of their registration. Thus, the technologies of BI and BA in the area of nursing allows to be a solution to overcome these adversities. BA is a convergence of BI and SI [2]. BI technology allows combining databases, architectures, analytical tools, applications and methodologies that aim to transform large amounts of raw data into useful information, to help make more informed and quality decisions [3]. BI concerns the decision process, transformation, analysis and distribution of data from various sources of information to improve the decision-making process [4]. In general, BI is a process that transforms data into information and, later, into knowledge [5]. Thus, it is possible to understand that the implementation of a BI system in the area of nursing brings specialties, since it makes it possible to provide more effective and faster responses and thus contribute to better decision making. In addition, decision support systems (DSS) are increasingly becoming essential tools for those providing health services, as the volume of available data is increasing dramatically and planning make better, more intuitive decisions. The main objective of these systems is to reduce uncertainty during the decision-making process [6]. In the nursing context, the value that a SAD can have is its ability to assist nurses to make better informed decisions [7].

The master's thesis project aimed to develop a BI system for the University Hospital Center of Porto (CHUP) in order to allow health professionals to extract knowledge through data analysis from the nursing area, to extent assisting in the process of decision making. For this, it was necessary to perform all tasks associated with BA projects, such as analyzing, extracting, transforming and loading data from the nursing area, in order to create as necessary dashboards, in the area of efficiency and quality indicators of nursing practice. For the development of the project, it was necessary to use two technologies: MySQL Workbench, for the implementation of the ETL process (Extraction, Transformation and Loading) and development of the Data Warehouse (DW); Power BI Desktop, for the development of the data visualization interface, that is, to create a set of dashboards in order to present the defined indicators and, thus, as assist health professionals in the decision-making process.

The article is divided into five sections, which begins with the Introduction and, later, presents the Development Tools, the Kimball Methodology, the Results and, finally, the Conclusion and Future Work. Section two describes the tools used to development the project. Section three describes the entire development process of the project, following the phases of the Kimball methodology. Section four describes the final result of the project. Finally, section five presents the conclusion and the future work to be developed.

2. Development Tools

This section presents a brief description of the technologies used for the development of the project, namely, MySQL Workbench and Microsoft Power BI Desktop.

2.1. MySQL Workbench

MySQL Workbench is a very complete visual tool with a simple to use interface and has several features, for example, MySQL database modeling and management. In addition, with this technology, it is possible to create complex entity-relationship diagrams, create and execute SQL queries, manage connections to MySQL servers, manage databases, make backups, among many others [8]. This technology was chosen as it is a complete, free and easy to use tool.

2.2. Microsoft Power BI Desktop

Power BI (PBI) is a data visualization tool from Microsoft that allows you to create a connection between the data and the end user. Power BI Desktop is one of the components of the PBI that installs on the local computer and allows you to connect to the data, transform and clean up that data to later create a data model and create reports that are collections of visual elements, such as graphs or tables, which provide visual representations of the data [9]. This technology was chosen because it is a free application and is one of the most used technologies in BI projects.

3. Kimball Methodology

This section describes the entire project development process, following all phases of the Kimball methodology.

3.1. Project Planning

According to the methodology adopted, the cycle begins with the Project Planning activity [10]. In this activity, the tasks related to the development of the project were identified, in order to ensure the proper progress of the project and the best possible result, always meeting the defined deadlines. This project aimed to develop a BI system that supports CHUP nurses, so that, through an analysis of the dashboards, regarding the personal production of nursing professionals, they have access to all information simplified and optimized to make more effective and intuitive decisions. In general, the BI system aims to help healthcare professionals to extract knowledge through data analysis, inherent to the volume and complexity of their registration. Thus, it was necessary to carry out all the tasks associated with BA projects: analyzing, extracting, transforming and loading the data provided in order to create the necessary dashboards, in the area of efficiency and quality indicators for nursing practice. Alongside the BA component itself, it was essential to carry out all the necessary tasks in terms of project management, in order to be able to ensure the proper progress of the project and the best possible result.

3.2. Business Requirements Definition

In this activity, business requirements were discussed and defined, in order to establish the main needs related to the nursing area of CHUP. Thus, a survey was made of which performance indicators would be crucial in nursing practice and which correspond to the needs of this area, in order to allow health professionals to extract all knowledge by analyzing these indicators, thus contributing to a process of more intuitive decision-making.

3.3. Technical Architecture Design

Figure 1 shows the architecture of the project, which is divided into two environments, the Development Environment and the Visualization Environment. The initial phase involves the collection of data from the CHUP's nursing area, to later carry out the process of extraction, transformation and loading (ETL) of these same data for the dimension and fact tables in the DW. Finally, the visualization tool presents the optimized information that will be provided to the end user in order to extract the necessary knowledge for better decision making. Since the Power BI data analysis tool has direct access to the information contained in the DW, it was not necessary to develop an OLAP cube.

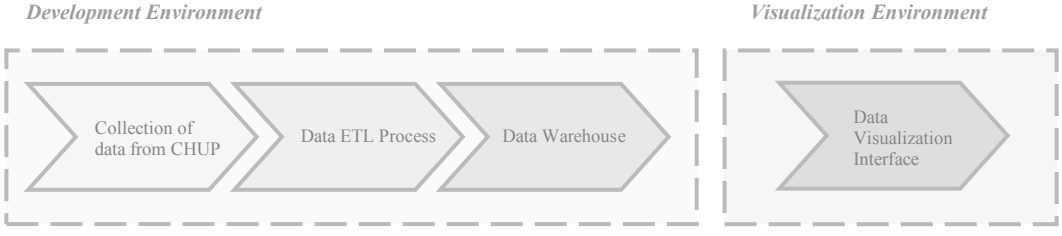

Fig. 1. Project Architecture

3.4. Product Selection and Installation

In this activity, the most appropriate technologies were selected and installed for the architectural stages. The tools selected and installed for the development of the project were MySQL Workbench and Microsoft Power BI Desktop. MySQL Workbench was the tool of chosen for the implementation of the ETL process and for the development of the DW. Power BI Desktop was the BI tool chosen to present the results, that is, through this technology it was possible to create a data visualization system referring to the nurses' personal production. The necessary dashboards were created in order to present the defined indicators, in order to simplify access to information and thus assist health professionals in the decision-making process.

3.5. Dimensional Modeling

The starting point of this activity was the understanding of data relative to the nursing area. Thus, these data were imported into a MySQL database. After the process of understanding the data, an exploration of them was made, in order to better understand all the information provided. In this way, through all the existing data, it was possible to understand what the links between the dimension tables and the fact tables would be, making some changes necessary in order to obtain the best possible dimensional model. Figure 2 shows the dimensional model constituted of dimension tables, fact tables and the respective relationships between them. The model is a schema in a constellation of facts since it has more than one table of facts and they share at least one dimension with each other.

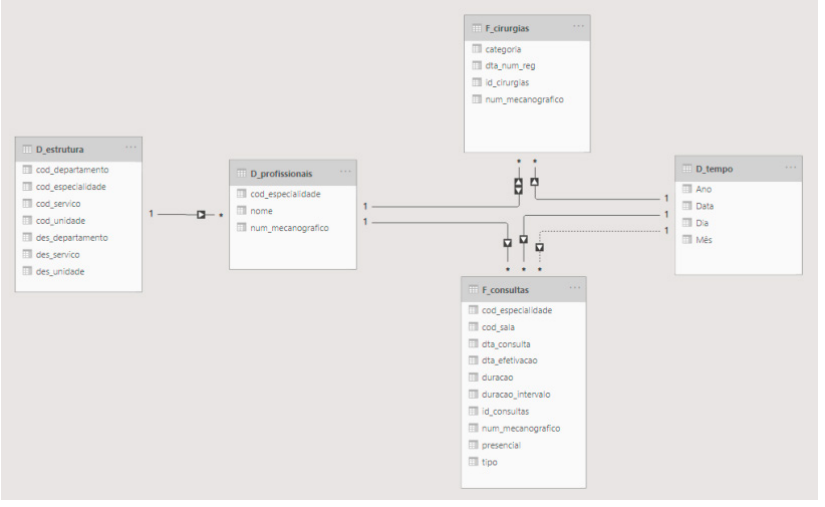

Fig. 2. Dimensional Modeling

3.6. Physical Design

MySQL Workbench was used to create the structure that allows the development of the DW, which is where it contains information regarding all dimensions and tables of facts, and also to establish the respective relationships between them. Finally, and regarding the analysis structure, Power BI Desktop was chosen to present the results visually.

3.7. ETL Design and Development

This activity is considered as one of the most important in the entire methodology cycle, since it is essential to make an assessment of the quality of the data, in order to find any inconsistencies that must be corrected to be able to load these clean data to DW. The MySQL Workbench tool was used to perform the ETL process. Once the data

presented some inconsistencies, it was necessary to make the required corrections, namely, to remove duplicate values, to remove lines that did not make sense, to replace data that presented a single letter with coherent words, to correct spelling errors and to remove special characters. In addition, it was necessary to create some new attributes, for example, id of the auto-increment type, since the fact tables did not have a defined primary key. After all the data processing / cleaning process, data was loaded into dimension tables and fact tables.

3.8. BI Application Specification

The BI application aims to provide the CHUP nurses with the information contained in the DW, in order to assist these health professionals in the decision-making process in the nursing area. For this, a development environment was created, which begins with the phase of data collection in the nursing area, followed by the ETL process of the data and, finally, the loading of the DW. In addition, a visualization environment was also created, which is where the data contained in the DW are presented visually. These two environments were created in order to be able to develop a set of reports and dashboards, according to the defined indicators, which allow presenting the optimized information to health professionals, so that they are able to extract all knowledge through data analysis and that contributes to a more intuitive decision making.

3.9. BI Application Development

This activity concerns the development of the BI application, that is, this is where the results are presented, in order to correspond to the analytical needs of the nurses at CHUP. Thus, the solution must meet the defined performance indicators. Power BI Desktop technology was used for the creation of the visualization environment, being necessary the connection with the MySQL Workbench to have access to the information available in the DW and thus create the reports and dashboards that aim to present the defined indicators. In addition, several pages were created, so that, through buttons, it is possible to navigate between the developed dashboards and thus have access, for example, to all analyzes related to a nurse's personal production. Figure 3 shows an example of a developed dashboard.

Fig. 3. Data Visualization

4. Results

This section describes the final result of the project taking into account the defined objectives. With the development of the project, it was possible to realize the importance of integrating the concepts of BI and BA in the nursing area. These integrations allow to bring numerous advantages for the public health institution, as for example, it allows health professionals to perform data analysis in a faster, more accurate and intuitive way, serving as support for decision making. After completing all the phases of the Kimball methodology, the project resulted in

a BI system that allows healthcare professionals to visualize their personal production and thus extract knowledge through data analysis, in order to help them make decisions. Through the dashboards developed that present the essential indicators for this area, nurses obtain information with more quality and intuitiveness and, allows data analysis to be carried out in a simple and fast way, which results in an improvement in the decision-making process. The solution obtained presents the most crucial performance indicators for the area in question, taking into account the needs it presented. Thus, with the developed system it is possible to obtain a better use of data from the nursing area.

5. Conclusion and Future Work

The project had as main objective the development of a BI system, which allows health professionals in the nursing area, to extract knowledge through data analysis, serving as support in the decision-making process. For this, it was necessary to perform all the tasks associated with BA projects, such as analyzing, extracting, transforming and loading the peculiar data of this area, in order to create the necessary dashboards in the area of efficiency and quality indicators, in a way to contribute to support the nursing decision. In this way, the data visualization system developed provides a set of quality indicators that aim to respond to the needs of the nursing area and, thus, allow to extract all knowledge through the analysis of the information contained in these indicators presented in the visualization interface. Thus, it can be concluded that the developed prototype allows a better use of the data stored in the databases, which will later contribute to the decision-making process.

Since there were some phases of the Kimball methodology that were not carried out, namely, Implementation, Growth and Maintenance, as future work would be to carry out these activities. This work starts by implementing the prototype in the hospital, making a direct link to the database of the public health institution and, thus, it is possible to make analyzes of the data in real time. On the other hand, guarantee the growth and maintenance of the prototype through the creation of new indicators in addition to those that are part of the project, in order to respond to the needs present in the nursing area.

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