International Journal of Education and Practice
2016 Vol. 4, No. 2, pp. 71-83
ISSN(e): 2310-3868
ISSN(p): 2311-6897
DOI: 10.18488/journal.61/2016.4.2/61.2.71.83

QUALITY ASSURANCE IN HIGHER EDUCATION USING BUSINESS INTELLIGENCE TECHNOLOGY

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ABSTRACT

The quality of higher education is of particular importance for the development and progress of modern society. Modern higher education institutions aim to improve their services, and establish a system of continuous quality assurance. Within the framework of the European Standards and Guidelines for Quality Assurance, Standard 1.6 requires the implementation of information systems for efficient management of study programs and other activities. During the phase of problem analysis and objectives, in regard to the application of information systems at the University "Dzemal Bijedic", the existence of heterogeneous internal and external data sources was established. In modern management, data is considered a key resource necessary for the survival and development of the institution. Accordingly, the research focus is on the development of models of business intelligence systems that will be based on existing data sources. This system would primarily be used to support internal quality assurance at the University, as well as management support for timely and optimal decision making process. This paper presents the tools and technology of business intelligence, and through practical example demonstrates the possibilities of the system.

Keywords: Higher education, Quality assurance, Information system, Data, Business intelligence, Decision support.

Received: 5 December 2015/ **Revised:** 12 January 2016/ **Accepted:** 15 January 2016/ **Published:** 19 January 2016

Contribution/ Originality

This study contributes in the raising awareness about using of modern information technologies in the process of quality management in higher education.

1. INTRODUCTION

Quality Assurance is a key element in the higher education reform process and it is considered a prerequisite to creating a European Higher Education Area (EHEA). The creation and functioning of a unique European Higher Education Area are impossible without an established Quality Assurance System which should enable comparisons of higher education institutions and their programs. Although the concept of Quality has always been part of the academic tradition, global changes and growing competition in every field of human industry, in the field of higher education as well, imposed the necessity of establishing institutional mechanisms aiming at continuous Quality Assurance and Quality Improvement of higher education institutions. With higher education being activity of special public interest and the driving force of social development and progress, taking care of its quality and improvement becomes the central objective of European education policy (Boris *et al.*, 2011).

A common position is that the primary responsibility for Quality Assurance in higher education lies with each institution, as well as for overall quality of education they are providing for their students. Thus, Quality Assurance

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becomes common responsibility for all participants in the higher education process, and even more than that. Continuous Quality improvement requires a professional system of established mechanisms and processes. Naturally, Quality Assurance mechanisms, whether they are external or internal, excluding the development of culture of Quality, will remain mere mechanical processes. That crucial and vital element marks the change in behaviors and attitudes of all people working in higher education institutions, proactive approach to improving all operating segments of the Institution, and its creative and innovative potential (Boris *et al*., 2011).

Standards and Guidelines for Quality Assurance in Higher Education are basically divided into two parts: *Standards and Guidelines for Internal Quality Assurance within higher education institutions* and *External Quality Assurance in Higher Education.* The Table 1 below shows Standards and Guidelines for Quality Assurance in European Higher Education area.

Table-1. European standards and guidelines for quality assurance

European Standards And Guidelines For Internal Quality Assurance	European Standards And Guidelines For The External Quality Assurance
Policy and procedures for quality assurance	Use of internal quality assurance procedures
Approval, monitoring and periodic review of programmes and awards	Development of external quality assurance processes
Assessment of students	Criteria for decisions
Quality assurance of teaching staff	Processes fit for purpose
Learning resources and student support	Reporting
Information systems	Follow-up procedures
Public information	Periodic reviews
	System-wide analyses

Source: Standards and Guidelines for Quality Assurance in the European Higher Education Area

Internal Quality Assurance is related to mechanisms of Higher Education institutions, principally to development of institutionalized policy of work in Quality Assurance and Culture of Quality, involving students in the process, development of monitoring mechanisms which are periodically reviewed, transparency and publication of results (Standards, 2009).

External Quality Assurance is related to systematic monitoring and takes into account the effectiveness of the Internal Quality Assurance system, and largely depends on there being an explicit internal quality assurance strategy, with specific objectives, and on the use, within institutions, of mechanisms and methods aimed at achieving those objectives (Standards, 2009).

2. INFORMATION SYSTEMS IN PROCESS OF QUALITY ASSURANCE

Electronic business is becoming inevitable and irreplaceable resource of the modern system of education. Information and communication technologies (ICT) are the infrastructural basis for successful conducting of everyday business processes at universities all around the world. Main indicators of efficiency are directly correlated with Quality and level of implementation of Information Technologies used for those purposes. Information is a key factor of modern society progress. For decades already, the most developed countries have been creating information societies, i.e. societies based on information and knowledge. Change Management is exactly based on increasing use of information technologies in every segment of business. Therefore, we hear more often about digital economy, new technologies development, knowledge investments, and quality information becoming the primary source of business efficiency.

According to that, information technologies are today largely used at all modern universities. Information technologies are used in different forms of business, from administration and teaching staff, to students as main actors of educational process. Many higher education institutions have implemented information systems in forms

of different educational software as a support to the educational process. Almost all relevant data is stored in electronic databases and is made available for those who need it most. A reliable and quality source of information is a key resource for development and progress in the higher education area, and the whole society.

European standards and guidelines for internal quality assurance within higher education institutions clearly dictate application of information systems as one of the necessary elements of Quality Assurance (Standard 1.6.). According to the mentioned Standard, institutional self-knowledge is the starting point for effective quality assurance. It is important that the institutions have a way of collecting and analyzing information about their own activities. Without this they will not know what is working well and what needs attention, or the results of innovatory practices. The quality-related information systems required by individual institutions will depend to some extent on local circumstances, but it is at least expected to cover (Standards, 2009):

- Student progression and success rates,
- Employability of graduates,
- Students' satisfaction with their programmes,
- Effectiveness of teachers,
- Profile of the student population,
- Learning resources available and their costs,

The institution's own key performance indicators

All of the above clearly indicates that the informatization of higher education institution is a very useful tool in the inernal and external quality assurance system. Relevant information about education is useful for the employers and the society in general, and also for the academic workers, students and potential employees. Defined standards point out the importance of collecting data and information, their storage in the electronic databases, their accessibility and versatility with respect to searching, and statistical analysis needed for effective management of higher education instituitions. In recent times, in this domain, as an integral part of information systems, there is a new noticeable discipline known as "Business Intelligence". Business Intelligence is a part of organization information system developed specifically to enable management of organization performances. Details of this area are shown in the next chapter.

3. BUSINESS INTELLIGENCE

The term "Business Intelligence" was coined by the Gartner Group in the mid-1990s. However, the concept is much older, it has its roots in the Management Information Systems (MIS) reporting systems of the 1970s. During that period, reporting systems were static and twodimensional and had no analytical capabilities. In the early 1980s, the concept of executive information systems (EIS) emerged. This concept expanded the computerized support to top-level managers and executives. Some of the capabilities introduced were dynamic multidimensional (ad hoc or on-demand) reporting, forecasting and prediction, trend analysis, drill down to details, status access, and critical success factors (CSFs). These features appeared in dozens of commercial products until the mid-1990s. Then the same capabilities and some new ones appeared under the name BI. Today, a good BI-based enterprise information system contains all the information executives need. So, the original concept of EIS was transformed into BI. By 2005, BI systems started to include artificial intelligence capabilities as well as powerful analytical capabilities (Efraim *et al*., 2010).

According to Larisse T. Moss and Shaku Atre, Business Intelligence is an architecture and collection of integrated operational, as well as decision-support applications and databases that provide the business systems easy access to business data (The Origins of Business Intelligence, 2015).

According to Pareek, Business Intelligence represents a broad category of applications, technologies and methods for providing access to data to help enterprise users make better business decisions. It combines products, technologies, and methods for better organisation of key information needed for the management in order to

improve performances and increase profit. Pareek defines Business Intelligence as a set of activities aimed at better insight and understanding of business operations, using different analyis of corporate and external data in order to make strategic, tactical and operational decisions and to take necessary actions to improve business performances. Key words of the definiton are "Improving business performances" and that is actually the purpose of Business Intelligence. It often includes a complex set of tools, databases, and products that form the infrastucture that would be able to evolve in accordance with the changes in environment (Pareek, 2006).

From the technical point of view, most authors mention the following as a key components of Business Intelligence:

- Data Sources,
- Data Warehouse,
- Online Analytical Processing,
- Data Mining,
- Client Tools.

The main component of Business Intelligence system are Data. For Business Intelligence systems, there can be various sources of data, and they basically include two types: internal and external, i.e. data generated within the enterprise, and data coming from external sources. Mostly, there are internal data resulting from the various transaction processing systems. Nowdays, Transaction processing systems are present in all segments of modern companies activities, regardless of their line of business. Main reason for their implementation is an efficient collection and processing of data in order to improve business activities and achieve better results. Besides operating systems, data can be found in archival databases, obsolete transaction processing systems, electronic documents stored in different locations within the company, etc. Also, it is important to note that those data company is getting from external sources, via e-mail, other web sites, social networks, jounals, institutes, can be very useful in the decision-making process. For example, these data can be used to acquire detailed information about competition and timely take actions leading to better business results. Whatever the location ane type of data storage are, they are equally important and need special attention.

Very often, the management needs information that is hard to acquire through operating transaction systems. It has led to emergence of Data Warehouses, which as opposed to classical transaction databases, serve the business analysis purposes and as decision support system for the highest level of organizational management. The term "Data Warehouse" denotes a set of data isolated from the transacion databases and stored in special data repository. Building the data warehouses, transaction databases are being unloaded and cleared of complex queries, which leads to their improved performances.

Data warehouse is a specially designed , analytical database used to storage data acquired from different internal or external sources. According to W. H. Inmon, data warehouse is a subject oriented, integrated, time-variant, and nonvolatile collection of data in support of management decisions. This definition gives four distinctive characteristics of the data warehouse (Inmon, 2005):

- **Subject oriented.** Data warehouse can be used for analysis in a particular segment of business, for example, for a company in retail business, subject of analysis can be just the sales department.
- **Integrated.** Data warehouse incorporates data form different sources, ex. Source *A* and source *B* can have different ways of identifying the same product, but when the data are summarized in the data warehouse, there will be just one way of product identiying.
- **Time-variant.** Data warehouse containes historical data. For example, form the data warehouse we can fetch data 3, 6 or 12 months old or older. This is in contrast to transaction system where exclusively current data are kept, so the transaction system will keep only the most recent address of the buyer, while the data warehouse while the data warehouse will keep all the addresses associatied with the customer.

- **Nonvolatile**. Once the data are loaded in the data warehouse, they will never be changed. Data warehouse can be loaded only with new data, while the existing data remain in their original form.

Unlike the classical transaction databases based on relational model, data warehouse belongs to the mulitdimensional databases build up on a basis of a dimensional model. For the purpose of the data warehouse, used to fetch several millions data at a time, relational data model proved to be inefficient. The problem is the fact that relational model is not adjusted to to perform complex queries over large amount of data, so the speed of running queries has significantly decreased.

Dimensional data model is a logical design technique aiming to show data in a standardized and intuitive way which enables quick access to data. Dimensional model structure is composed of one table with a multipart key, called the *Fact table*, and a set of smaller tables rellated to it, called *Dimension tables*. Every dimension table has a primary key that corresponds to one of the components of the multipart key in the fact table. This starlike structure of dimensional model is often called a Star shema (Ralph, 1997). Tipical example of the Star shema is shown below (See figure 1).

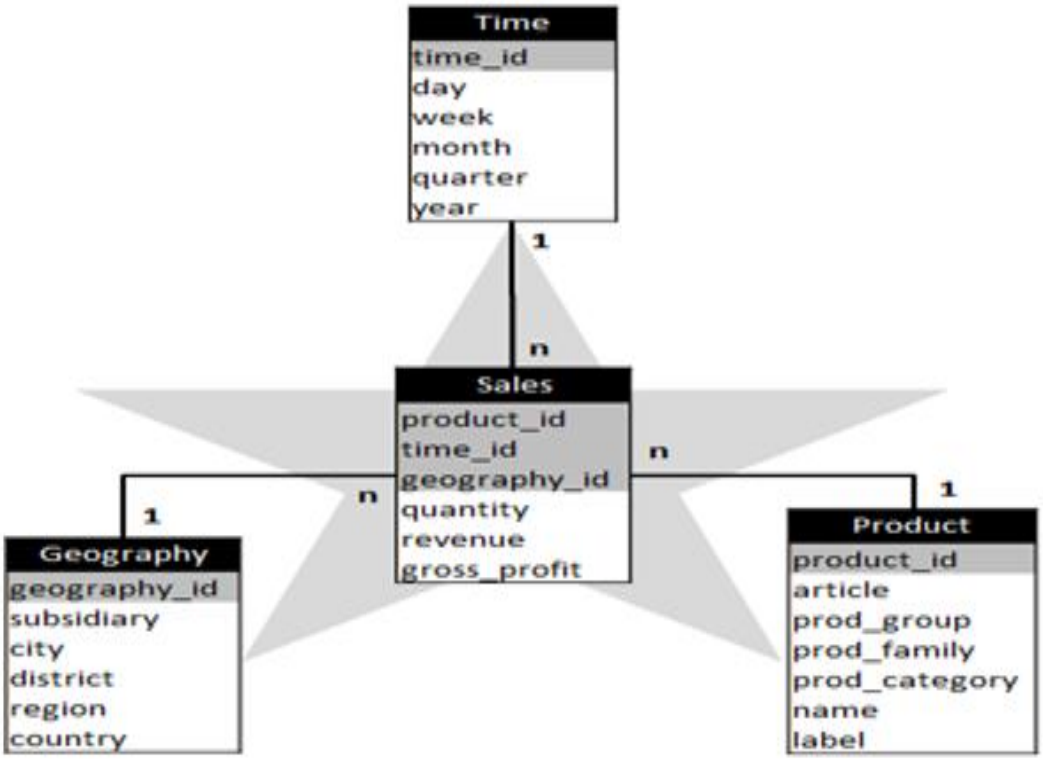

Figure-1. Star schema

Source: http://en.dwhwiki.info/design/star_schema

Data gets loaded into the data warehouse from different sources, very often heterogeneous. The most extensive work in that process is integration and organisation of data contents, which takes up to 70% of time needed to project and implement a data warehouse. Processes of Extracting, Transforming and Loading of data (ETL) are the heart of the system of data storing and presents the connection between operating transaction systems and data warehouse built for analysis and reporting. Import of data from source systems to data warehouse consists of three steps (Pareek, 2006):

- **Step 1:** *Extraction* of data is a process of choosing and extracting operation data, interesting from the storing perspective,
- **Step 2:** *Transform* of data is a process of integrating separate data and its further inspection, cleaning of data, remodeling and adjustment prior to loading into the data warehouse.

- **Step 3:** *Load* is a phase of input of previously prepared data into the target data warehouse.

With an increasing amount of information becoming available, and emersion of strict requirements for quality decision support, we came to understanding that classical ways of electronic data processing can't meet the new conditions and it is necessary to define new ways of data processing, specially designed for the purpose. One of the most widespread and extremely successful ways of extracting knowlegde from data are Online Analytical Processing – OLAP tools, actually multidimensional analysis. Traditional reporting was used to present data that the company had stored in different databases, whereas OLAP tools are used for explaining certain business occurences. The most important and valuable characteristics of OLAP tools is precisely based on the multidimensional analysis, meaning that data can be seen simultaneously through number of filters or dimensions. Number of dimensions is not limited, but in the practice it can go over 10. Taking into account that it surpasses our average comprehension capacity, we can conclude that these tools enable increase of human intelligence. Also, an important feature of these tools is the speed that enables to run the query and getting a response in a short time, mostly within a few seconds (Ante, 2013).

Basic elements of OLAP technology are the so called Cubes with data loaded from data warehouse. Fact and dimension tables are being taken from standard shemes (Star or Snowflake) and they are stored externally, in a cube-shaped repository. The cube combine more dimensions, such as time, geographic position and production lines, with agregated data, like sales and stock data. The cube provides a multidimensional view of data, and its specific design guarantees the optimization of the report. Multidimensional data structures are best visualized as cubes, and particular cubes within the cubes of data. Each side of the cube is considered a dimension. Ex. in the sales cube one dimension would be location, and its different categories could be cities, cantons, countries, etc. Each cell of that cube containes agregated data (measures mentioned earlier) relating dimensiones. An example of OLAP cube with sales data is presented in the Figure 2.

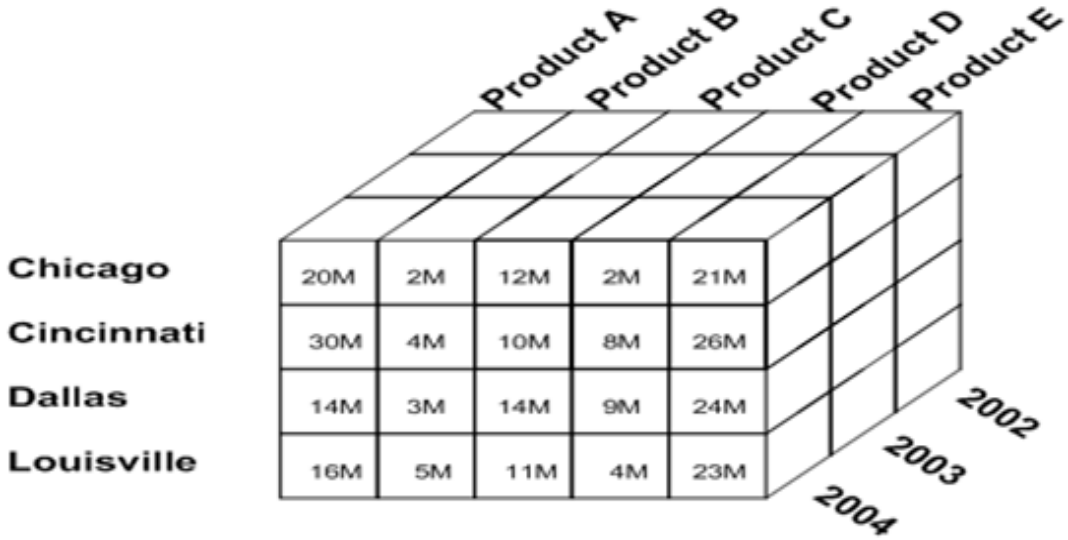

Figure-2. Cube
Source: https://docs.oracle.com/html/B13915_04/i_olap_chapter.htm

Very often, in the process of information research we reach for more advanced techniques of data analysis. Generaly speaking, Data Mining is a process of developing Business Intelligence from the data companies collect, organize, and store for the purpose of increasing their availability and transformation of data into useful knowledge. There are more definitions of data mining. It's a process of disovering new knowledge among the big data sets also, data mining can be defined as a process of discovering hidden patterns and connections between the data. Simply speaking, data mining is a method of extracting interesting, new and potentialy useful information or patterns,

contained in large databases aimed at making the right business decisions. Data mining is an iterative process and its progress is determined through research using different automatic or manual methods. It is most often used in reasearch and analysis of the scenario where the possible outcomes are unknown. Actually, it presents a search for new, worthy, nontrivial information in any given moment. That is a cooperative effort of man and the computer. Best results are achieved by balancing the knowledge of the expert in describing the problem and objections and computer search capacities (Mehmed, 2011). If there are problems in achieving business goals or realization of the budget, operating management should, as soon as possible, access the information in order to have enough time to solve the problem. In other words, if it's a monthly objective, they will need data on a daily basis. Various Client tools are used for the purpose of inspection and data search. Tools for accessing data warehouse and OLAP structures give a powerful image of data stored in a way closely related to human cognitive processess. Todays modern tools are most often applications that doesn't require software installation to the end user computer. They are easily accessible thorugh internet browser, companies web sites, and an integration with different office tools.

4. MODEL OF BUSINESS INTELLIGENCE SYSTEM

Model of Business Intelligence system has five main determinants (Željko and Goran, 2003):

- **Information** discovering new knowledge, widening horizons aimig at better business decision making to increase the posibility of future success of organisation in a dinamic environment.
- **Analysis and segmatation**, crucial is the analysis of information used as a basis for segmentation, or defining information fit for sending to end users.
- **Personalisation**, information becomes important only if personalized, i.e. directed to the right user.
- **Multiple canals distribution**, in the process of providing the user with useful information we need to use every information solution.
- **Action, interaction, transaction,** use information in the process of modeling a concept of organizational development.

So, the model of business intelligence includes infrastructure, functionality, organisation and operating and it can be divided into next phases: planning and managment, data collection, data analysis, and distribution of final information products. With an aim of improving implementation procedures, it is recommendable to include end users into the phase of planning, carefully define their requests, comply with standards, choose an adequate platform and tools and make a stretegic plan of the project and its distinctive phases. It is important to pay special attention to the phase of collecting data in order to determine all usefull data sources both within and outside the organisation. This is usually the longest and most expensive phase in the process of establishing business intelligence system, and on the performance quality of this phase depends the posibility of data analysis and finally the whole reports given to managerial structures of the organisation.

4.1. Information Systems at the University "Dzemal Bijedic" of Mostar

Today, at University, there are a few software solutions for the purpose of providing support for everyday business activities. Software support is implemented through following packages:

- Software solution for student services,
- Distance learning management system,
- Software solutions for financial operations:
- Software solution for payroll accounting,
- Accounting software solution,
- University web site (Content management system – CMS),
- University information system.

In addition, it is importante to note that some other activities are mostly conducted in electronic way, using diverse services like e-mail and electronic documents for data storage in different types and formats.

Table- 2. Unversity data infrastructure

Data sources	Meaning
Student service system	Data about students and their success rates, payments of the school fees, syllabus, and teaching programmes, certificates and confirmation, etc.
Distance learning management system	Data about students and their success rates, payments of the school fees, syllabus, and teaching programmes, certificates and confirmation, exam term dates, notifications, schedule of classes, educational topics and other relevant data.
University information system	Data about teaching staff and their success rates, projects, exam applications, diplomas, etc.
System for payroll accounting and human resources	University staff data, their payments and other forms of allowances.
Accounting system	Accounting data for each faculty.
Web site of the University	Public data in the form of notions, documents, galleries, etc.
Electronic documents	Data about projects, conducting of classes, students survey, decrees, ordinances, etc.
Mail system	Communication among staff.
External sources	Data about competition and labor market, statistical data, data about published scientific works, etc.

Source: Authors of paper

Detail analysis of information infrastructure of the University, identified great amount of data stored in different types and formats. They were formed by using many software solutions and other forms of electronic business over the years. Information technologies are used in almost every segment of business, primarily using electronic in education process, and financial activities. In the first phase of developing a system of business intelligence, it is necessary to identify data sources and establish this meaning in the context of Quality Assurance. Accordingly, the following table gives the preview of data sources at the University as well as short description of their meaning:

However, all of the above mentioned data is generally available through standard user reports and offer no possibilities of detailed reviews and analysis. Thus, the University managmenent is prevented from accessing useful information in time. In order to solve the problem, a specific model of University business intelligence system has been presented.

4.2. Model of University Business Intelligence System

Based on the identified data sources, it can be concluded that there are many of them that can be used for the right purposes. First of all, those are the data stored in a unique database of students service system which has also been upgraded to meet the requirements of the University information system. Centralization and 78inancial relational data structure is a positive feature of this system and it gives excellent foundation for developing a business intelligence system. Data about students, their success rates, university staff, teaching plans and programmes, can easily be used for analysis that are key factors in the Quality Assurance process. Because of technological compatibility and similiarities, this database works well with distance learning support database which also has stored data relevant for advanced analysis and reporting and they act complementary databases.

Also, it is important to mention financial analysis that are using data produced by application of software solutions for 78inancial and accounting operations. For successful financial analysis, due to a decentralized data storage, it is necessary to do a preliminary data integration, as a postulate for insight and analysis of financial management. In no case we should ignore electronic documents containing data stored in an unstructured form.

Almost all types of electronic data storage are exploitative in the process of creating a business intelligence system, including preliminary integrations and transformations as a way of fitting the intended analysis.

A generalized model of business intelligence system, developed for the purpose of Quality Assurance support at the University of "Dzemal Bijedic" is presented below (See Figure 3.).

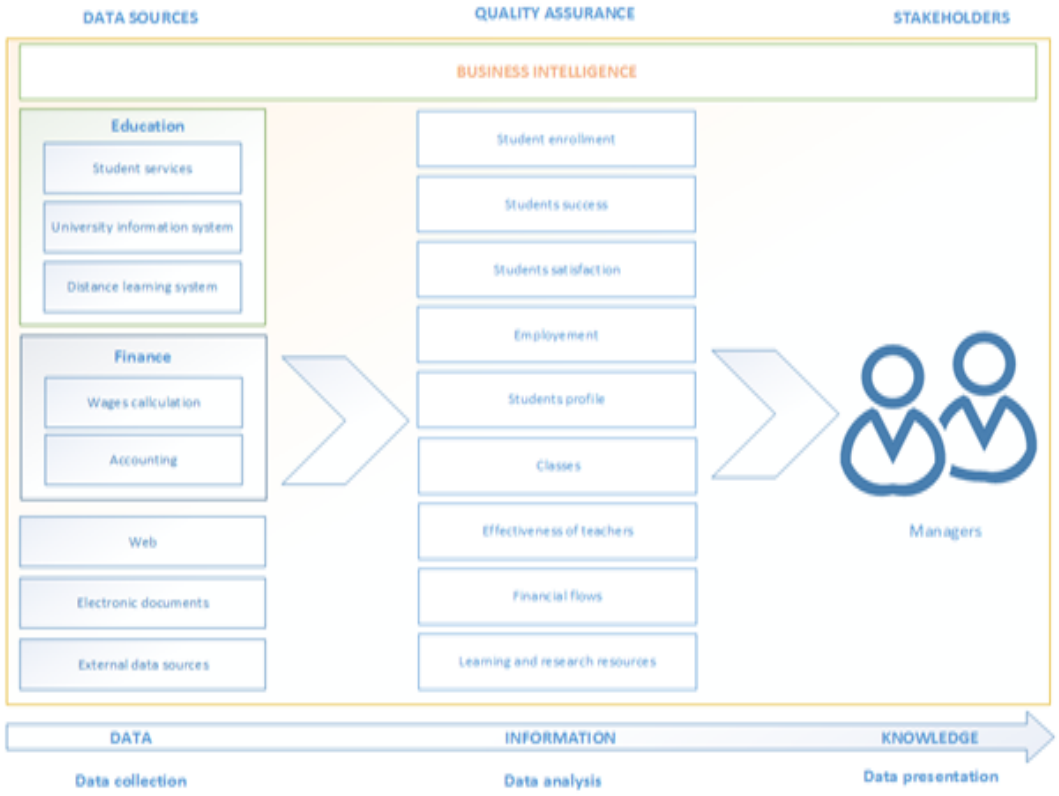

Figure-3. Model of University Business Intelligence system

Source: Authors of paper

We must accentuate that the business intelligence system is never finite. In the future it should be expanding in accordance with the progress of information technologies, development of new tools, and increase in the amount of data and its accessibility within and outside the University.

4.3. Arhitecture of University Business Intelligence System

After analysis of the business process, current problems and objectives, and identification of relevant data sources, what follows is an elaboration of arhitecture of business intelligence system. At the University, the arhitecture of the Business Intelligence system is very heterogenoeous and it consists of several levels:

- External data,
- Process of integration and transformation of data,
- Central data warehouse,
- Data access level, and
- Information access level.

As a result of heterogeneous structure of data storage, one of the main phases in the process of system development is establishment of a central data warehouse and creation of an efficient system for integration and transformation of data. That is also a prerequisite for further development, i.e. for setting up a system for access and usage of data.

After finishing the process of data centralization, considering the nature of the business intelligence system, it is logical to see this as a completed process for the most part. All that is left is an implementation of presented techniques of business intelligence, including the design of various OLAP cubes, development of data-mining models, creating reports, and assuring data access via different user oriented presentation tools

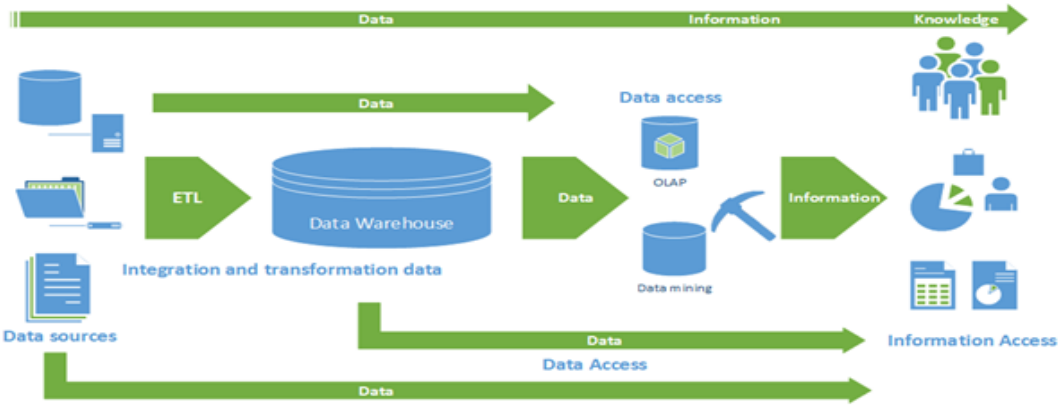

Figure-4. Architecture of University Business Intelligence System

Source: Authors of paper

5. EXAMPLE: ANALYSIS OF STUDENT ENROLLMENT

Analysis of student enrolment has been conducted for all member faculties of the "Dzemal Bijedic" University in Mostar. It focused on the analysis of the number of students enrolled at University creating graphical representation of data by academic year, faculties, departments, and other relevant criteria. For that purpose, we needed to develop a dimensional database model, import data from source systems in order to integrate them, create data cube and provide end-users with interactive access to data. Implementation was completed using MS SQL Server database and advanced analysis management system, while the data cube was created using SQL Server Data Tools. For searching in data cubes, reports were created and published in the Reporting service, and Excel was used for dynamic analysis and graphical presentations of data.

Relational database which is in the backgroung of student service system and database of distance learning management system, were used as a basis for creating a dimensional model, or the data warehouse model. Structural part of the aforementioned databases was denormalized and star schema was formed (See Figure 5.)

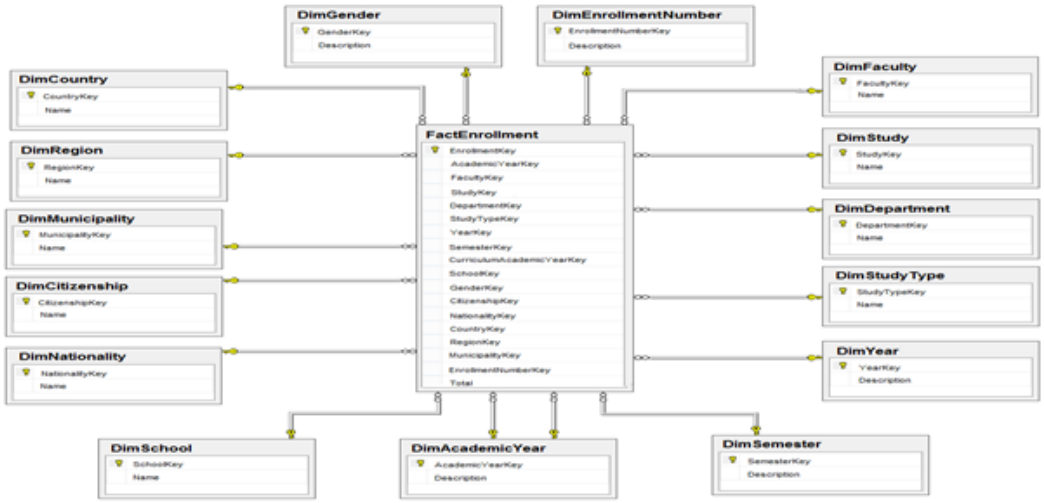

Figure-5. Student Enrollment Star Schema

Source: Authors of paper

The next step, after creating a dimensional database is its loading with data. This step is one of the most demanding and long-lasting in the process of implementation of data warehouse. Data is acquired from source systems, they are transformed, i.e. adapting to specific rules and limitations of the destination directory, and finally loaded to destination tables. Having in mind the compatibility of technologies, in the process of data transfer, manual process of selection, transformation and loading was used, along with the use of T-SQL commands and simple tool for import and export data which is incorporated into SQL server platform enabling to create packages useful for future data transfers. Some of the most notable transformations performed on the source data set:

- Standardization of data values from different sources,
- Elimination and formatting of the unknown values,
- Formatting referent values,
- Removing duplicates,
- Adjustment of data types,
- Data generation,
- Aggregation and grouping,
- Calculations, etc.

After the initial phases, that are very simple and fast, there are the data cube modelling operations. Operations on the data cube include adjustment of dimension tables, creating hierarchy, setting measure values and defining of data aggregation type. When the data cube is ready, it is being processed, loaded, tested and published to SQL Server Anslysis Service.

Architecture of the OLAP system developed for the purpose of analysis of student enrolment at the University is shown below in the deployment diagram (See Figure 6).

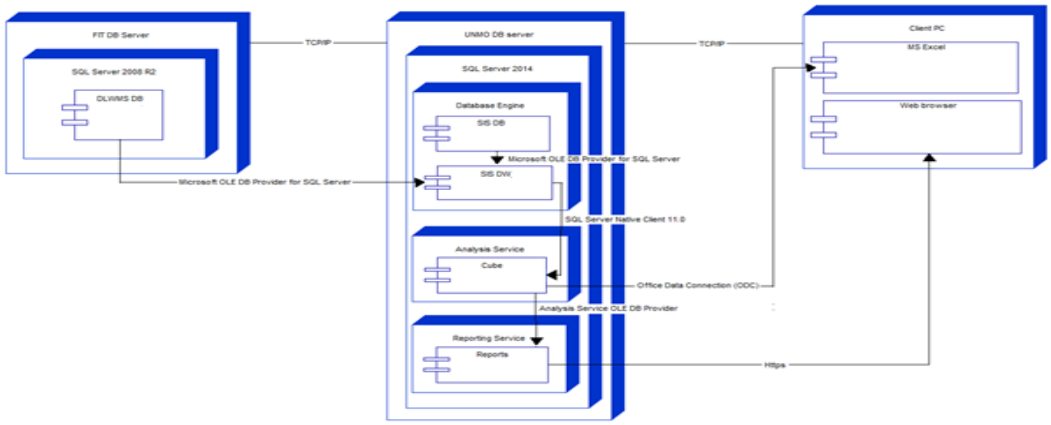

Figure-6. Deployment diagram

Source: Authors of paper

Data analysis is a final and key step in the OLAP process. System implementator is expected to enable for the end-user easy and secure access to data. From the end-user perspective, this phase brings a simplified access to data, without any special knowledge requriements, and is aimed at detailed analysis and recognition of useful information among them. Considering the specificity of analysis and the number of end-users, it is recommended to enable access to data via as well as the access to the reports according to end-users competencies. Parties who are interested in those reports (Stakeholders) created for the purpose of analysis of student enrolment are definitely all member faculties, i.e. personell in charge of the educational process at the faculty (usually vice dean of academic affairs), management of the University and also the staff in charge of Quality Assurance of education process. Below is the example of a report created on the basis of available data cube (See Figure 7).

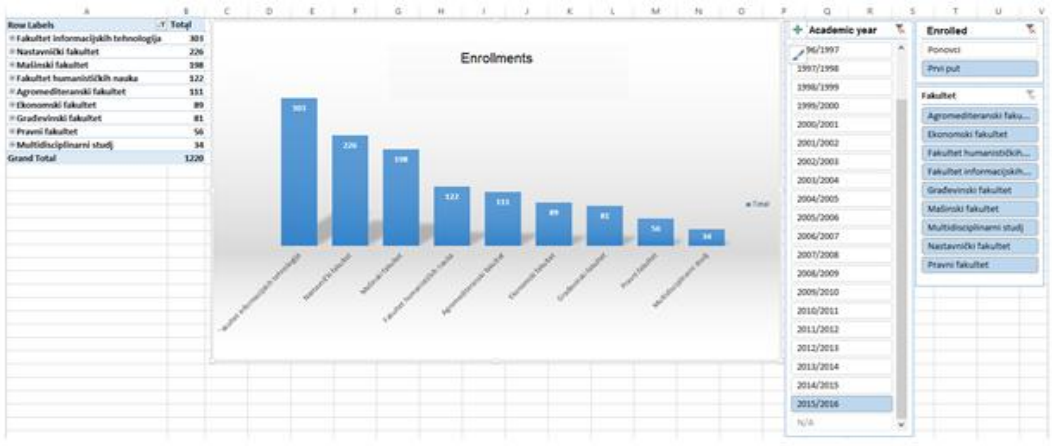

Figure-7. OLAP Report (MS Excel)

Source: Authors of paper

Multidimensional analysis enable the end-user to have an insight into data according to his wishes and needs, which contributes significantly to the decision-making process. Analysis previously presented, is of key importance for trend analysis of students enrollment looking at it from a different points of view. Created data cube ensures quick access to data and a complete set of different perspectives regarding data in forms of various reports and analysis. Some of the key reports easily derived from the data cube and ready for University management use are:

- Structure of student enrolment at University by academic years,
- Number of active students at University distributed by Faculties and Departments,
- Number of first time enrolled students and second or more time enrolled by academic years, for all faculties,
- Number of students who withdrew their applications (college dropouts),
- Number of active students listed by educational plans and programmes at Faculties,
- Structure of students depending of their status and chosen option of studying,
- Structure of students showing previous education,
- Structure of students related to their place of residence (country, canton, municipalities),
- Number of domicile and guest students enrolled at University, i.e. particular Faculties,
- Structure of students enrolled to University, related to their nationalities,
- Structure of students by their sexes, and many other reports depending on the specific management requirements.

All of the above mentioned kinds of reports are directly correlated to the Quality Assurance in Educational process and can be used in the procedure of defining key success indicators of a certain institution. Information given in the reports, significantly contributes to new findings on educational process and structure of students. Based on such findings, it is possible to make some strategic decisions, like removal of some study courses, introduction of new study programmes and departments, optimization of work schedule and resources in order to reduce expenses, and many other decisions which lead to improvement in education process quality and services provides by University.

6. CONCLUSION

Quality of education is a key indicator of business efficiency of every institution of higher education. Therefore, in the European Higher Education Area, during the last decade, large investments have been made aiming at development of educational system and setting of unique standards for conducting the process of Quality Assurance.

Focus of these research is on the defined standards and guidelines for internal Quality Assurance with special regard to information systems. Based on the conducted analysis it can be concluded that the information infrastructure at University is well implemented. However, main problems appear in the process of accessing and searching data needed for the management of the University. Also, research focuses on business intelligence system and their abilities in providing necessary information for the University management. Concept of business intelligence system is defined exactly by activities of collecting and consolidation of data and their analysis, i.e. transforming data into useful information. In regard to existence of differenc data sources, we created basis for modelling of business intelligence system which should enable high level of reporting and accessibility of information.

Validation of the introduced model was done in a practical example. Using the OLAP tools, we presented some specific data and published analysis that confirmed many benefites of business intelligence system. Results of the analysis point out some important indicators applicable for the purpose of improving decision-making process in respect to Quality Assurance. Implementing of the system enabled additional level of information, creating prerequisites for many analysis useful for improving educational services as a main factor of social development. Future research would be directed to the objective of refining the presented model in order to make new knowledge and predict future trends in higher education area.

Funding: This study received no specific financial support.

Competing Interests: The authors declare that they have no competing interests.

Contributors/Acknowledgement: All authors contributed equally to the conception and design of the study.

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