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# Implementing a business intelligence cost accounting solution in a healthcare setting

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**Abstract**

The health system environment in Portugal is a constant concern for our society. In view of this, like any other sector, the hospital area has a complex structure containing a large volume of information, which makes the decision-making process difficult. With this, there is a need to improve the management of health institutions' services and resources. Taking this into account, the solution involves the transformation of the current system with the help of information systems to be implemented. Thus, the idea of implementing information systems that use Business Intelligence in hospitals arises, the focus of this project is to assist managers in the analysis of analytical accounting. In partnership with the Centro Hospitalar Universitário do Porto, it was decided to explore the use of Business Intelligence, with the objective of implementing a complementary solution to the existing cost accounting plan, with the objective of improving efficiency and providing managers with new tools for manage your resources and plan for the future as needed.



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## 1. Introduction

The use of Information Systems is already proven to have an extremely important role in current organizations. Despite the healthcare industry having a different business paradigm, it faces the same challenges.

However, the adoption of technologies like BI is still low even with numerous success cases. The adoption of these technologies not only can improve efficiency, efficacy, and healthcare service quality but economical transparency in real time as well [1]

This case study is part of an ongoing project being developed between the University of Minho and various healthcare units in Portugal called AIDA (Agência para a Integração, Difusão e Arquivo de Informação Médica e Clínica). AIDA's main goal is to integrate, disseminate and record great quantities of data from different data sources and provide tools to facilitate human interaction [2]. In this specific case study, it was decided to explore certain areas that were being neglected, namely cost accounting. Since even in the health care sector has the need to manage efficiently its available resources, it was required by law for every public entity to have a cost accounting plan, and in the hospital context the most recent being PCAH (Plano de Contabilidade Analítica dos Hospitais), it was decided to try and implement a BI solution that integrates the hospital cost accounting plan to try and provide its users new advantages [3,4,5}.

## 2. Background

The hospital sector in Portugal has developed its systems of information to increase the efficiency and effectiveness of the work performed. However, although there are several projects related to the use of technologies to improve services there are few if any adopting BI technology [6]. It is true that hospitals have complex systems for invoicing, however the infrastructure to support managers in decision-making regarding cost accounting information is practically nil. Such as any other sectors of activity, the hospital sector has needs regarding the management of its resources.

Analytical accounting or cost accounting, provides detailed cost information that management needs to control current operations and plan for future ones. Management then uses this information to decide how to allocate resources to the business area in a more efficient and profitable manner [7].

With the development of systems that integrate BI solutions with existing plans, it may be possible for organizations to improve the decision-making process in a more sustainable way. With these tools, it is possible to collect, process, store and distribute information to support the decision-making process and assist in control. For this to be possible it is needed to integrate the various information systems that are invaluable to the organization day to day operations. However, this raises several problems, namely the interaction of the various systems within the organization. Since often each service, or area of an organization has a closed system, this makes sharing information complicated. The case in question, due to the size of the hospital units, and the way they are structured in various units and departments together the closed systems used, the volume and complexity of data has become increasingly difficult to manage. It is necessary to ensure that information sources are distributed, ubiquitous, heterogeneous so that the various systems communicate and share information. For this to be possible, it is necessary to ensure interoperability between the various components of the entire system. Interoperability being the capability of information systems, devices and applications communicate and cooperate in the use of information in a coordinated way at the organizational, regional level or national to provide the correct information in a timely manner [8,9]].

Since there was already interest in resolving problems with this nature, it was decided to create platforms such as AIDA, in which this project is based on. AIDA, as the name implies, aims to collect, disseminate, and archive a large volume of information, which can be used to generate knowledge and for the decision-making assistance [10]. Since there was interest in expanding the scope of the BI system already integrated in various healthcare units, it was decided to focus on a previously neglected area, which is cost accounting, in a way to integrate the BI platform with existing plans and regulations.

## 3. Methodology and tools

During the project development, 3 methodologies were used. First used was DSR (Design Science

Research) for information research, and Kimball and KPI (Key Performance Indicator) methodology for the product development. The DSR is a research paradigm which tries to solve human problems by creating artefacts, this way contributing new information as scientific proof [11]. Normally, this methodology is divided in 6 different phases: Problem and motivation identification; Defining solution objectives; Design and development; Demonstration; Evaluation; Communication. The Kimball methodology is a development methodology that serves as a guide to the implementation and development of BI projects where DW (Data Warehouse) are created [12]. It's based on the business life cycle and guarantees the guiding of the artefact development, from business requirements to BI solution creation. The methodology is separated in 12 different phases: Project planning; Project management; Definition of business requirements; Architectural design; Selection and implementation; Dimensional modelling; Structural Design; Data design and development; Analytical application specifications; Analytical development of the application; Launch; Management and growth. The last methodology used was the KPI methodology which is used in the creation of the key performance indicators that organizations use to monitor the performance of various key business activities. This methodology is divided in 4 main phases: Start; Development; Implementation; Revision.

## 4. BI solution development

First of all, before starting developing the BI solution, it's needed to plan the set of steps to successfully finish the project. The first step is trying to understand the organization environment: What the organization is all about and it's needs. For this to be possible it's necessary to study the organization, and its area of activity. Only then, should we worry about defining business requirements, understanding the information to be worked with and building the product using the various tools and methodologies needed.

### *4.1. Business requirements*

In this stage, the most important part is trying and understanding the needs of the organization. In this context, the CHUP (Porto's University Health Care Centre) objectives are implementing a BI solution with the current cost accounting plan in a way to provide new advantages to its users. In order to reach those objectives, business requirements were defined.

#### ***4.1.1.*** *Functional requirements*

- Detailed and hierarchical understanding of the various cost codes.
- Comprehension and distinction between cost and income classes.
- Creating temporal logs for balance sheets.
- Representing the required information in visual elements (Dashboards).
- Improvement existing Dashboards already in development.

#### *4.1.2. Non- functional requirements*

- Easy to understand solution.
- Easy to use solution.
- Low maintenance product.
- Web solution.
- Product that allows expansion.

### *4.2. Project Structure and Development*

After defining the necessary tools and requirements, the process began with data collection and allocation in database. The next step was a ETL (Extract, Transform, Loading) process where, through scripts specifically created for this purpose, it was refined any incongruities that the used data might contain. For the construction of dashboards, it was decided to use Microsoft Power BI. Before starting any database modelling, it is necessary to

analyse the data. Since the data that was provided by the CHUP is originally from different sources of excel files, it is important to extract that information to a database to start working on them. After understanding the contents of the extracted data, the next step is verifying its usefulness. When the previous step was completed, it started an in-depth exploration and treatment of the remaining data. With constant interaction between all interested parties, it was possible to determine the database tables and its respective attributes. Although, to help satisfy some of the business requirements, it was created several support tables with new attributes. With the database structure defined, we started loading data to its respective place. The most important part of the ETL project, was the creating of a new table and attributes, that were required to create a hierarchical structure, that while it was implied, it was necessary to develop the BI solution correctly. When this process was completed, the final result was the creation of the following tables: “Balanco_custo”; “Niveis_hier”; “Classe_custo”; “Fact_kpi”; “Especialidadekpi”; “Fact_conta”; “Especialidadeconta”; “Conta”; ”Niveis_hier”; “Classe_custo”; ” Tempo”.

### *4.3. Dimension Model*

The data warehouse designed for this project can be represented through a dimensional model. In the Figure 1, the model is represented to provide a better perspective of the data warehouse. This model is divided in 3 constellations, with the first one portrayed with 4 different tables, highlighting the balanco_custo which is the fact table and the connected 3 dimensions tables: niveis_hier, tempo and classe_custo. The second constellation is made up of one fact table and a dimension that are facto_conta and especialidade_conta, respectively. The last constellation is also comprised by one fact table and dimension called facto_kpi and especialidade_kpi, respectively.

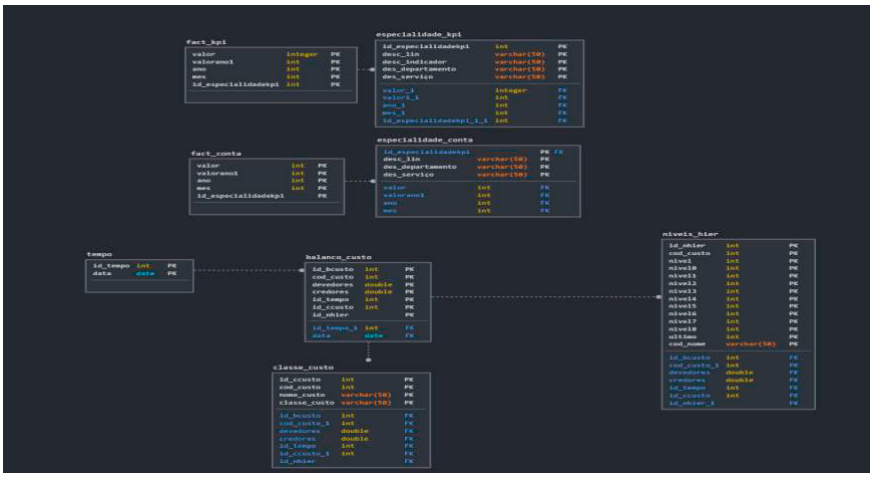


Figure 1 Dimension model

## 5. Dashboards

The information is presented through various visual reports called dashboards. The dashboards went through continuous refinement until the last version where all parties were satisfied with the result. The Figure 2 shows some the most important dashboards of the final product. The Figure 2 (a) is one of the most important dashboards, because the most requested requirement was the hierarchization of costs and profits. The source from where these data were extracted, while had all the costs and profits present, the data was not structured properly making it difficult to understand the connection between costs/profits. This way is also more efficient timewise, because instead of a spreadsheet full of hundreds of lines with numerous codes, there is an understandable structure that facilitates data search. There are also other ways that this dashboard helps users with data searching. The table to the right allows users to search specific codes that show the full history of a specified account, making it easy to compare values from different time periods. There are also filters that allow to narrow data search, in this case it is possible to filter year and month of the required information. The dashboard present in Figure 2 (b) is also important because, while the previous one had the most detailed information, this dashboard allows a visual representation.

For example, the present graphics allow a quick peak at various metrics created in a concise way. The "Rendimentos" tab is a mirror for the "Gastos", the only difference is that "Rendimentos" details profits and "Gastos" costs. The last dashboard is part of a series of improvements made to a previous attempt of integrating cost accounting to the CHUP BI platform. Since the improved dashboards show a similar structure, varying in small details according to different data. This dashboard shares similar functionalities to the previous dashboards. It possesses a similar visual representation structure, for example, pie chart that divides costs by account groups.

All in all, the examples shown, follow the same principle. The need to provide new information quickly and in a condensed way. This allows to work more efficiently, because it reduces significantly search time, but also provides new perspectives, since it is possible to apply new metrics and variables that while implied in the source data are not easily seen at first glance.

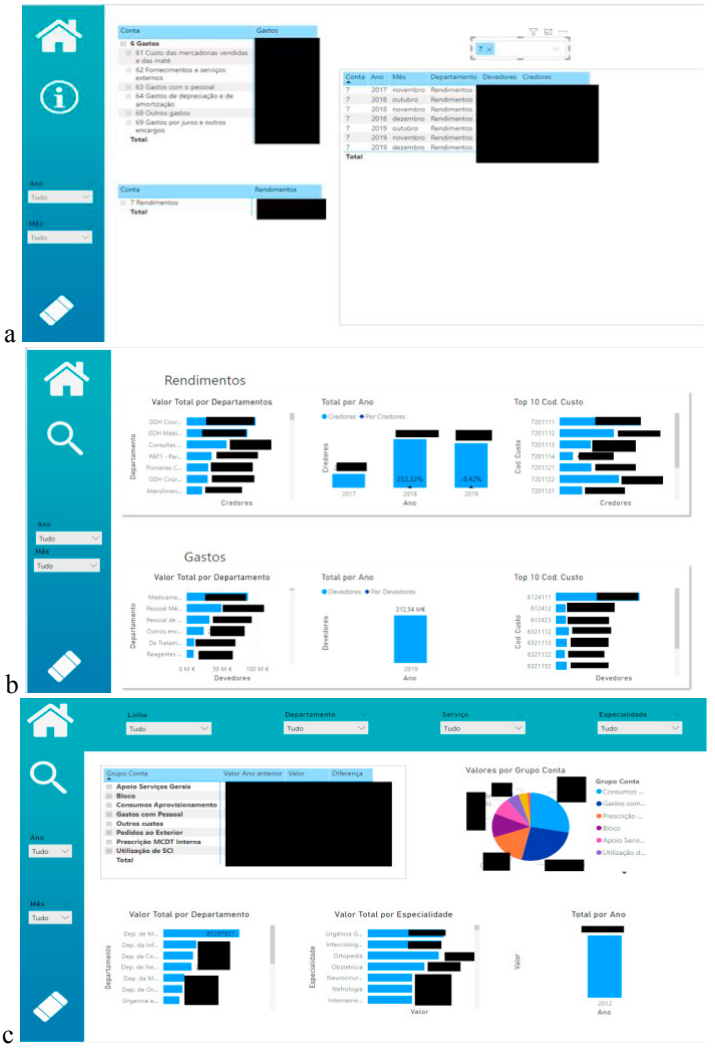


Figure 2 Dashboard examples

## 6. Discussion

In short, the information obtained from this BI solution presents an important summary of the organization's expenses and income, as well as summarizing which departments/specialties have the highest costs/income. In addition, with the restructuring of the new and improved dashboards, it is possible to diversify and increase the

quality of information. With this, managers obtain a perspective of the organization as a whole, giving them the opportunity to understand what the main expenses and or income are. Despite being a public health service institution where spending and profits are not the priority, it is always important information to have when making day-to-day decisions. Another very important feature is the creation of the history, as it allows comparing expenses/income over the years and tracing the hospital's path of growth. Through this solution, management is easier and faster, since through filters they can select the most relevant information to the situation they are in.

The development of this product allows the process of decision making to be more impactful, since it uses up to data information and new information perspectives. Since this product is part of an ever-expanding BI solution, this is a major advantage for the organization because it captures all available knowledge in a simple condensed platform that enables management to put together better-informed decisions.

## 7. Conclusions and Future Work

This project began with the idea how could BI help with decision making and how to implement with cost accounting plans in use. Knowing the fact that this project is part of an ever-expanding BI solution, this area seemed the next logical step to explore. Since the solution was developed with this in mind, providing relevant information, in an accessible and intuitive way for managers, allowing them to make the right decisions, bringing efficiency and effectiveness, through organizing cost information as needed to reduce time spent on data analysis. This solution is able to extract, store and properly process data from CHUP, providing the knowledge in real-time through a visualization interface, with a set of capable metrics to respond to the needs of decision makers regarding the management of cost accounting. The completion of this work allowed us to conclude that BI is, in fact, suitable not only in a clinical setting, as there are already solutions implemented in this area in the hospital, but in the administrative area as well. This project has a lot of potential for future work, not only because it is an ongoing project capable of expanding to multiple areas within the hospital, but also explore other parts in cost accounting that were not included in this solution for various reasons and because these plans implemented are ever evolving.

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