

## Business Intelligence Systems

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*The aim of this article is to show the importance of business intelligence and its growing influence. It also shows when the concept of business intelligence was used for the first time and how it evolved over time. The paper discusses the utility of a business intelligence system in any organization and its contribution to daily activities. Furthermore, we highlight the role and the objectives of business intelligence systems inside an organization and the needs to grow the incomes and reduce the costs, to manage the complexity of the business environment and to cut IT costs so that the organization survives in the current competitive climate. The article contains information about architectural principles of a business intelligence system and how such a system can be achieved.*

**Keywords:** *Business Intelligence, Data warehouse, OLAP*

### 1 The Business Intelligence Concept and its Appearance

The concept of business intelligence became more and more used during the last years, and now, this association of terms is used across different fields from data technology to business modeling.

Business intelligence represents a wide area of applications and technologies for collecting, storing, analyzing and providing access to information for improving businesses process modeling quality. [1]

The business intelligence statement, „getting the right information to the right people at the right time” [2] focuses on the fact that business intelligence uses information and not data due to the included capabilities for processing raw data into intelligent information, that is valid and accepted by the entire company and which can be consistently used in process modeling.

The business intelligence term was introduced by Gartner Group in middle of the 90s. The concept, on the other hand, existed long before being used in mainframe reporting systems.

The Gartner Group defines business intelligence as “an umbrella term that includes the applications, infrastructure and tools, and best practices that enable access to and analysis of information to improve and optimize decisions and performance”. [2]

It was due to reporting and analyzing requirements that the need for such systems keeps the same growth rate as technology does.

We can all agree that in the current economic environment, information and its accuracy represent a successful key to any business. Though it’s about accomplishing a simple sales report or extracting raw data from a database, analyzing data always provided precious information to company managers.

Over time, the interesting data was provided to persons with decisional role within a company as reports, statistics or analyzing documents. But what happens when the volume of data increases so much that classical storage and reporting systems can’t keep up with it?

At the beginning, some decided to archive old data and keep the current data. This solution worked perfectly until it was realized that old data is as good as the new

one and then in started the reversed process. Unfortunately, all these steps wore only complicating the process of analyzing and elaborating reports.

A solution was necessary in that moment. Big companies realized that they can't keep up with their competitors. More and more complex products wore appearing on the market. Exploiting precious resources like a company's historical data needed to be approached with a new technique. It was just a matter of time until the conceptual answer and the technical one appeared, and that answer was business intelligence systems.

The business intelligence term was used for the first time in 1958, when Hans Peter Luhn used it in an article. Business intelligence, as it is known today, it's supposed to be developed form decision support systems which evolution begun in the late 60s, reaching a major point in the middle 80s. Decision support systems had their origin within computer assisted models which wore created with the purpose of helping company management in taking decisions and performance scheduling. From these decision support

systems took birth in the late 80s the concepts of data warehouse, OLAP (on-Line Analytical Processing) and business intelligence. [3]

In 1989, Howard Dresner used the term of business intelligence to group under the same topic all methods and techniques used for taking decisions which wore based on solid facts. Starting with the 90s, the frequency of using the business intelligence term has increased even more. The 1990s represented a formative period for business intelligence applications and products [4]. During this period, organizations realized that they needed arrange of business intelligence capabilities to satisfy a diverse set of user needs. Ultimately, this range could be grouped into five distinct categories or "Styles of Business Intelligence" applications. The 5 styles of Business Intelligence applications include:

- a) Data Mining and Advanced Analysis
- b) Visual and OLAP analysis
- c) Enterprise Reporting
- d) Dashboards and Scorecards
- e) Mobile Apps and Alerts



**Fig. 1.** The Microstrategy architecture that offers all 5 Style of Business Intelligence with a single organically-developed architecture [4]

Nowadays, investments have risen in a field like business intelligence. Software developers haven't delayed in developing special solutions for business intelligence, so big processing machines were made for using such systems and the research in the field grew. Business intelligence is strictly tied to technologies like data mining, OLAP, data connections and data warehouses.

Therefore, business intelligence is based on an aggregate of concepts and technologies which cooperate for helping companies and their decisional activities. As we said before, usually, an organization must own at least one storing and processing data system.

In the current environment, everything is based on information; companies provide informational activities needs and the internet makes the information transfer without having distances barriers.

Everything is information. Companies get to own, as we said before, data that can no longer be stored by the classic database systems. Researches in business intelligence revealed that storing, analyzing and exploiting an organizations data could provide precious information to a company such as predictions, patterns or complex reports.

## **2. The Utility of a Business Intelligence System**

Every organization has a number of informational systems that contributes to its good ongoing daily activities. Though it's about an informatics system for client management, sales, payments, or human resources, all these are managing the daily process transactions, and are being designed for that purpose. Usually, these systems are known as transactional systems (OLTP – On-line transactional processing), and their essential role is to assure a good data consistency.

Most transactional systems have an infrastructure based on a relational data base specially designed for the well function of these systems. The data model on which this systems are based is represented in the entity-relation diagram, which leads to a normalized structure, in which the information regarding a certain entity are stored in a single table, and the link between entities is made with relations. The relational model, with the principles that it implements, proved to be a very good solution for transactional systems, being implemented and used, even currently, by the majority of organizations. This gathers information in a single place, removing the redundancy if possible, so that the data could be easily found and updated, to overcome the big number of daily transactions.

A business, no matter how big it is, doesn't assume only entering the data in a system. The data must be uploaded with a purpose, to keep track of the sales, for example, therefore most transactional systems offer complex utilities to help generating reports. Unfortunately, these reports will be limited strictly to the operational or transactional system which generated them, and the effort of understanding how the whole business works, based on these limited reports, is by far unsuccessful.

The complex questions to which analysts would like to find answers through reports usually needs data from more than one transactional system. Though the data can be extracted from a system, to have a general view of the business, the data should be correlated with data from other systems. What will generating reports based on data from different systems imply? A well knowing of the systems, the technologies in which they are built in, filtrating the unwanted data, etc. Because people with decisional role in a company are usually less technical, generating such reports would be impossible to them.

Business intelligence comes with a solution to all these.

A business intelligence system is a mix of technologies and concepts that are specially designed to help managers take decisions. How does an informatic system really help? As we said before, the data owned by an organization is an important and useful source of information. Based on these data you can generate reports, predictions, sale charts or establish the best market segment. Unfortunately, a company cannot always store its data in transactional databases, because their volume would significantly slow the data processing time. Therefore, many companies choose to implement a business intelligence system.

A business intelligence system is based, in 90% of the cases, on the implementation of a different database than the transactional one. Usually, the implemented database for such a system will have huge dimensions, being installed on machines with high processing capacity and it will be designed for massive queries. All data relevant to the business analyze will be inserted in this database. The basic data on which ideas can be stated and from which relevant information for the organization is extracted, is established in the analyzing and designing stage of a business intelligence system.

Certainly, not the entire data of an organization will be relevant for analyze. A part of the data will be filtered, precisely to provide the answers that analysts look for. Once the data that needs processing and their transactional system location is established, the database design for the business intelligence system can start. This special database, having the purpose to store the historical data, is built as a data warehouse or as a data concentration.

Developing and implementing an historical database it's not enough for providing business intelligence. This data must be exploited so that information is extracted. Major software companies have developed

various tools for complex reports and dashboards. There are various methods for harvesting data (data mining), and the OLAP (On-Line Analytical Processing) technology is, usually, the mainstay of a business intelligence system.

### **3. The Role and Objectives of Business Intelligence Systems inside an Organization**

Business intelligence solutions bring added value inside enterprises, serving as a base for making fundamental changes, new collaborations, acquiring new customers, creating new markets.

- *The business intelligence system's role in taking decisions*

At a strategic level, business intelligence makes possible the establishing of objectives in a precise mode and following their achievement, allowing different comparative reports, also performing growth simulations or forecasting the next result on the base of some assumptions.

At a tactic level, the business intelligence system can offer a base for making marketing, sales, finances, income or management decisions. The systems allow the optimization of future actions and performance modifiers on an organizational aspect, financial or technologic on the purpose to help enterprises to reach their strategic objectives in a more efficient way.

Regarding the operational level, business intelligence solutions are used in establishing the ad-hoc analyzing and answering questions related to suppliers cooperation, clients and operations already in developing inside each department.

The main objectives of the business intelligence systems are resumed shortly in the next figure:

- *Using business intelligence solutions*

In the competitive climate of our days, it's vital for organization to offer a fast access to information, at low cost, for a larger number and variety, for the users. The solution of this problem is a business intelligence system that offers a set of technologies and software products that gives the users the needed information to answer the questions that appear in solving business problems.

*a. The need to grow the incomes and reduce the costs*

The days where the user could manage and plan the activities using monthly reports and IT organizations had a lot of time on their disposal to implement new applications, are over. Today companies need to quickly develop applications in order to offer their users a faster and easier access to information that reflect changes of the business environment. Business intelligence systems focus on fast delivery and access of information to users

*b. The need to manage the complexity of the business environment*

It becomes harder to understand and manage a complex business environment and to maximize the investments. Business intelligence systems offer more than queries and reports solutions, they offer analyzing instruments of complex information and data mining.

*c. The need to cut IT costs*

Today, the investment in IT systems is a significant percent of companies' costs. It is not necessary just to reduce these costs, but also, to obtain maximum benefits from the information managed by the IT systems. The new IT technologies like the Intranet and 3 level architectures reduce the cost of using the business intelligence systems by a large variety of users, especially managers.

#### **4. Architectural Principles of a Business Intelligence System**

In an overview of the microstrategy platform architecture for big data [4], cloud business intelligence and mobile application, the architectural principles of a business intelligence system are stated as following:

*a) Scalability and High Performance*

All design decisions must ensure that the strategy can deliver consistently high performance as the system scales upward, and must anticipate order-of-magnitude growth beyond today's state-of-the-art standard (user scale, data scale and application scale).

*b) Economies of Scale*

All design decisions must explicitly deliver greater economies of scale as a system grows – using techniques like in-memory data processing, caching, object reuse, automated administration, and collaborative analytics. We make sure that the strategy implementations require an absolute minimum of IT personnel, require the fewest servers, and minimize the workload on expensive database resources.

*c) Complete Functionality*

All designs decisions must ensure that architecture offers the full range of business intelligence functionality on a single service-oriented architecture, so that customers can satisfy all of their business intelligence requirements without the need for additional integration work.

*d) Incremental Growth*

All design decisions must ensure that customers can incrementally grow their business intelligence infrastructures – from small to large, from departmental scope to enterprise cope, from isolated islands to consolidated applications, and from reporting to dashboards to OLAP to ad hoc

analysis to alerting to mobile apps. This allows customers to initially buy just the functionality they need, and to incrementally grow their business intelligence solution as their requirements naturally expand.

*e) Openness and Extensibility*

All design decisions must ensure that the strategy's vast functionality continues to be fully accessible through Web services APIs.

*f) Centralized Consistency with Distributed Governance and Self-service*

All design decisions must support the goal of a consistent single version of the truth throughout the enterprise using a single shared metadata and pervasive security architecture. Yet, the architecture must also provide a high degree of autonomy to distributed development teams (managed by departments and divisions), and to individual users allowing them to create enterprise-consistent solutions at a local level.

*g) Rapid Development and Deployment*

All design decisions must promote rapid development and deployment of new reports and applications. Some developers have invested significant engineering energy in creating a vast array of reusable metadata objects, by creating a security architecture that is applied automatically and pervasively with no effort on the part of the report designer, and through design paradigms that allow novices and experts to play a role in accelerating the report design process.

*h) Consistent Experience*

Developers continuously work towards providing the same business intelligence experience from any user interface—desktop, web browsers, or mobile devices. Any feature, however simple it may be, is

added to the platform in a way that it can be easily available from any user interface. This philosophy enables business users to seamlessly change their interface to access critical business reports without losing any functionality. These requirements are from long-time customers who invested in high-scale business intelligence applications. Today, the goal of these same customers is to host many diverse business intelligence applications on a Cloud instance, or make these applications Mobile. The architectural tenets discussed earlier ensure their long-term success in this process.

## **5. Achieving a Business Intelligence System**

When a company decides to implement a system for business intelligence, it's good to consider that the implementation of this kind of technology is based on a very long and laborious process. Usually, just the analyzing stage can take a year, of course, considering the size of the organization and the complexity of the business behind. Another very important aspect to mention is the one of high costs that the developing of such a system involves; according to the statistics, the amortization of developing costs of a business intelligence system is done in a few years.

*a) Transactional systems as a data source*

The first stage in any business intelligence system is always the analyzing stage. In this first stage, the aims of the business intelligence system are set. As we mentioned before, any organization has a mix of operational systems, also known as OLTP Systems (On Line Transactional Processing Systems). These systems are usually used to process the company's current transactions and can be used for managing clients, sales or suppliers. These can be ERP (Enterprise Resource Planning), CRM (Customer Relationship Management), POS (Point Of Sale) Systems, etc. Usually, these source

systems keep the data for a limited time and afterwards the data is being archived. Studies in business intelligence field revealed that exploiting transactional data leads to a useful business analyze. The transactional data becomes a data source for the data warehouse, another important component of the business intelligence system. Depending on the organizations, business intelligence needs and the systems purpose, external data, such as other organizations data or statistic data, can be selected as reliable data source. At the end of the analyzing stage, analysts must have a general point of view over the organization targets.

#### *b) Data warehouses*

The analyzing and implementation phase of the data warehouses, it's for sure the most important phase in developing the business intelligence system and it's closely correlated with other phases. In this stage, it will established how the ETL process is going to be realized, how it will be implemented the OLAP cube or in what technology will the reports be made in. [5] So, a data warehouse is still a database, mostly relational, which is implemented differently than the standard databases and contains historical data of a certain interest. Ralph Kimball, known for his interest in business intelligence, defined the data warehouse as "a copy of transactional systems, especially structured for querying and analysis". [6]

Depending on the coverage, the warehouses can be divided in Enterprise Warehouse, Data Marts and Virtual Warehouses. The Enterprise Warehouse collects all the information, which regards the whole organization. Usually, this provides very big volumes of data, containing detailed data, and also aggregates data, and as dimensions, most of the times it reaches tens of terabytes. Data concentrations or data marts contain only a subset of the data volume from the

organization, specific to a certain group of users, being limited to specific subjects. The data contained by those data concentrations, are usually aggregate data. The virtual warehouse is "a set of visions of the operational databases" [7], being easy enough to implement, but needing supplementary capacities on the data servers.

A data warehouse usually contains aggregate data, detailed data and metadata. Aggregate data, even they determine a rise of data redundancies, are necessary in a data warehouse, because they improve the systems average response time. These assume a point of prior processing, so that they will be ready for the management's needs: they can be consolidated, totalized, summarized.

Detailed data is the relative recent data, delivered to the user, usually to execution level.

#### *c) Extracting, Transforming and Loading Data*

The ETL (Extract, Load, Transform) is one of the main components of a business intelligence system, on which it depends in highly measure, the data accuracy the organization will analyze. [8]

The data extraction will be a very laborious process and many times can be a challenge for developers, because this stage depends on the good functioning of the business intelligence system. Data which will be extracted in this stage is the one loaded in the data warehouse and on which the transformations and reports will be made in the next stages. For this reason, it is very important that the data is correctly extracted from the source files. Most of the times, the data is constituted from data files (flat files), exported from relational databases, but there are situations in which external data has to be loaded in the data warehouse. The big challenge is the transformation process of all the data resources in one single type,

accepted by the data warehouses. The ETL process, during its extraction phase, will take care of this problem. It will “inspect” the data files, will check if they are in a certain format, will load the data in an initial database and will reject all the incorrect data. A first data filter that is to be loaded is made in this first stage.

The data transformation stage is made from a set of rules and functions that apply to the extracted data in the first step. The purpose of this process is to prepare the data for the loading stage. Depending on the business intelligence system requirements, this stage can imply very complex transformations of the extracted data, or, on the contrary, they can be very little refined; all depend, of course, on what the systems has to fulfill.

The transformation stage is, like the data extraction stage, a very laborious and challenging process, being one of the key stages in implementing a business intelligence system. In this stage the data transforms in relevant information for the organizations management.

The data loading stage represents the last of the three ETL subsystem stages and it consists in loading data in the target tables. Of course that during this stage, the situation can be different from an organization to another, depending on the business requirements. Some companies can request that this loading to be made at certain time moments; data can be loaded daily, monthly, annually etc. For some data warehouses there can be an initial loading, for others they can only make updates or complementary data insertions.

#### *d) Multidimensional Data Analyze*

OLAP (On Line Analytical Processing) is a well known technology in business intelligence. This technology has its roots in complex analyzing and processing methods, they look as a ensemble of dimensions, hierarchical and interrelated measures [9]. The OLAP technology offers, first of all, system performances,

meaning that data is aggregated and as a multidimensional cube.

At present there are different types of OLAP analyzing, and the software developers come with multiple technologies for multidimensional analyze. OLAP analyzing instruments allow the elaboration of complex reports, but for viewing the reports special designed instruments can be used.

### **Conclusions**

Business intelligence is, at this time, one of IT fields with continuous improvements. Starting with basic theoretical notions and ending with the new technologies that are developing this way, business intelligence concepts are in the sight of all IT people.

As we mentioned before, business intelligence appeared as an answer to the economics’ environment needs. Big organizations and multinational companies have already implemented a solution for business intelligence. Though implementing this kind of system is extremely laborious and expensive, the benefits proved to be many more. As it was proven in the paper, integrating storing and exploiting an organization’s data can bring important advantages.

The main advantage in using business intelligence is the ability to transform data into information. This allows companies to develop an efficient mechanism of making decisions, in other words to make better and faster decisions. The benefits can be important for the company’s management in making strategic decisions, but it can also help department leaders, analysts or any other member of a team faced with having to take decisions.

Analyzing intelligent data has always been important because through this analyze intelligence is being generated. Business intelligence is like an endless story, applicable in fields like audit, risk management, diplomacy or lobby

activities. And new fields are just shaping up. This would be the case of merge between business intelligence and artificial intelligence, merger that would lead to a new concept, artificial business intelligence (ABI).

In these conditions we must admit that these technologies are just at the beginning of a long journey, in a world where the key of success stands within the capacity of making better decisions in a shorter time than the competition. Besides, a company's life depends more and more on such decisions, which will make impossible not to admit the benefit brought by business intelligence.

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