Using OLAP Tools for e-HRM: A Case Study

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ABSTRACT

In the growing challenge of managing people, Human Resources need effective artifacts to support decision making. On Line Analytical Processing is intended to make business information available for managers, and HR departments can now encompass this technology. This paper describes a project in which the authors built a Data Warehouse containing actual Human Resource data. This paper provides data models and shows their use through OLAP software and their presentation to end-users using a web portal. The authors also discuss the progress, and some obstacles of the project, from the IT staff’s viewpoint.

Keywords: Absenteeism, Business Intelligence, Data Warehousing, Human Resource Management, Online Analytical Processing, Workforce Analysis

INTRODUCTION

Since the late 1980’s and the beginning of the 1990’s, Business Intelligence (BI) tools have been proposed as valuable tools for companies (Inmon, 2005; Kimball et al., 1998), helping with decision support. Inside and outside the Human Resources department there is need for information that is not delivered by traditional HR systems, such as intranets (Guiderdony, 2007). On Line Analytical Processing (OLAP) is one of the BI proposals for making information available for managers.

Most of the literature examples of OLAP used in companies is based on financial or production data, for instance, the sales amount.

According to Ngai and Wat (2004), the use of Information Systems in the HR to help make more precise decisions is only the tenth in the ranking of their perceived benefits.

In this paper we present the experience gathered during the course of a project that aimed to apply OLAP tools for HRM, targeting on employees demography and absenteeism. This text represents the point of view of the IT staff regarding the project progress and sequels, intending to provide an example of how such powerful technology can help the Human Resource area, and potential difficulties in this way.

The projects began in 2005 at the Human Resources department of a public Brazilian University. It offers 58 undergraduate and 127 graduate courses and is organized in 20 Institutes and Schools, one academic medical center, 23 research centers and an administrative area. The
institution employs teachers and researchers, technical and bureaucratic staff, physicians and nurses, comprising about 10,000 workers.

This paper is organized as follows: in the next sections there are, respectively, an overview of the adopted Business Intelligence theory, the description of implementations of two Data Marts regarding Human Resource information and how their content can be provided to final users. In the remaining sections, we discuss the challenges faced during the project, the drawbacks, lessons learned, project follow-up and present our final remarks.

**Business Intelligence Overview**

The concept of Business Intelligence (BI) refers to the abilities of the corporations to retrieve information related to their operation processes and area of activity, in a flexible and dynamic way, allowing the analysis, detailing and understanding their work and providing means for decision support. The term has been popularized since the late 1980's by Howard Dresner and the Gartner Group (Power, 2002).

The data managed by Business Intelligence systems have certain specific characteristics, reflecting on the way they are gathered, stored and retrieved, which will be briefly explained in the following sessions.

**EXTRACT, TRANSFORM AND LOAD**

The process of obtaining and modifying the data for feeding a Business Intelligence database is called ETL, in respect to the three steps it involves: Extract, Transform and Load.

In the Extract step data are typically queried from other systems of the company, the so-called OLTP—On Line Transactional Processing—that supports the day-by-day organization operations. Spreadsheets and plain text files can also be used as data sources for Extraction.

In the Transform step the data are handled aiming to fit in the view the users of the decision support system have of the process and of the facts they represent. This means unit conversions, codes standardization, data filtering, categorization and so forth.

In the Load step the data produced by the prior steps are stored in a special database structure called Data Warehouse, which is described as follows.

**DATA WAREHOUSE AND DATA MART**

The Data Warehouse (DW) is a large data repository (Immon, 2005), obtained from all the relevant sections of the organization. The Data Warehouse contains the raw material for the management's decision support system.

When the Data Warehouse is updated from ETL, no data is deleted or overwritten. Instead, the data are accumulated, constructing the history of the data involved in the company operations.

The data structure of a DW often does not follow the common database systems techniques that use normalization to ensure data integrity and less storage space. Instead, the data are de-normalized and arranged in such a way that helps to query for reports and analysis.

From the organization Data Warehouse, the information related to each area of interest is separated, forming Data Marts. Each Data Mart (DM) is a subset of the whole DW focused on a special subject of the decision support systems (Figure 1).

Data on a DM is arranged according to the star schema: each relevant data from the organization, known as fact, is stored in a structure called cube, which can be viewed or decomposed according to pre-defined categorization of the data, known as dimensions of the cube. The dimensions are some typical meaningful attributes of the fact, such as time, customer type, products and geography of the organization.

The dimensions can have several hierarchies for classifying the facts according to many points of view, each hierarchy being composed by different levels of granularity.
ON LINE ANALYTICAL PROCESSING

Retrieving data from a DM requires specialized software that can deal with cubes and dimensions. Besides, it must be able to provide a single entry point for the managers of the organization to search for the information needed to their decision making process. This role is fulfilled by the On Line Analytical Processing systems (OLAP).

An OLAP system provides means for accessing a Data Mart, listing its cubes and related dimensions, constructing reports, regardless of the particular data it contains. This way, the user does not need to learn how to operate different systems, and also programmers do not need to develop new programs and reports for each subject addressed by the Data Marts.

Through an OLAP, a user can build reports and charts that summarize the facts retrieved from the DM according to the selected dimensions. This way, it is easy to create cross-tabulation by dragging and dropping dimensions on rows or columns.

It’s also easy to change the granularity chosen by a certain dimension, in a process called drill-up or drill-down, when the user navigates through the hierarchic levels of a dimension.

For each of these modifications on the table structure, the data on the cross-table cells are re-summarized on-line, providing immediate answers for the user and helping decision-making.

OPERATIONAL DATA STORE

Along with the use of data warehouses, companies sometimes faced situations in which the information needed to support a decision was not fully present in the BI systems, neither available nor easily retrievable from the operational systems and databases. To bridge this gap, Inmon et al. (1996) proposed the Operational Data Store – ODS.

The Operational Data Store can act as an intermediate repository for data coming from the operational and legacy systems, and going to the Data Warehouse and Data Marts. The data ODS content is fine-grained, current-valued or at least often updated, and subject-oriented. The ODS is fed with operational data from several sources, which are put together to serve as a single source of information for reports and another Decision Support Systems, and for the ETL of the DW (Figure 2).

EMBEDDING OLAP VISUALIZATION INTO WEB APPLICATIONS

Sometimes managers need to see data with different levels of granularity in the same compu-
tational environment. Facing any unpredicted or suspect behavior in the operational data triggers a lookup in the BI data in order to discover a trend, prevent some future failure or explain any apparent outlier information. Having both the current and the historical data side by side is helpful to place the suspicious data in the historical scenario of the organization and take the necessary decisions and steps.

Nowadays, there are many available technologies that enterprises can adopt to bear their IT software infrastructure. Some are proprietary or customized, bought or developed exclusively for that organization. On the other hand, the growing presence of free software that provides solutions with the same level of quality is undeniable. From the first set, we can cite the Microsoft® .Net Framework used by many organizations to support their software; from the last one, the Sun Java™ and particularly the JEE platform has a broad spread use.

Many literature sources (Few, 2009; Casati et al., 2004; Malik, 2005; Niven, 2008) refer to a need of an “enterprise dashboard” in which BI data can be promptly seen and understood. This artifact can be achieved by the use of a report generator such as Jasper Reports (http://jasperforge.org). It is a software solution that can be embedded in a large range of Java applications, both for web and desktop environments, and has both free and commercial license models.

There is a whole package of tools from the Jasper repository intended to be used with Business Intelligence and OLAP visualization, called Jaspersoft Business Intelligence Suite. Its main component is the report generator, but there is also support for interactive querying and dynamic dashboard customization for advanced users.

With the report generator, components such as the Pivot Table can be mixed with pie charts in order to obtain the desired visual information. The IT team responsible for the development and maintenance of the operational Human Resource Information System can add this functionality to the new or existing software.

As information security is always a concern in HRIS, in order to not expose unnecessary or confidential data from the employees, the BI Suite provides single sign-on integration with external security systems such as LDAP and Windows Active Directory Services, with granular access control by row, column, cell or report. It also enables an audit trail logging, with which one can know who accessed which report and when.
As a result, when someone from the HR staff uses the operational software in his or her daily activities—let us say, interview a candidate for a job or a promotion—he or she can see the necessary updated or outdated data from the person, with the background data of the whole organization or of a single department, all in a single software tool, providing better reference for comparisons and decisions.

Implementation of Data Marts

To help with the decision-making of the Human Resource area of the University we modeled the Absenteeism Data Mart and Employees Data Mart. Thus, we met the demand for information referring to workers counts and absenteeism rates distinctly. The following sections will detail each constructed Data Mart.

USING BI ON THE WORKFORCE ANALYSIS

The ability of profiling the workers of an organization is a common need in Human Resource activities. According to Burke and Ng (2006), some of the up-to-date subjects in HR are related to demographic changes of workers, such as aging and cultural diversity. In the studies presented at the United States Worker Health Chartbook (NIOSH, 2004) the major variables considered were age, sex, ethnicity and occupation. These variables can be applied both inside and outside an organization. But specifically inside the enterprise, more attributes may be added to depict the worker’s profile.

Modeling the Employees’ Data Mart

The Human Resource Management Systems (OLTP) used at the organization stores the workers’ enrollment data in several distinct tables. Our first challenge was to choose a set of attributes, candidates to become dimensions, which accomplish the maximum number of requirements from some Human Resource departments and other business areas of the University.

Besides, we decided to elect some extra dimensions to put in the model, trying to avoid a new modeling caused by new requirements in a short period of time. We defined the sum of employees as the fact for the cube and conclude the data model shown in Figure 3.

This cube was planned to be updated monthly, so the Time dimension contains month and year for every snapshot of an employee’s situation, taken on the last day of the month. The Statute dimension stands for the legal characteristics of hiring contracts.

Workplace means the current position in the physical and organizational structure, (institutes, departments, and so on): the Journey dimension represents the nominal workday length and Frequency Situation reflects the employee availability at the workplace (still working, retired, on vacation, absent and so on). The other dimensions are self-explanatory.

APPLYING BI FOR ABBSENTEEISM

According to Chiavenato (2002), Absenteeism is an expression used to designate a worker’s faults or absences in the enterprise. Quick and Lapertosa (1982) suggest the following classification, regarding the cause of absence:

- Sickness at Work Absenteeism: originated by professional diseases or work accidents;
- Health Absenteeism: produced by diseases other than those related to work;
- Legal Absenteeism: when the absences are predicted and accepted by laws;
- Compulsory Absenteeism: situations beyond the worker’s will, for instance, any penalty or arrest.
- Free Will Absenteeism: generated by personal affairs and situations without legal subsidy.
Couto (1998) emphasizes that it is very important to know how to measure and understand absenteeism rates in a corporation, based not on a single point of view, but instead involving areas as:

- Operational Management: focus on frequency control to detect and avoid problems with team productivity, exceeding hours on duty and overload of tasks.
- Human Resources: build projections to foresee the future needs of the working force.
- Occupational Safety and Health: aims to detect and prevent diseases produced by work situation, resulting in programs to deal with hazards and enhance life quality.

Based on these approaches, authors define several different absenteeism rate formulas, with slight variations in the input data, but all having the general rationale of quantifying the ratio between absent and expected workforces. Couto (1998) defines his rates based on the average number of employees working and the number of days that are important for each analysis: number of missed days, number of days on medical leaves, and so forth.

Couto (1998) highlights the importance of choosing a single standard of absenteeism calculation in order to make it comparable in terms of time evolution and distribution in the company geography. This convergence can be obtained by a single system that provides the data to the whole organization, however respecting particular needs, by using the tools as Business Intelligence software described below.

THE ABSENTEEISM DATA MART

From an OLTP system used in the company to store and process data related to the daily attendance of the employees, we define a star schema that uses this information in a consolidated and complete way. The information structure is modeled in agreement with the dimensions that were defined in the project.

To build the Cube, in the beginning of the project, we considered the use of the number of days of absence (Couto, 1998) as the fact for the cube. But due to characteristics of the organization, such as the variety of shift durations, and the availability of data on the HR operational system, we changed it to use the number of hours to populate the cube.

The cube thus sums the amount of hours every employee has for each frequency situation of the organization. The number of hours is obtained through the verification of the employee frequency, which is registered in a database that stores the daily amount of hours that the employee works, is absent, or is in any other exceptional situation.
To use as Dimensions, besides some historical dimensions of enrollment data like the workplace, frequency situation and gender, we created a special dimension called Absenteeism, which contains the items Integral Actuation, Partial Actuation and Long Term Absence (Figure 4).

We considered as Integral Actuation on the company all employees that worked, or were absent in accordance with the Brazilian Consolidation of the Labor Law (CLT, 2007, article 473) during the month under consideration.

Absences that were shorter than thirty days in a row or that were not legal were defined as Partial Actuation on the company. Absences exceeding thirty days in a row were regarded as Long Term Absence.

It’s possible to view the amount of hours in a certain frequency situation using only the fact itself, without estimates. The number of hours is split among Integral Actuation (I), Partial Actuation (P) or Long Term Absence (LT).

Besides, we can apply a function to translate the raw number of hours into a generic absenteeism rate, \( r(x) \). To get the Integral Actuation rate in the company, we divide the amount of hours of the Integral Actuation by the total number of hours of Actuation, Integral plus Partial, or

\[
 r(I) = I / (I + P). \tag{1}
\]

The absenteeism rate of the Partial Actuation is obtained from the division of the amount of hours of the Partial Actuation by the sum of hours of the Integral Actuation plus the hours of the Partial Actuation, or

\[
 r(P) = P / (I + P). \tag{2}
\]

To get the Long Term Absence rate, just do the division of the amount of hours in the Long Term Absence by the sum of hours of the Actuation Integral plus the hours of the Actuation Partial plus the hours in the Long Term Absence.

\[
 r(LT) = LT / (I + P + LT). \tag{3}
\]

Based on these formulae we built some reports that access the absenteeism Data Mart, providing the HR staff and managers with a worker’s absence information.

**Spreading Knowledge**

The data marts were finalized, though the information is still obscure for the end-user, then we concluded that a layer have to be created between the data mart and the end-user, because there must be means to access the data to get valuable information for analysis.

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*Figure 4. Star schema for absenteeism data mart*

<table>
<thead>
<tr>
<th>Cube</th>
<th>Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workplace</td>
<td>Time</td>
</tr>
<tr>
<td>Journey</td>
<td>Occupation</td>
</tr>
<tr>
<td>Absenteeism</td>
<td>Gender</td>
</tr>
<tr>
<td>Absenteeism Data Mart</td>
<td>Frequency Situation</td>
</tr>
</tbody>
</table>

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Rasmussen et al. (2002) describe five different scenarios for integrating BI tools with the data source:

a) Adopt only one BI tool to access the OLTP data source;

b) Adopt more than one BI tool to access the OLTP data source;

c) Integrate some BI tools to access the OLTP data source, by using a single web portal as a user interface to all the BI tools;

d) Use BI tools that come with the OLTP information systems by accessing its data source (e.g., functions of the HRIS that might generate analytical reports and querying);

e) Use one or more BI tools by accessing a data warehouse.

We knew that the end-user has, not often been able to manipulate any kind of BI tool, thus some reports have been made available on a web browser. On the other hand, some users were experts at generating reports, graphics and analytical functions using a BI tool, for that reason, having an OLAP tool available was essential. Therefore, maintaining a portal where analytical reports could be accessible on the web, and disposing a BI tool for some end-user was our goal.

Having BI tools accessing the HRIS data sources was unnecessary because we had the data warehouse and data marts structured, consequently, alternatives a), b) and d) were disregarded, but c) was not, because using a web portal for some reports was a fact, then we joined options c) and d) once our goal was to build a web portal where analytical reports could be available, and in the same interface give access to the BI tool adopted to access the data marts.

**USING THE OLAP TOOL**

Aiming to exemplify the features of an OLAP tool, we will describe below the use of the Absenteeism Data Mart through a BI software tool. The use of the same tool for accessing the Employees Data Mart is very similar.

By accessing the Data Mart the managers can create themselves several spreadsheets and charts, or access some pre-built ones. Figure 5 shows a simple but typical table, where we can perceive the star-schema structure: dimensions in rows and columns, and a fact summarization in the center cells.

The dimension Time was used for columns in the Month hierarchy level, and the dimension Absenteeism was placed in row titles, using both levels Type and Subtype. The fact presented is the number of hours for each situation, summarized by a Sum function. The data were filtered to show only the months 01/2006, 02/2006 and 03/2006.

A common OLAP tool allows us to apply user-defined functions and calculations to the raw facts. For instance, to the same data used for Figure 5 we can apply the formulas described on the previous section for the absenteeism rate in the organization, producing the report shown on Figure 6.

Since the users' needs for this system concern mainly the Partial Actuation index, we can plot a chart to view its behavior during all the months of 2006, as shown in Figure 7 by simply changing the filter of the Time dimension and applying the fact data to the Y axis of the chart.

If the user becomes curious about whether this behavior repeats itself every year, he or she can drill-up the Time dimension, by accessing the Year hierarchy level, and producing another report and chart (Figure 8). Managers now can get informed about possible workforce variations along the year.

Other dimensions, as the Workplace for instance, can be added to the sheet by simply dragging and dropping onto the rows or columns, and then the same procedure of drilling up and down can be applied for finding departments or offices of the organization where the absenteeism rates require more attention from the Human Resources department.
Figure 5. Typical BI table, showing dimensions (gray) and facts (white)

Figure 6. Processing the raw fact using Absenteeism rate formulas

Figure 7. Chart for the Partial Actuation rate during the year of 2006
HR-BI PORTAL

Setting the portal as the primary point of interaction was our purpose, and then Human Resource – Business Intelligence Portal was the name granted to the web interface that made available the access to the BI tool and the analytical reports created.

The end-user community has access to this web portal according to three security levels:

1. Public: human resource quantitative reports, created in the BI software, which were chosen as a valuable information accessible to everyone;
2. Private: human resource costs and payroll reports, created in the BI software, which only the human resource area, managers and authorized users can access;
3. Restrict BI tool: qualified users able to generate analytical reports and graphics according to their needs.

Lessons Learned

When our first cubes were released to users there was great acceptance and signals of a promising future to the project (Prado et al., 2007). However, during the following months, we perceived a gradual lack of interest from users in the system. Despite many available warnings concerning BI project pitfalls (Imhoff, 2005), we faced a situation in which we needed to investigate the real causes and try to correct them. The following topics summarize these findings and some considerations of the IT team.

RAW DATA HAS VALUE

A common requirement after the implantation was to allow users to see which people were placed in each cell of the fact table. This requirement shows us that data in a human resource system has a singular feature when compared with other systems, as raw data are about persons who, by themselves, are significant to a manager’s analysis.

This behavior lets us consider the use of an Operational Data Store in addition to the Data Warehouse as a data source for Decision Support Systems of Human Resource. The data store has a fine-grained amount of data, where the information about people is preserved, while in the data warehouse we could focus on quanti-
fied data to manage analysis. It is important to notice that we must try to build an OLAP that establishes communication between the two bases, starting from the DW but going to the ODS whenever it is needed.

THE USERS' INTERACTION DESERVES MORE ATTENTION

The most common user interfaces for exploring multidimensional data use the table-based approaches (Siefer, 2006) in which the user displaces dimensions and facts on a bi-dimensional structure and effectively applies filters. The user constructs nested or compound tables and may have navigational control through subsets of the data available in the cubes. The table paradigm fits well with the users' capabilities, since they are familiarized with spreadsheets and other Office-like software.

Nonetheless, the data selection and filtering prior to the table viewing revealed to be a problem. Sometimes the users did not apply the correct dimensions combination, leading to inappropriate results, lack of reliability on the tool, so they have abandoned its use. The purchased OLAP tool did not provide some necessary data constraints, leaving the user excessively free to handle the data.

Another drawback was the absence of a reach-through capability of the tool, enabling the user to scrutinize the raw data (maybe in an ODS, as proposed in 4.1). Issuing a query to retrieve the underlying data became an IT task, via SQL, and the final users evaded the direct interaction with the OLAP software. Front-line employees cannot wait for IT queries, and as a result, they take action based on experience and intuition rather than in facts (Ahlberg, 2007).

FREQUENTLY CHANGED REQUIREMENTS

After the data warehouse implantation, the arousal of new requirements from some clients that had not been interviewed in the previous phase was common. A quick solution could be a data warehouse refactoring, resulting in some ETL process tuning. But, just after the new solution was found, the clients asked for more dimensions or facts that had not been provided by the data warehouse. The BI reporting has grown and changed in dramatic ways (Ahlberg, 2007), and scalability must become a concern.

Faced with this reality we believed that, inspired by the evolution of the software development process, which assumed a requirement change as natural and not as the big evil that we need to avoid, the development of a BI system should also assume that as something unavoidable. Therefore, despite the fact that the project methodology is in BI systems, evolution must be the premise, or rather, we need to understand that the clients' and the business needs will not be stable, and could be based on agile methodologies that were already concerned to it. Agile development strives to deliver small units of functionality that make good business sense (Chu, 2005).

DATA GRANULARITY VARIES AS IT AGES

In face of the requirement changes addressed by the users we observed that the variability of a requirement is totally dependent on data lifetime. A data warehouse project needs to consider that updated data will need low granularity while outdated data will not.

Considering that, we suggest that the premise in a BI project identify not only which data are relevant, but also which data are relevant in a timeline. For example, we observed that for the last absence/cost data, the managers need to know which people are qualified to act directly with each person. On the other hand, in an older data analysis (older than 12 months) we observe the needs for statistic data that show evolutive institutional snapshots, resulting in macro decisions despite punctual decisions.

Managing data and business context together in real time and ensuring data structures are aligned to handle different levels of granularity, and the completeness of data is a key
feature that we must make an effort to achieve (Rogalski, 2007).

**Project Evolution and the Chase for Maturity**

Despite of team’s great expectation in the beginning of the project, as time went by the final product has become little helpful in making decisions related to human resources after two years of existence.

The employees’ data mart has supported the statistical yearbook report, nowadays, the main usefulness of the OLAP tool. Dynamic reports were built by the team in 2006 and they have been used since then. Unfortunately this task has been executed for the IT area. The IT area has used OLAP tool to extract data, after their conversion into spreadsheets, formatting spreadsheets and finally sending data to the final user. The final user hasn’t extracted data because the OLAP tool is considered very difficult to use and the IT area hasn’t had top management’s support to pass this task on to final users.

The absenteeism data mart was abandoned, nobody extracted data directly through the OLAP tool. The final users always need other dimensions and always need the names of employees. The IT team has extracted data from data store with SQL consults. Another problem is that a lot of missing data are edited after the ETL’s day. In the future it is very important that the IT team review the ETL.

The data store has supported many other reports that are important to a Human Resource Area. These reports have been extracted from data store with SQL consults. The team’s expectation was to implement improvements and develop more data marts, but urgent demands have taken all the time of the team.

We believe that the main factor to minimize problems is to form a team that is focused on Business Intelligence. This team will have primary responsibility for developing the environment of business intelligence based on the urgent demands and difficulties of users. This team would provide rapid solutions to promote quality assurance of data and the increased use of OLAP tools for users.

**CONCLUSION**

As highlighted by Zeleny (2007), there is a growing need for information and knowledge in the Human Resource area. Business Intelligence has been providing this information for other areas in the organization. It is time for the HR to encompass this technology in its favor.

In this paper we provided two sample models for OLAP cubes containing Human Resource specific data and showed their use through software. We also discussed the progress of the project and how some specific difficulties from HR have aroused.

Daily practice shows us that modeling HR systems for BI should not follow only the literature examples and practices, but must instead define its own methods and models, in order to address the specific issues of the Human Resource area.

We believe that the future of this project relies on making an effort to address the points covered in previous sections. We hope it can alert other projects regarding the use of BI in HRM, aiming to avoid these misfortunes and have better results.

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