INFORMATION ARCHITECTURE ANALYSIS USING BUSINESS INTELLIGENCE TOOLS BASED ON THE INFORMATION NEEDS OF EXECUTIVES

Fabrício Sobrosa Affeldt
Sady Darcy da Silva Junior
Federal Institute of Education, Science and Technology of Rio Grande do Sul
Porto Alegre, Brazil

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ABSTRACT

Devising an information architecture system that enables an organization to centralize information regarding its operational, managerial and strategic performance is one of the challenges currently facing information technology. The present study aimed to analyze an information architecture system developed using Business Intelligence (BI) technology. The analysis was performed based on a questionnaire enquiring as to whether the information needs of executives were met during the process. A theoretical framework was applied consisting of information architecture and BI technology, using a case study methodology. Results indicated that the transaction processing systems studied did not meet the information needs of company executives. Information architecture using data warehousing, online analytical processing (OLAP) tools and data mining may provide a more agile means of meeting these needs. However, some items must be included and others modified, in addition to improving the culture of information use by company executives.

Keywords: business intelligence, information needs, information architecture, OLAP, data warehouse.

1   INTRODUCTION

Information technology should help organizations to understand their position in relation to their competitors, learn about their customers, monitor relationships with suppliers and control strategic objectives (Venkatraman; Henderson, 2004). Business Intelligence (BI) technology aims to improve the quality of information delivered to managers; it is being increasingly used in the business environment and has been the subject of scientific research.

BI, or business intelligence, encompasses broad concepts: a) an intelligence tool based on information and monitoring the environment using data from various sources (Petrini; Pozzebon; Freitas, 2004); b) a technological tool to support managerial business decisions in organizations by means of software. With respect to technology, systems centralize information from multiple data sources, in large quantities, stored in data warehouse systems (Inmon, 1997) or data marts (Kimball, 1998), with flexibility in accessing, structuring and navigating through information (Barbieri, 2001; THOMSEN, 2002).

Information architecture is an important factor in making businesses more agile and based on factual analysis, rapidly and consistently providing company executives with the necessary information so that decisions can be made based on these analyses (Tupper, 2011; Thomsen, 2002; Inmon; Terderman; Imhoff, 2001).

In a survey of large Brazilian companies, Petrini, Pozzebon and Freitas (2004), found that 73% had been using BI for just over 3years. The authors concluded that its implementation, at that time, was based more on technological objectives than information needs. This led to problems in the initial use of BU technology, whether in establishing information needs, defining its relevance for the business or identifying the necessary indicators. In a more recent study, Popovic and Jaklic (2010) reported that investment in Business Intelligence in Latin America is on the rise. Brazil alone spent US$ 251 million on the sector in 2009, with a trend toward growth in the coming years. This type of technology has long been restricted to large companies. However, research points to an increase in its use among small and medium-sized companies. A study by the Gartner Group (Gartner, 2011) observed that many companies use BI, but some still fail in extracting the benefits of this technology and have a long way to go in building an architecture that will enable them to get the best results from this type of solution. A similar conclusion was reached by Popovic and Jaklic (2010) when analyzing the impacts of BI implementation on information quality. The authors report that a gap still exists between the needs of executives and the information provided by the system.

The importance of dynamic and agile analysis of the data registered and organized via traditional transaction processing systems justifies the study of BI application and the possibility of better information use, employing a method to define and prioritize the necessary company information for executive decision-making. This gives rise to the research question for the present study: how can information architecture meet the information needs of executives using Business Intelligence (BI) tools?

The aim of this study was to assess how information needs can be met by BI, and which of these are not registered in the current systems used by the company analyzed. A case study research strategy was applied, based on multiple data sources.

The information architecture used by the company was analyzed within a framework of Business Intelligence. Architecture and technology were evaluated based on the information needs of executives, identified through semi-structured interviews, secondary data and the suggestions of company IT analysts.

The paper is structured as follows: Sections 2, 3 and 4 address, respectively, theoretical aspects concerning information and executive decisions, information needs, and Business Intelligence. Section 5 discusses the methodological aspects of the study, while section 6 describes the case study performed. Section 7 deals with information architecture and an analysis of information needs, and section 8 contains the final considerations, limitations and challenges for future studies. This is followed by a list of references used in the study.

2   THE IMPORTANCE OF INFORMATION IN EXECUTIVE DECISIONS

The strategic management of organizations is a broad concept which, according to Wright, Kroll and Parnell (1997), refers to senior management methods for achieving results in accordance with the missions and objectives of the organization as a whole. These methods are often linked to formal plans for defining elements that serve as a guide in organizational strategy. Mintzberg, Ahlstrand and Lampel (2000) reported that most management methods are based on evaluating strengths, weaknesses, threats and opportunities, establishing goals and devising action plans.

Information is essential to planning and decision-making; however, its complexity and the speed with which it must be processed and analyzed, combined with the accelerating pace of change in the economic processes of globalization and business, has made this process increasingly critical (Porter, 1990). Cohesive information is one of the elements executives use when making decisions, requiring a basis which enables data analysis in order to generate information. Knowledge is considered an important economic resource and is created based on the ability to interpret facts, create ideas, innovate products, perceive complex relationships and solve problems (Davenport, 1998; Choo, 2004).

As well as being responsible for decision-making, an executive's role includes disseminating, monitoring and being a spokesperson for organizational information (Mintzberg, 1972). It is on the basis of information that relationships are built and data are transformed into relevant information, allowing effective solutions to be created for the organization and society as a whole.

3   THE INFORMATION NEEDS OF EXECUTIVES

The information needs of business executives have particular characteristics. Excess information in systems can also be considered a problem. Rockart (1979) found that information systems presented problems when executives were required to search through a number of reports, which contained varying degrees of detail, making it difficult to select the important information. Thus, it was argued that each business area should define its particular information needs so that systems could be developed and used in accordance with these definitions, based on Critical Success Factors (CSF). Davenport (1998) reported the existence of several difficulties, including identifying

information needs, the large amounts of data stored within the systems and the need for human intervention in order to make information available.

Executives process information from a variety of internal and external sources, making decisions, formulating strategies, and distributing information both within and outside the company. This is achieved based on their own ideas as well as through internal operations, events, analyses, trends and even pressures. The key to a support system for company executives is relevant information that is delivered quickly and cohesively, enabling decisions to be made (Mintzberg, 1972) that are not only based on facts and structured information, but are also affected by factors such as affection, preferences and experiences (Simon, 1965).

Choo (2004) proposes that information not be considered as an object (resource), but rather the result of people, constituting <u>meaning</u> through messages and insinuations, since it resides not in artifacts (systems, spreadsheets, documents), but in the minds of people. Hence, there are three basic steps to obtain and use information: *a) information needs:* represent cognitive gaps that prevent people from progressing and cause uncertainty. In this respect, determining these needs should not only consider the question 'what do we need to know?', but also 'why do we need to know?', 'what is the issue in question?', 'what do we already know?', 'what can we expect to find' and 'how will this help?'; *b) search for information:* after identifying the need, based on determining the possible sources, select which sources to use, locating or contacting and interacting with the sources. Choosing and searching for information is influenced by the amount of time, effort, cost required for interaction, complexity and environment; *c) using information:* how an individual uses the information selected: contextual development, understanding a particular situation, knowing how and what to do, gathering facts, confirming another piece of information, forecasting future events, motivating or sustaining personal involvement, developing and improving relationships and personal accomplishment. People can choose to suppress these needs, avoiding problems and declining to search for information. On the other hand, they can also opt to seek information, understand it and use it, carrying out their roles.

In addition to issues related to obtaining and using information, Thomsen (2002) presents an example for the scope of decision, relating it to the systems and hierarchical levels of organizations. At operational levels, the number of decisions is more frequent and the decision scope involves less information, and is serviced by transaction processing systems (operational). At the tactical level, the scope and number of inputs increases while the number of outputs declines. At the strategic level, a decision encompasses a greater number of input information. The number of decisions is lower, but more complex and with a greater impact on the organization. It is on the tactical and strategic levels that OLAP tools, BI and Decision Support Systems (DSS) operate. Figure 1 depicts the example used by Thomsen (2002).
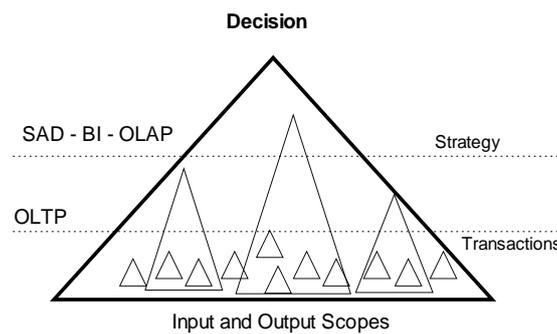
Figure 1: Scope of Decisions.

Source: Thomsen (2002).

Information need is a fundamental issue in the development of a system, but other elements surrounding it must also be analyzed, such as searching and use. The development of a system should always take into account the supply of useful information to solve problems, considering its quality and quantity. The process of decision-making and information sharing for the entire organization is performed based on technological tools, the most suitable of which is called Business Intelligence (Barbieri, 2001; Thomsen, 2002; Petrini, Pozzebon; Freitas, 2004).

4   BUSINESS INTELLIGENCE (BI), TECHNOLOGY AND INFORMATION ARCHITECTURE

Business Intelligence (BI) can be conceptualized as a set of information systems that support decision making, based on other data storage, analysis and data mining technologies (Thomsen, 2002). However, there are theoretical gaps in some aspects of the concept that best defines Business Intelligence as a technological tool. Suppliers of IT solutions hold a variety of views in relation to the operational scope of these systems and their emergence. BI is geared towards obtaining information using data stored in transactional databases (Degent, 1986; Barbieri, 2001; Quandt; Fernandes, 2003). In this respect, the aim of a BI system as a technology is to create a structure that transforms data registered within the organization into information useful in decisionmaking, thereby creating value for the company (Thomsen, 2002).

Information is structured via fact and dimension tables into a data storage component. Dimension tables hold descriptive data reflecting an aspect of the business, that is, they help to define a component via information. Examples of dimension tables are: products, time and brand. These tables are described by attributes, that is, characteristics that define them. For example, the dimension *product* can be identified by the attributes color, weight, size and unit price (Kimball, 1998), while the concept of fact is related to the storage of numerical measurements for the business, that is, a factual measurement associated with a dimension. For example, the dimension *product* may be associated to a fact, *sales,* which is also related to the dimension *time.* In this hypothetical relationship, an analysis could be conducted to obtain the monthly sales for a product.

Business Intelligence consists of three basic components: a) **data storage,** in data warehouses (DW) and data marts (DM) (Inmon, 1997; Kimball, 1998; Serra, 2002); b) **analysis tools**, called *On Line Analytical Processing* (OLAP), that allow navigation among information (Tomsen, 2002); c) **data mining** (*data mining*), which enables the extraction and discovery of patterns of information in data and specific cases (Harrison, 1998; Taurion, 1997).

The implementation of BI technology provides better results, however, when aligned with two elements. First, it should be based on the information needs of executives, enabling them to centralize information regarding the critical success factors (Rockart, 1979) of an organization. According to Petrini, Pozzebon and Freitas (2004), another important issue is that implementation should be based on supporting executive decisions, that is, on information relevant to the business and indicators created in accordance with strategic objectives. Barbieri (2002) suggests that BI also incorporate balanced scorecard indicators (Kaplan; Norton, 1997), vital for extracting strategic information from transaction processing systems.

In order to achieve the desired results, it is essential that technological tools be used to construct information architecture that supports decisions. As per Tupper (2011), information architecture supports executive tasks and it supplies specific numbers, reports, access to data and forms, allowing learning to occur regarding the products and services of a company, thereby improving business performance based on facts and dimensions. Figure 2 depicts a *framework* with the Technologies and components of an information architecture system.
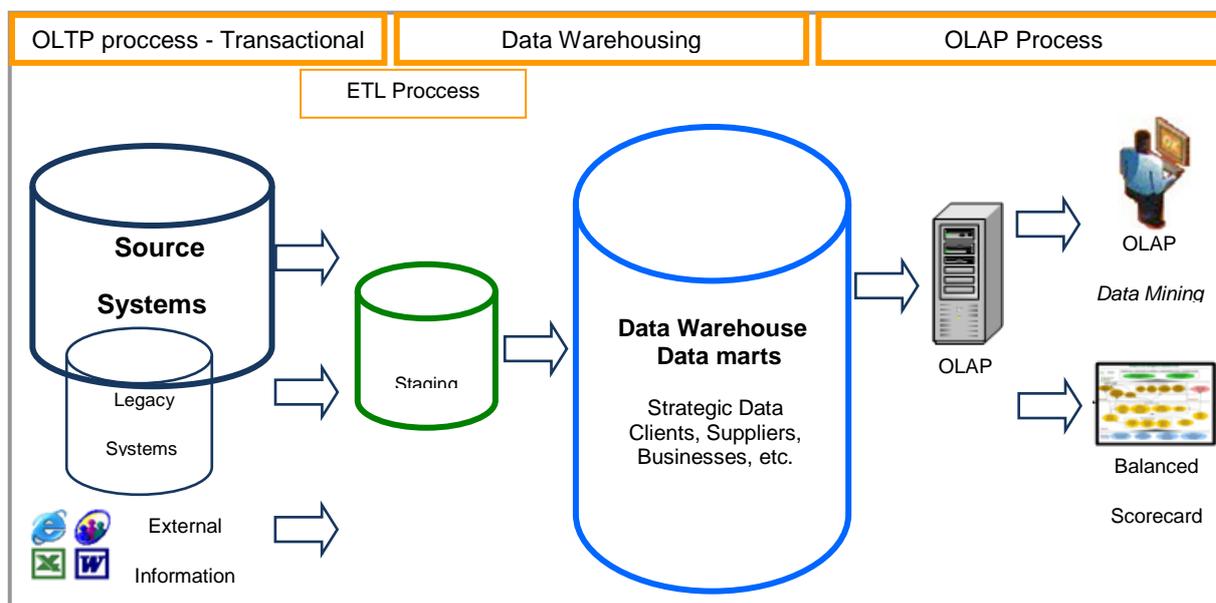
Figure 2: Framework of Information Architecture.

Source: Author, based on theoretical reference.

According to Barbieri (2001), strategic business plans (SBP), the IT plan (ITP) and balanced scorecard (BSC) must be aligned. Business Intelligence (BI) technology should provide the data required for the plans and indicators of the BSC as the core technology, since it defines the structures of information needs that can be stored in the

system. The SBP has been considered an administrative technique that creates awareness of certain elements among the entire organization: strengths, weaknesses, goals, targets, threats and opportunities, among others (Rezende, 2002). The ITP, on the other hand, refers to the need for strategic, tactical and operational structuring of "IT and its resources: hardware, software, telecommunications systems, data and information management" (Rezende, 2002, p. 20).

Construction of an information architecture system should follow a gradual process of analysis and development, based on what Inmon (1997) calls the "data warehousing process". This allows the use of a database stage for extracting, transforming and loading data (ETL process). Data warehousing can be performed using source systems, either the organization's own integrated system or external systems, such as: electronic spreadsheets, workflow systems and information obtained online.

5   RESEARCH METHODOLOGY

Research was conducted using a case study, the method recommended in order to understand phenomena and their contexts in the stages of development. This strategy is generally applied in studies investigating a contemporary phenomenon within its actual social context and in what ways boundaries between the phenomenon and social context are not clearly defined (Yin, 2001). In addition, a set of systematic and rational activities was used to achieve objectives, evaluating and correcting errors. Data were collected from multiple sources, primarily via in-person semi-structured interviews (the questionnaire applied is presented in Annex I), analysis of information needs, a variety of documents and comparison with information systems.

The case study was based on the relationship between the following factors: the research question, extent of control of researchers and time of the phenomena studied. The study was developed based on the relationship between Business Intelligence (BI) technology and the information architecture capable of satisfying information needs for decision making by executives. Research was conducted in three stages. The first phase, **Research preparation**, was conceptual in nature. This involved defining the theoretical foundation to be used, the theme (information architecture and Business Intelligence) and objective of the study. The definition of the subject was related to the choice of theoretical approaches for the investigation: determining a basic area for the bibliographic review, defining the research problem and justifying the study.

The second stage was that of **Research Planning** and included conceptual and practical elements, aimed at establishing conceptual relationships in relation to theoretical aspects and methodology. A schedule was drawn up by analyzing IT literature, information needs, information architecture and BI and its technological components. A research protocol was compiled, in which variables were grouped into: organizational context, planning of IT resources, human resources and information needs.

The third phase was denominated **Research execution** and consisted of reviewing and defining data collection instruments in accordance with the schedule, determining contacts for semi-structured interviews, as well as the interviews themselves and their transcription. An additional task was that of gathering and analyzing secondary data, which were significant in this study as the sources of

information required for information architecture. With respect to data analysis, each interview lasted approximately seventy minutes (average duration). Transcribing each interview took on average three and a half hours. Execution was divided into steps, aimed at collecting primary and secondary data to construct the proposed result.

a. **Interviews with Business Managers:** focusing on obtaining important information regarding how executives perceived the company under study in relation to information technology, information systems and human resources (people). A total of seven business executives were interviewed, from different areas of the organization. Interviews were numbered and classified, with only some excerpts from the transcriptions presented in this study. During this process, the information needs of executives were also identified, serving as a basis in analyzing whether these were met by the organization's existing information architecture system.

b. **Interviews with IT Analysts:** these interviews were conducted in order to compare the perception of company IT analysts regarding information technology, information systems and information needs against those of the executives. A total of six IT analysts were surveyed, who catered to the organization's business departments. Interviews were numbered and classified, with only some excerpts from the transcriptions presented in this study. The IT analysts provided support in analyses of existing secondary data, assisting in the understanding of the data models and systems in operation;

c. **Study of the Company Business:** important in order to associate business processes with analytical solutions and information needs. In the specific case studied, this step proved to be significant in the analysis of the company context, containing different businesses. Understanding of the business was achieved by studying secondary data, cross-referenced against interviews and with the support of IT analysts (interviewees);

d. **Study of Information Architecture Capabilities in Meeting Information Needs**: achieved by analyzing the architecture and information from source systems. Source systems are the sources of registered data that were used to construct the organization's information architecture system. Among the data analyzed, the following are found: configuration information, databases, documentation on strategic plans and system reports, obtained from company management.

The arrangement of secondary data was complex due to the variety of formats, media and sources studied. Those capable of being stored in digital format were separated and duly identified. Documents such as spreadsheets or plans (SBP, ITP and BSCC), in digital format, were placed into a directory accessible only by researchers, submitted to analysis and received comments relevant to the study. Analyses were performed based on the text and diagrams of these materials. It is important to note that when researchers encountered difficulties understanding these materials they were assisted by the interviewees and IT analysts, who had extensive knowledge on the subject.

6   CASE STUDY

This section discusses the organization under study and describes the collection and analysis of primary and secondary data.

6.1   The Organization Under Study

The case study was conducted in an organization that operates a variety of businesses in the service sector. It consists of four companies that represent the Rio Grande do Sul business sector, with activities geared towards promoting and developing the economy of that state and Brazil as a whole. The first company operates within the education and technological services industries, the second in the social arena, the third promotes integration between universities and businesses and the fourth carries out services in the fields of economic research, industrial certification and other services catering to industries. This organization was selected because it has an integrated system with a single database for most operational applications, and its information architecture was in the implementation phase, using BI.

6.2   Primary Data

Primary data were gathered through interviews. This section briefly describes the analysis of these data, in accordance with the sections of the research instrument. The content of interviews was evaluated and high, average and low values were assigned to classify variables. High, average and low levels were recorded in studies by Reich and Benbasat (1996) and Audy and Brodbeck (2203), with levels in the present study attributed by the researchers based on content analysis of the interviews. The analyses presented were grouped, that is, they represent summaries of interviews with business executives and IT analysts. Several contradictions emerge from the analyses, and are remarked on when this occurs.

6.2.1   Organizational Context

The assessment of the organizational context aimed to obtain a general overview in relation to the use of IT and how executives perceived the position of this department within the organization. This section provides a description of variables such as the focus of the organization's IT department and receptiveness to new technologies, in order to determine the perception of the interviewees regarding these variables.

According to the analysis performed and the interviews conducted, the focus of the IT area is that of providing **operational support for business.** Evaluations of the interviews indicated concern regarding the strategic use of information. For example, we identified a need to create a platform of more detailed information, enabling better relationships with clients and the use of existing databases to add value.

The organizational context assessment found that interviewees perceived the capability of meeting **informational needs** at operational level (corporate) as high. Fulfillment of these needs at the final product level (in areas associated with management) was perceived as average, with improvement needed. There is a clear need for the use of tools to improve the strategic fulfillment of information needs, as demonstrated by an excerpt from one of the interviews:

> Information needs are not entirely met, particularly in regard to management and strategic information. Most areas rely on accounting and financial information, which often takes time to

be made available, meaning these areas lack fast access to this data (Entrevista 005, 2004, p.1)

6.2.2 Planning for IT Resources

This section addresses the perception of interviewees concerning planning and investment for resources related to technological aspects, including: hardware, software, telecommunications systems, management of data and operating systems.

The organization adopts a single planning methodology for all the companies that make up the System, with a centralized IT department. Differences were observed with respect to system development. A certain maturity was highlighted in resource planning, since it has been carried out in line with this methodology for several years by most of the companies.

6.2.3 Human Resources

In relation to human resources, we evaluated issues such as professional IT qualifications, training of system users, participation in ITP and SBP and effective knowledge of the business among IT professionals. Regarding the qualification and training of IT professionals, most of the interviewees attributed high levels. This point was also emphasized for planning of the organization's IT area. Knowledge of the business among IT professionals was considered average.

6.2.4 Information Needs

The information needs of executives were studied based on the concept of Critical Success Factors - CSF (Rockart, 1979), analyzing whether these were provided by the organization's current transaction processing systems. Information needs were investigated through interviews with company executives and IT analysts and the analysis of documents, systems in use and database models.

It was found that measurement of indicators via transaction processing systems was only partially achieved and that some were not integrated into the corporate systems. For example, some indicators are entered manually and measured through electronic spreadsheets. One interviewee emphasized the need for systematic control of indicators using IT tools, specifically Business Intelligence (BI):

> We are currently developing a tool to monitor the metrics. At operational level we have tools with these characteristics, but we feel they can be enhanced, improved. We understand that Business Intelligence tools, for example, exhibit components that meet these needs (Entrevista 006, 006, 2004, p. 6-7).

With respect to the **existence of specific systems for obtaining strategic information**, most interviewees cited BI tools. BI has been gradually implemented within the organization, initially in specific areas where its implementation could be assessed and modifications recommended for specific solutions. Decision support systems, data warehousing, data mining and balanced scorecards were cited as tools for indicator analysis.

IT analysts interviewed stressed that searching for and cross-referencing information in the transactional database may result in performance issues for the remaining systems and, as such, the ideal solution would be an exclusive database specifically for this purpose. Chart 1 presents a summary of the main information needs identified, categorized by subject.

Chart 1 Main Information Needs

Subject	Information	Brief Description	Inf.(1)	Source
Cost Control	Revenue generated by marketing agents	Percentage of revenue generated by marketing agents for other Units.	Y	IS (2)
Education	Technical Man-hours	Number of man-hours spent on technical and technological services.	Y	IS Interviews
Education	Placement Rate	Percentage of graduates inserted into the labor market	N	BSC (3)
Strategic	Recurring Revenue	Rate of Committed Recurring Revenue	Y	BSC
Strategic	Projects and actions	Number of projects and actions that ensure quality and innovation in Technological Services.	Y	Interviews
Strategic	Projects and Partnerships	Number of projects and partnerships established and maintained with other organizations.	Y	IS
Strategic	Joint projects	Number of projects involving more than one Unit	Y	BSC IS
Strategic	Brand Recognition	Perception of the general public (media, companies and potential clients) regarding the brand.	N	BSC
Strategic	Operating Results	Growth capacity calculated by the difference between current income less current expenditure.	Y	BSC
Client Profile	Perceived value of the service provided	Estimated perceived benefit by the companies serviced.	N	BSC
Client Profile	Special service for contributors	Indicator design plan including number of visits, priority service and price differences according to size and demand.	N	BSC Interviews
Client Profile	Client satisfaction with Professional education	Rate of client satisfaction with Professional Education	N	BSC
Client Profile	Satisfaction with Technological and Technical Services.	Rate of client satisfaction with technical and technological services.	N	BSC
Services to Society	Number of individuals benefitted	Number of direct beneficiaries of social responsibility initiatives	Y	BSC
Services to Society	Percentage of investments in social initiatives	Expenditure on social initiatives in relation to the revenue budget.	Y	BSC

Source: Authors.

(1) Inf. : Indicates whether the information can be obtained by the organization's current systems;

(2) IS – Integrated System, automates the operational processes of organization units.

(3) BSC – Balanced Scorecard – there is currently no software to measure the indicators.

It is important to underscore that the items presented in Chart 1 represent the main needs among all of those identified. These indicators may consist of other indicators in the form of calculations. A total of 170 key indicators were identified, with a variety of sources and formulas, classified by subject into 9 proposed data marts (DM). Two main causes were cited in relation to difficulties obtaining information and performance indicators: transaction processing systems not containing the information and the profile of information use. In other words, the executives do not yet have a culture of using analytical tools, representing a challenge for the organization.

6.3 Secondary Data

The secondary data in this research were the study of company business and its source systems.

6.3.1 Study of the Company Business:

A **Study of the Company Business** was conducted in order to relate business processes with analytical solutions and information needs, and involved an analysis of systems and system models, cross-referenced against interviews and supported by IT analysts.

The operational structure of the company provides services in the following areas: social, education, technology, international relations and foreign trade, agribusiness, business expansion and incentive, infrastructure, competitiveness, economic research and studies, legal consultancy, the environment and sustainable development, support for micro and small industries and labor relations.

One of the companies in the organization uses the BSC tool (Kaplan; NORTON, 1997) as part of its strategic planning. The methodology has been in place for approximately two and a half years and enables planning to be measured using objectives, indicators and targets. It also allows communication planning for the entire company via a strategy map. The method is currently under development in another company within the group. However, the existing information architecture does not yet provide access to these metrics in BI tools. They are measured separately, as confirmed in interviews with both company executives and IT analysts.

6.3.2 Study of the Source Systems

The companies are interconnected by an Integrated Management System, referred to as the IMS in this study. It consists of several modules that provide most of the transaction controls needed for process management. The IMS modules were developed internally by organization employees, in accordance with the specific needs of each area. They are maintained according to demand in the business areas and carry out specific functions, including: accounts payable, accounts receivable, tax control, inventory control, accounting and cost control. All the systems are integrated into a single database.

The role of the main system modules is summarized in Chart 2, together with the type of support the system provides to the organization, indicated by: 'O', for operational support, 'M', for management support and 'S' for strategic support. Strategic support systems are capable of providing information that can be cross-referenced and analyzed to improve business performance (O'brien, 2001).

Chart 2: Main IMS Modules.

Module	Brief Description	Support
Health Agenda	Allows appointment scheduling for healthcare professionals, controls medical charts, refers services to suppliers and maintains records of leave.	O
Scheduling	Manages spaces administered by the Gated Community System, Exhibition Center and Theater. Performs scheduling, rental and quoting for spaces and services in the Mobile Units and areas of the Sporting Centers	O, M
Revenue	Controls operations responsible for monitoring payments from institutional funds, identifying late payments, and forecasting amounts receivable. Controls installments related to transactions following audit visits. Controls direct and indirect revenue.	O, M, S
Corporate Records	Services all the companies, recording information pertaining to industries within Rio Grande do Sul, products, raw material and performance markets. Also contains data on individuals and legal entities such as suppliers, clients, associations, unions and federations.	O, M
Accounts Payable	Enables the preparation, control and execution of payments to suppliers, comprising the following modules: maintaining a record of suppliers and bank details, maintenance of payment documents, forecasted payments, payment control reports, reports of payments made to suppliers, as well as accounting.	O, M, S
Accounts Receivable	Operates the records of agreements between the organization and client companies, for payments with installments by employees in the units. Manages billing documents, as well as overdue, maturing and defaulted payments	O, M, S
Inventory Control	Maintains records of the physical and financial inventories of products in the business units, issues inventory statements and calculates the average cost of merchandise, as well as recording accounting operations.	O, M
Asset Control	Registration and control of the inclusion and handling of all assets and property, managing processes related to definite equity write-off, enabling the registration of changes or additions to assets.	O
Tax Control	Performs bookkeeping and tax control operations, consisting of: Input and Output records, Inventory Records, Calculation Records, Voluntary Disclosure, Tax files (GIA, DIRF and GPS). Enables the registration of tax documents, calculation of tax debits and credit and issuing invoices.	O, M
Bidding and Purchasing	Enables a Bidding Process for purchases, controls the receipt of proposals for supply, issues Purchase Orders and monitors and records negotiations with suppliers. Issues operational and management reports.	O, M
Marketing	Maintains clients records; classification of customers by market segment,; preparation and monitoring of initiatives and campaigns.	O, M, S

Action Plan	Allows the planning of expenditure, performance and strategic positioning of units and management. It is currently being adapted to balanced scorecard use.	O, M, S
Accountability	Gathers accounting information in all activity centers. The information is sent to other systems, serving as a basis for accounting and cost control.	O, M
ISS – Integrated School System	System composed of six modules aimed at addressing the specificities of administration in Operating Units within the education sector.	O, M, S
Training System	Maintains a record of scheduled and completed training. Tabulates quantitative information (times and amounts) for the forecasted budget against actual results.	O, M, S

Source: Authors.

Remarks: Compiled based on Strategic IT Planning (ITP) and analyses of interviews, secondary documents and system manuals.

7   Analysis of Organizational Information Architecture

Based on the research phases previously described, the organization has taken steps to define its information architecture using technological components of Business Intelligence. The following section contains a description of the architecture and the analysis regarding the fulfillment of information needs.

The organization designed nine data marts (DM) which, once fully "loaded" with the relevant information, will form the corporate data warehouse (DW) (KIMBALL, 1998). Implementation is underway using dimensional models, storing tables based on facts and dimensions. The following **data marts** were designed:

1) Strategic information: provides information on the strategic performance of different units within the organization, such as: monthly performance reports (strategic indicators); margin indicators for organizational managers and detailed information regarding organizational units;

2) Sales Analysis: provides information such as the average *ticket* for business units; information regarding the division of sales (counter; card; check; company agreements); time comparisons (previous month, last month of the year); progress (through graphs); participation by branches and employees (clerks and managers); participation by suppliers and products in sales;

3) Client Profile: provides information regarding loyalty programs and promotional campaigns, customer segmentation (by category, age range, gender, socioeconomic profile and occupation, among other criteria); will allow market basket analysis (product mix vs. ticket level);

4) Human Resources: supplies information that facilitates the sizing of teams (total number for the company and by area), redistribution of personnel by shift and performance analysis in business areas;

5) Purchasing Analysis: provides information on the ranking of suppliers and products, and division by categories (of suppliers), margin of products, logistics by supplier and participation by laboratories and products;

6) Cost Management: supplies information on the administration of operating expenses (fixed and variable) for companies and business units.

7) Educational Services: reports on the loyalty programs for students; participation of contributing companies; promotional campaigns for courses; customer segmentation and correlation (correlation of courses for students/clients);

8) Technical Services: technical, laboratory and workshop services provided to clients;

9) Social Services: services provided to society (education, health, leisure, dentistry and disease prevention services).

The basic structure of the main database tables developed to hold the data marts is presented in Chart 3, with the relevant classification.

Chart 3: Description of the multidimensional tables designed.

Table	Main Functions	Fact / Dimension
Student	Enables the registration and control of student records. Controls loyalty programs, classification, study levels and occupation.	Dimension
Campaign	Maintains a history of marketing campaigns, recording the effectiveness and return on each campaign. Maintains a history of social initiatives.	Dimension
Client	Enables the registration and control of customer records. Controls loyalty programs, classification, study levels and occupation.	Dimension
Corporate	Controls the history of organizational structure. Enables sub-classification by holding, region, zone and neighborhood.	Dimension
Expenditure	Maintains a history of all types of company expenditure.	Dimension
Distribution	Allows the control and distribution of meal vouchers through the Distribution and Assembly Center. Allows the control and distribution of products by warehouses.	Dimension
Inventory	Maintains a history of inventory control for products in the business units.	Dimension
manufacturer	Maintains records of product manufacturers.	Dimension
Branches	Enables the monitoring of branches of company units (business units, drugstores, operating and educational units, Finance units). Allows differentiation by type, capacity, status and location.	Dimension
Supplier	Maintains a history of product suppliers.	Dimension
Personnel	Maintains a history of employee profiles for the organization (all levels).	Dimension

Geography	Maintains a record of the locations of all company units. Enables localization by country, state, city, neighborhood and zip code.	Dimension
Partners	Maintains a history of partner organizations and institutions, including universities, the government, companies and non-governmental organizations.	Dimension
Product	Maintains a history of products, product departments, product groups and subgroups, recording all product-related information. Records product classes and the classification history of products.	Dimension
Time	Maintains a history of data scaled by time, such as year, semester, quarter, month, week, day. Allows time-based comparison.	Dimension
Type of Receipt	Allows differentiation between types of payment receipts for sales and purchases. Associates forms of payment (cash, card, company agreements and others).	Dimension
Shifts	Monitors shifts to keep a record of sales history. Enables analyses regarding sales "peaks" on a given day.	Dimension
Campaigns	Maintains a record of marketing campaigns and students enrolling.	Fact
Citizenship	Maintains a record of citizenship initiatives carried out by the company and organizations responsible for services to society.	Fact
Accounting	Maintains a history of accounting records.	Fact
Billing	Records the billing history for all companies within the organization.	Fact
Enrollments	Maintains a history of student enrollments for the organizations providing services in the education area.	Fact
Payments	Records payments made and received.	Fact

Source: Authors.

The information architecture is gradual and consists of three basic BI technology components: *storage, analysis and mining*. With respect to storage components, the model includes dimension tables based on the concepts of facts and dimensions, using data marts and gradual data warehousing (Kimball, 1998).

Information architecture allows for the use tools to enable navigation among information via OLAP applications (Thomsen, 2002). These act on data stored in the data marts, enabling tasks such as information analysis and cross-referencing, detailing and summarizing, issuing reports on the information analyzed, recording reports on the OLAP application server, generating graphs and exporting information to electronic spreadsheets and files. Analyses can be performed at management and operational level (sales and customer profiles, for example), as well as the strategic level, by measuring the indicators defined in the balanced scorecard and included in the model.

In regard to mining tools, the information architecture system will include data mining applications enabling searches for relationships between the information stored on databases (DMs and DWs) and patterns discovered in information that supports business decision making. This component is not yet in use and, as such, a more extensive analysis is not possible.

Based on an assessment of the information architecture, and cross-referencing against interviewee responses, it is evident that the system satisfies the proposed theoretical requirements presented in the theoretical framework of this study, with most components of the framework found in the literature present in the system.

On the other hand, the information needs identified were only partially met. Although the organization has already partially implemented information architecture, the strategic use of information was considered low, a fact evident in the responses of interviewees. This indicates a need for greater development of the architecture in order to align the information obtained in the process with strategic organizational objectives. The outcome of this study is similar to that reported by Popovic and Jaklic (2010) in that a gap exists between the needs of executives and the information they receive, particularly from a strategic standpoint. It was observed that most of the information needed is present in the organization's transaction processing system, but it is not yet used analytically via OLAP tools. Moreover, the interviewees reported that not all the required information is delivered quickly and cohesively and not all the executives have a culture of using this information effectively to generate new opportunities.

The information architecture was found to be well-structured, but progress is needed with respect to meeting the existing information requirements. Furthermore, we believe that in addition to improvements in technological development and the information provided by the architecture, the cultural issue in relation to strategic use of this information should be addressed within the organization.

8   FINAL CONSIDERATIONS

BI technology supports the structuring of information, delivering it rapidly and cohesively so that personnel may use it to improve business performance. In the present study, tools were analyzed in relation to the fulfillment of executive's information needs, from a theoretical and practical perspective. The information architecture of an organization provides a means of constant connection with its clients, suppliers and partners, and should be geared towards strategic management.

The strategic management process can be supported by BI technology through architecture of information that should integrate and centralize different data sources, whether internal or external. The construction of information architecture performed in this study led to the conclusion that BI tools can be important in providing business executives with the necessary information.

In the case studied, transaction process systems did not meet all the executive's information needs, though information architecture applying BI demonstrates technological and business characteristics that satisfy a significant portion of these needs. There is also an issue regarding the lack of knowledge among the executives interviewed concerning the potential of the technology for creating analytical applications. This factor was shown to be relevant and warrants further investigation.

We believe that the objective of the study was accomplished through analysis of the information architecture and comparison against the information needs of executives, identifying a number of gaps for the organization. A long-term assessment is needed to determine whether effective <u>use</u> of BI technologies in the organization will indeed result in strategic improvements in performance or the creation of new business.

Limitations were present with regard to the qualitative nature of the study, since conclusions cannot be generalized. The case study conducted provided greater depth; however, the practical conclusions cannot be generalized for other organizations, serving only as context for research. An additional limitation was that the study came to a close prior to complete implementation of the information architecture system. Thus, it was not possible to evaluate all the outcomes, although some areas had already shown good results.

It is suggested that future studies conduct research and analysis focusing on the effective results of implementing BI technology, determining whether this brings real benefits to company performance and allows the creation of new business or changes in existing business. Another challenge would be to analyze companies that have already adopted BI, ascertaining whether the method of constructing the architecture was based on the information needs of executives.

REFERENCES

Audy, J. N; Brodbeck, A. F. (2003). **Sistemas de Informação: Planejamento e Alinhamento Estratégico nas Organizações.** Porto Alegre: Bookman.

Barbieri, C. (2001). **BI – Business Intelligence: Modelagem e Tecnologia.** Rio de Janeiro: Axcel Books.

Choo, C. W. (2004). Preenchendo as Lacunas Cognitivas: Como as Pessoas Processam Informações. *in* DAVENPORT, T. H.; MARCHAND, D.; A. DICKSON, T. **Dominando a Gestão da Informação**. Porto Alegre: Bookman.

Davenport, T. H. (1998). **Ecologia da Informação:** Por Que Só a Tecnologia Não Basta para o Sucesso da Informação. São Paulo: Futura, 1998.

Degent, R. J. (1986). A importância Estratégica e o Funcionamento do Serviço de Inteligência Empresarial. **Revista de Administração de Empresas**, v. 26, n. 1, p.77-83.FULD, L. (2011). **The New Competitor Intelligence.** New York: Wiley, 1995, pp. 417-436.

Gartner, Group. Key Issues for Analytics, Business Intelligence and Performance Management, 2011. Disponível em: < http://www.gartner.com/technology/it-glossary/business-intelligence.jsp>. Acesso em: 20/01/2012.

Harrison, T. H. (1998). **Intranet Data Warehouse.** São Paulo: Berkeley, 1998.

IDC. (2011). **IDC Brasil divulga panorama do mercado de BI na América Latina.** Disponível em: <http://www.idclatin.com>. Acesso em: 06/06/2011.

Inmon, W. H. (1997). **Como Construir o Data Warehouse.** Rio de Janeiro: Campus.

Inmon, W. H.; Terderman, R. H.; Imhoff, C. (2001). **Data Warehousing:** Como Transformar Informações em Oportunidades de Negócios**.** São Paulo: Berkeley.

Kaplan, R. S.; Norton, D. P. (1997). **A Estratégia em Ação:** Balanced Scorecard. 9 ed. Rio de Janeiro: Campus.

Kimball, R. (1998). **Data Warehouse Toolkit**: Técnicas para Construção de Data Warehouses Dimensionais. São Paulo: Makron Books.

Mintzberg, H. (1972). **The Myths of MIS**. California Management Review, pp. 92-97.

Mintzberg, H; Ahlstrand, B; Lampel, J. (2000). **Safári de Estratégia.** Porto Alegre: Bookman.

Petrini, M.; Freitas, M. T.; Pozzebon, M. (2006). Inteligência de Negócios ou Inteligência Competitiva? Noivo Neurótico, Noiva Nervosa. In: **Anais do 28º ENANPAD**, Salvador - BA.

Petrini, M.; Pozzebon, M.; Freitas, M. T. (2004). Qual é o Papel da Inteligência de Negócios (BI) nos Países em Desenvolvimento? Um Panorama das Empresas Brasileiras. In: **Anais do 28º ENANPAD**, Curitiba - PN.

Popovic, A.; Jaklic, J. (2010) Benefits of Business Intelligence System Implementation: an Empirical Analysis of the Impact of BI System Maturity on Information Quality. **European, Mediterranean & Middle Eastern Conference on Information Systems** .

Porter, M. E. (1990). **Vantagem Competitiva**. Rio de Janeiro: Campus.

Quandt, C. O.; Fernandes, A. C. C. B. (2003). Aplicação do Conceito de Inteligência Competitiva e seu Impacto no Processo Estratégico em Organizações do Terceiro Setor. In: **Anais do 27º ENANPAD**, Atibaia - SP.

Reich, B. H.; Benbasat, I. (1996). Measuring the Linkage between Business and Information Technology Objectives. **MIS Quarterly**, p. 55-81.

Rezende, D. A. (2002). **Tecnologia da Informação Integrada à Inteligência Empresarial**: alinhamento estratégico e análise prática nas organizações. São Paulo: Atlas.

Rockart, J. F. (1979). Chief Executives Define Their Own Data Needs. **Harvard Business Review.** 57(3), pp. 81-93.

Serra, L. (2002). **A Essência do Business Intelligence.** São Paulo: Berkeley.

Simon, H. (1965). **Comportamento Administrativo**. Rio de Janeiro: USAID.

Taurion, C. (1997). Data Warehouse: Estado da Arte e Estado da Prática. **Developers' Magazine**, Rio de Janeiro, n.6, p.10-11, fevereiro.

Thomsen, E. (2002). **OLAP: Construindo Sistemas de Informações Multidimensionais.** Rio de Janeiro: Campus.

Tupper, C. D. (2011). **Data Architecture:** From Zen to Reality. Burlington-EUA: Elsevier.

Venkatraman, N.; Henderson, J. C. (2004). Plataformas de Negócios para o Século XXI. *in* DAVENPORT, T. H.; MARCHAND, D.; A. DICKSON, T. **Dominando a Gestão da Informação**. Porto Alegre: Bookman.

Wright, P.; Kroll, M. J.; Parnell, J. (1997). **Strategic Management:** Concepts. 4th ed. Prentice-Hall.

Yin, R. K. (2001). **Estudo de Caso – Planejamento e Métodos.** 2 ed. Porto Alegre: Bookman.

Zwicker, R.; Souza, C. A. (2003). **Sistemas ERP no Brasil: (Enterprise Resource Planning) Teoria e Casos**. São Paulo: Atlas. p. 63-87.

ANNEX I
Semi-Structured Questionnaire used for the Interviews

No.	Questions – Organizational Context
OC-1	What is the focus of the IT area in the organization (operational, strategic)?
OC-2	What is your perception in relation to receptiveness regarding new information technologies (is there resistance or not)?
OC-3	In your opinion, is there adequate proximity between management, IT professionals and information users? Why?
OC-4	In general, how do you perceive the alignment between IT and the business strategy of your organization?
OC-5	How do you perceive the complexity of an IT department in meeting the needs of a variety of organizations with different needs?
OC-6	What is your perception of the integration issue, where information systems are used by more than one company?
OC-7	What is your opinion regarding the fulfillment of information needs within the business areas?

No.	Questions – Planning of Information Technology
IT-1	How are the IT Resources of the organization planned in accordance with the needs of the different areas / Business Units?
IT-2	How do IT Resources receive investments within the organization?

No.	Questions - People
PEO-1	Are personnel in the IT department qualified and trained to meet the needs of your area and the company?
PEO-2	Are system users trained/skilled in using the systems, according to your area?
PEO-3	Do system users and executives from the different areas participate in the planning and design of the systems?
PEO-4	Do executives from the different areas participate in planning for the IT department?
PEO-5	Do IT personnel have knowledge of the business for the area in which they operate? How are they trained?

No.	Questions - Information Needs
IN-1	What are the main indicators or strategic information needs of your business?
IN-2	Do the current Information Systems allow access to and control of these indicators?
IN-3	Are there specific systems that can be used to obtain this information?
IN-4	What are the main problems with obtaining this information using the current systems?
IN-5	Where (documents, reports, systems) would it be most appropriate to search for these metrics?
IN-6	How frequently (monthly, weekly, fortnightly) are these indicators monitored?
IN-7	How frequently (monthly, weekly, fortnightly) are these indicators revised and reformulated?

REMARKS:
a) The questions are not restrictive and the script (open-ended) allows for questions that are not included.
b) The script was used to guide the interviews, taking into account the approach and fluency of interviewees;
c) The interviews were recorded, with the authorization of interviewees, and transcribed for subsequent data analysis;
d) Data required to conduct the study that were not collected in the interviews were requested from interviewees on a separate occasion.