

# **BUSINESS INTELLIGENCE AND DATA WAREHOUSE PROGRAMS IN HIGHER EDUCATION INSTITUTIONS: CURRENT STATUS AND RECOMMENDATIONS FOR IMPROVEMENT**

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**Abstract.** The purpose of this article is to explore the current situation and the main challenges in existing Business Intelligence (BI) and Data Warehouse (DW) curricula. On the base of this research, certain recommendations for their improvement are made. At the same time, the paper gives concrete guidelines for the development of a clear and comprehensive graduate profile with knowledge, skills and social competence in the field of BI and DW. This is particularly beneficial for universities and other higher education institutions, that seek to offer courses with high quality content and tendencies, adequate to the latest education, in the concerned area. The paper is written within the Erasmus plus KA2 project “Developing the innovative methodology of teaching Business Informatics” (DIMBI), 2015-1-PL01-KA203-0016636.

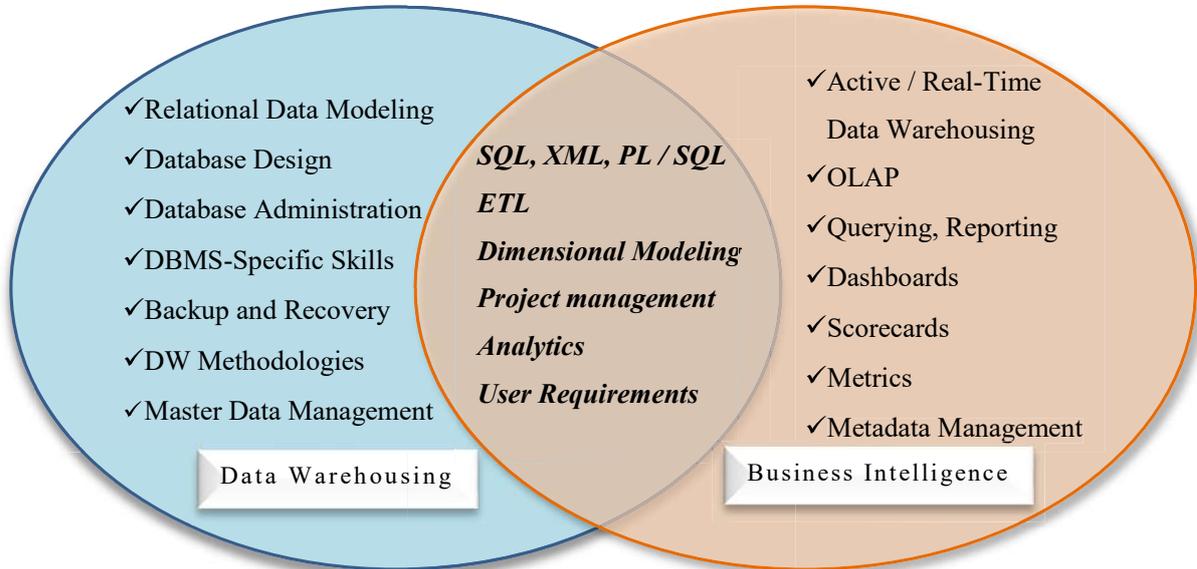
**Key words:** Business Intelligence, Data Warehouse, education content, improvements in Business Intelligence education, BI curriculum, Business Intelligence and Data Warehousing skills

## **1. Inquiry on the labor market needs in terms of knowledge, skills and social competence in relation to Business Intelligence and Data Warehouse**

Before analyzing the existing situation in BI and DW education, we shall take a look at the labor market requirements concerning the job skills, educational requirements and social competence needed in relation to BI and DW. The importance of this inquiry is determined by the need to define the basic criteria which a future specialist in this highly popular and profitable field must cover. It comes as no surprise, then, that jobs for business intelligence analysts and DW specialists are becoming more attractive and they are among the top 10 best-paying science, technology, engineering and mathematics jobs (Bednarz, A., 2014).

The technical skills required for job positions in BI and DW are very similar and overlap quite often, although there are topics that are specific to only one of the two areas (figure 1). For example, skills like dimensional modeling, analytics and defining user requirements are required in both business career fields. On the other hand, skills related to

the ability to visualize and analyze data with different dashboards, scorecards and metrics are usually specific to Business Intelligence job positions.



**Figure 1.** Skill overlap between Data Warehousing, and Business Intelligence  
 Source: Adapted from Shirani, A. and Roldan, M., 2009

The data warehousing skill set includes the foundation of relational database knowledge, though sometimes this information may not be explicitly stated in a job description. One characteristic of this group of skills is a requirement for experience with specific software products for data warehouse database design and administration. In addition, proficiency in the underlying DBMS is essential for any DW job.

Most DW job positions require specific experience with DBMS like Microsoft SQL Server, Oracle, IBM DB2, Teradata, SAP BW (Business Warehouse).

Several of the most required skills are extracting, transforming and loading data, as well as good knowledge / experience with multidimensional data modeling, such as star schemas, snowflakes, normalized and de-normalized models, handling "slow-changing" dimensions / attributes.

We can summarize the top ten DW skills and their rank according to their importance and frequency in the job listings (table 1).

**Table 1.**

Top Ten Data Warehousing Skills

Rank	Knowledge / Skill	Percent
1	Extract, transform, and load (ETL)	81.7
2	Dimensional modeling; DW methodologies; DW architecture	65.0
3	SQL; PL/SQL; other programming languages (Perl, PHP)	61.7
4	Project management	55.0
5	Data security; backup; recovery; performance tuning	53.3

6	Master data management (MDM); data quality; metadata management	36.7
7	UNIX; Linux	31.7
8	User requirements	28.3
9	Analytics	26.7
10	Reporting	18.3

Source: Shirani, A. and Roldan, M., 2009.

As we mentioned earlier the required Business Intelligence skills overlap with foundational Database Management and DW skills. At the same time in this skill set there are specific requirements like experience with dashboards, scorecards metrics; querying, reporting; data mining and metadata management. One of the most important skills here is the ability to work with SQL and specific software like Oracle, Tableau, MS Power BI or IBM Cognos. In many job positions two or three of these software programs are required as a minimum.

According to the investigations conducted by some authors (Shirani, A. and Roldan, M., 2009) we can list the top ten BI skills and their rank (table 2).

**Table 2.**

Top Ten Business Intelligence Skills

Rank	Knowledge / Skill	Percent
1	OLAP; querying; reporting	68.3
2	Extract, transform, and load (ETL)	58.3
3	User requirements; project management	55.0
4	Dashboards; scorecards; metrics	43.3
5	Dimensional modeling, DW architecture	41.7
6	Analytics; data mining	38.3
7	UNIX; Linux	36.7
8	SQL; P:/SQL; other programming languages	36.7
9	Security	31.7
10	Metadata management	28.3

BI and DW job positions usually require a Bachelor or Master degree in Computer Science, Informatics, Computer Engineering, Business Information Systems, Accounting, Mathematics or an equivalent program. More complicated jobs may require a master's degree in Business Analytics, Machine Learning or Business administration.

Professionals in the field of BI and DW should be able to conduct interviews and gather the needs, motives and desired outcomes for the BI environment they are going to build. An important requirement is the ability to present complex ideas in a clear, concise fashion to technical and non-technical audiences. They should have very good communications skills and macro - perspective, e.g. to adopt a different perspective or mind set. BI specialists need to look at recent data trends and recommend solutions for increasing profit and reducing loss, so they should be able to solve different kinds of problems.

**Based on the analysis presented, we can conclude that DW and BI specialists usually should have some of these skills:**

- technical skills – experience with specific tools and technologies like DBMS

(such as MS SQL Server, Oracle, IBM DB2, Apache Hadoop, MySQL), ETL tools (such as SSIS, Informatica, Pentaho), Reporting tools (SSRS, SSAS, IBM Cognos, Business Objects) and BI tools (such as MS Power BI, Oracle BI Enterprise Edition, IBM Cognos and Tableau).

- analytical skills – ability to break down a series of complex data and bits of information, to view and analyze different situations from a very logical perspective, to develop an overall conclusion, and to find solutions for problems of advanced complexity.
- “soft” skills – such as organization and time management skills, communication skills, active listening and active learning.

## **2. Inquiry on existing curricula in the field of Business Intelligence and Data Warehouse. Parameters of implementation of these programs**

The investigation of the current state of the existing curricula in the field of Business Intelligence and Data Warehouse is necessary in order to build a fuller picture of different parameters such as the place where these programs are offered, delivery time, terms of implementation and learning outcomes. The analysis should provide a brief inquiry about universities which offer disciplines, full courses or degree programs in selected area.

As a starting point in the current paper, we used the last report of BI Congress (Wixom, B., Ariyachandra, T. and Mooney, J., 2013) – The State of Business Intelligence and Business Analytics in Academia 2012, that summarizes data for 319 universities in 43 countries. Most of the universities, included in the survey, are in the USA (206) and the rest are in Australia (11), Belgium (1), Brazil (3), Canada (7), China (6), Croatia (1), Czech Republic (1), Denmark (2), England (1), Finland (2), France (5), Germany (19), Greece (1), Hong Kong (2), Hungary (1), India (4), Ireland (1), Israel (1), Jordan (1), Korea (1), Latvia (2), Malaysia (1), Mexico (3), New Zealand (2), Norway (3), Oman (1), Peru (2), Poland (2), Portugal (2), Russia (2), Scotland (2), Serbia (2), Singapore (2), Slovenia (3), South Korea (1), Spain (1), Sweden (1), Switzerland (4), Thailand (1), The Netherlands (1), Turkey (1), UAE (1).

According to the survey, 173 universities offer Business Intelligence (BI) / Business Analytics (BA) embedded within another course at the undergraduate level and 141 at the graduate level. 153 universities offer full course in BI/BA at the undergraduate level and 165 at the graduate level. 47 universities offer concentrations/majors in BI/BA at the undergraduate level and 74 at the graduate level.

Over 41% of the surveyed universities reported an increase in the size of their BI/BA course portfolio compared with the 2010 survey.

Based on these data we can conclude that **student interest in the field of Business Intelligence and Business Analytics is growing. Many universities start new courses and programs in BI / BA area, including universities in Bulgaria.**

46% of the university respondents offered “Data Mining/Predictive Analytics” courses. This is the most reported course offering category. 45% offered “BI/BA – Introduction” course in their programs. Other BI/BA courses are Statistics (44%), Quantitative Analysis / Modeling (41%), Introduction to IS (41%), Data Warehousing

(39%), Data Management (37%), Decision Support (34%), IT Management / IT Strategy (29%), Data Integration / ETL (21%) and others.

As we can see, the *Data Warehousing* course is offered by 39 % of the participating universities. However, our brief survey on the Internet shows that “Data Warehouse” is covered more often as a part of the program with title *Business Intelligence* or similar and rarely occurs as a title or part of title into a separate discipline. For example, in universities like Carnegie Mellon University, Pittsburgh, which has 6 units about Data Warehousing in a course under the name *Business Intelligence & Data Analytics* and University of Westminster, London, where *Data Warehousing and OLAP* is an option module in a master degree program titled Business Intelligence and Analytics.

It is important to know what **academic disciplines and departments** are involved in delivering BI or BA courses. In this sense according to the earlier mentioned report of BI Congress 76% of the BI/BA courses are taught by the MIS/IS/IT discipline, followed by Statistics (28%), Decision Sciences (23%), Marketing (19%), Computer Science (17%), Accounting (10%), Finance (9%), QA (7%) and other university departments.

**The delivery time** of courses in BI and DW area usually takes 1 year or even shorter in case with online delivery type. The analysis is based on an inquiry on the website <http://www.mastersindatascience.org/> with search about Business Intelligence Master’s Degrees.

The expected learning outcomes in selected BI and DW programs generally include skills and abilities to:

- develop skills of inquiry, analysis, interpretation and synthesis necessary for the successful design, implementation and management of Business Intelligence;
- understand the key technologies used in Business Intelligence;
- develop knowledge of data analytic tools and techniques;
- extract, cleanse, consolidate, and transform heterogeneous data into a single enterprise data warehouse;
- systematically extract relevant data from a database, integrate and process data from multiple sources ready for data analysis;
- use computing methods, tools and techniques to solve a range of practical problems;
- select and use appropriate software tools for Report/Dashboard development.

Based on our research in 5 universities (University of Westminster, Carnegie Mellon University, Saint Joseph’s University, Stevens Institute of Technology, Nova Information Management School) **we can conclude that the main modules in BI programs in most cases include similar units like:**

- Foundations for Business Intelligence
- Business Analytics / Performance Management / Economic Analysis
- Database Management Theory and Practice
- Decision Support Systems (DSS) / decision modeling
- Data Warehousing / Data Warehousing and OLAP / Data Warehousing and Business Intelligence
- Data Mining
- Statistical Learning & Analytics / Statistics and Operational Research
- Knowledge Management

- Management Issues in Business Intelligence

This conclusion is useful for further purposes, related to the development of new curricula in the field of Business Intelligence and Data Warehouse.

### **3. Develop guidelines for new and innovative teaching curricula in the field of Business Intelligence and Data Warehouse**

Based on the research made concerning the education and tendencies in BI / DW sector, we can offer concrete guidelines for the new and innovative teaching curricula in the field of BI and DW. It is necessary to notice the main challenges encountered by universities offering BI / BA/ DW or similar programs and some suggestions for their complex improvement.

In the above-mentioned report of BI Congress we can find interesting replies to the question “What are the greatest challenges you face in delivering BI/BA within your curriculum?”. Almost one half of the universities have indicated “*access to data sets*” (45%) (Wixom, B., Ariyachandra, T. and Mooney, J., 2013) as the greatest challenge.

Other challenges mentioned in the report include:

- Students do not have the skills (39%);
- Finding faculty who can teach the content (35%);
- Students’ aversion to statistics (33%);
- Finding a suitable textbook (33%);
- Finding suitable cases (31%);
- Staying current with practice (29%);
- Lack of scholarships for students to study the area;
- Teaching students from multiple disciplines.

**Based on this research and our own investigation in different universities offering BI and DW courses or disciplines, we can find some basic flaws and give our suggestions:**

1. Most BI programs don’t offer curriculum online or, if they offer it, it doesn’t contain clear and detailed information about the content of the course and themes. This is especially true for Bulgarian universities.

2. BI courses require suitable textbooks and online materials, but still few universities have an education and communication platform or website with unrestricted access to educational resources. It is important to create an online platform which will include rich material base with the manuals, tutorials, interactive books and tools necessary to implement and realize the methodology of BI and DW.

3. The use of real/realistic datasets is essential. A good idea is to use the same realistic dataset with different BI software products and after that to analyse the received outcomes.

4. BI curriculums should pay attention to different methods and tools and have to be clearer about the business value and the importance of BI.

5. The units (modules) should provide a more detailed description of the educational content. For example, the unit about *Predictive analysis* may be described in this way:

Compare and contrast different predictive analysis methods like:

- *Classification* – Linear Discriminant Analysis (LDA), Decision Trees, Perceptron Algorithm, Back Propagation Neural Networks

- *Regression* (Function Approximation) – Multiple Linear Regression, Neural Networks

6. It is a good idea to provide step-by-step tutorials for students. Easy software installation for students, so that they can also work at home.

#### **4. Development of a graduate profile with knowledge, skills and social competence in the field of Business Intelligence and Data Warehouse**

There is a growing demand for specialists that can develop and implement BI solutions and DWH projects in order to improve processes and to support better strategies. The forecast is that in the next decade this trend will continue. In this regard BI and DWH course are focused on developing in-depth knowledge and skills about the essence of Business Intelligence and DW/BI system deployment, support and growth. The program also incorporates knowledge about dimensional modeling, data mining, predictive analysis methods and statistical analysis. In this regard, each BI / DW curriculum must be accompanied by a clear and comprehensive graduate profile with knowledge, skills and social competence in the field of BI and DW.

BI data can include historical information (typically stored in a data warehouse or smaller data marts), as well as current data gathered from different sources. Thereby the BI analysis can be used to support both strategic and tactical decision-making processes.

The BI / DW course **should teach students to use more effective different tools for BI analysis and to take decision on the application for specific business organizations.**

**The course purpose /goals/** can be present in this way:

The key aims of the course are to:

- provide knowledge and skills about a wide range of topics in Business Intelligence, with a particular emphasis on DW development and use and the issues associated with mining, integrating and analyzing both unstructured and structured data;
- develop skills of analysis, critical thinking, synthesis and the ability to solve complex problems;
- make students understand the role of analytical applications and BI tools of information visualization.

**We suggest that the intended learning outcomes be described in the following categories:**

1. Knowledge and understanding

- understand the key components, principles and concepts of BI;
- systematic knowledge of the nature, architecture and design of the DW;
- understand the capabilities of decision support processes enhanced by the use of BI and DWH support;
- knowledge of open source BI tools and different data analytics techniques;

- understand how relational and dimensional data are organized, cleansed, transformed, stored, and accessed with a variety of tools including dashboards and scorecards.
2. Intellectual and practical skills
- develop skills of inquiry, analysis, interpretation and synthesis necessary for successful design, implementation and management of Business Intelligence;
  - analytical skills to identify new business opportunities or identify inefficient business processes;
  - develop skills of dimension modeling;
  - ability to use different data mining algorithms and techniques;
  - ability to use different open source BI tools;
  - skills in Data Integration and ETL (Extract, transform and load)
  - skills in Dimensional modeling, DW methodologies and DW architecture.
3. Social competence
- the BI/DWH course enables students to develop very good communication skills: written, verbal and presentation abilities to explain the results effectively, as well as to work as part of a team through different exercises and group activities;
  - develop detail-oriented persons with very strong analytical, number and problem solving skills;
  - students will cultivate organization and time management skills.
- After successfully completing the course, students will be able to find work as:
- Business analyst / BI analyst
  - Business Intelligence developer / consultant
  - Data Warehouse architect / manager
  - Data miner / analyst
  - Data scientist / researchers or tutors in academic institutions
  - Management / Marketing consultant

## 5. Conclusion

Based on the findings of this study, several conclusions can be drawn. In order to meet the growing market needs for specialists in the fields of Dimensional Modeling, Business Analytics and DW architecture, higher education institutions have to improve and periodically update their BI / DW course content.

Publishing online a clear and comprehensive information about the curriculum aims, content, learning outcomes and teaching methods used are essential to provide greater competitiveness and accessibility to the education offered.

At the same time universities should seek various opportunities for collaborative projects with businesses, in order to ensure better compliance of the material taught with the real needs of businesses.

Using a range of appropriate realistic datasets and case studies, as well as problem-based learning scenarios will help with developing solid analytical and problem solving skills. In addition to this, it is a good idea to use the same dataset with different BI software products and then analyse the outcomes.

The services offered in the Business Intelligence field are rapidly evolving, which requires universities to be more flexible and adaptable to the changing environment.

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