SELF-SERVICE BUSINESS INTELLIGENCE FOR HIGHER EDUCATION MANAGEMENT

Dejan Zilli,
International School for Social and Business Studies, Slovenia
dejan.zilli@vizija.si

Abstract:
Higher education institution management faces the challenge of improving study process quality and efficiency. Employable graduates are the result every education institution wishes to produce. Graduation rate is therefore crucial key performance indicator (KPI) important in many national models of financing higher education institutions. To achieve performance improvements of institution undergraduate retention rate has to be measured and analysed. Unfinished coursework indicates problems in the study process which management can correct with assignment of extra academic workload to faculty staff. Principles of equity and transparency have to be considered in the academic workload management process. Information technology (IT), in particular self-service business intelligence (BI) can help management with timely and relevant information about study process. In this case study of designing a data warehouse for higher education management the use of different KPI's is discussed. Dimensional models of proposed BI solution are presented. Future research will include assessment of relative technical efficiency of higher education institution, prediction of undergraduate retention and analysis of obstacle for successful graduation.

Keywords: information technology, business intelligence, higher education management, key performance indicators

1. HIGHER EDUCATION MANAGEMENT AND EFFICIENCY

Optimal management of the higher education institution consists of processes dealing with funds and resources (students and employees). All of these categories can be monitored as input variables and as the processes by which they are transformed into output variables. The most important is the teaching process, which can be improved by the provision of timely and relevant information for decision making.

The efficiency of the study process can be measured by the student graduation rate, which is an important criterion in several national models of financing higher education institutions. To assess the relative technical efficiency of higher education is recently mainly used non-parametric approach, namely method of linear programming called DEA (Data Envelopment Analysis). Examples of application of the method are found in the research of Thanassoulis et al. (2010) and Aristovnik and Obadić (2011). This aspect of the efficiency of the study process ignores that the graduation rates are under the influence of external factors which are beyond the control of decision-makers at higher education institutions, which is taken into account in the study of Sav (2012).

De França et al. (2010, p. 50) state important input and output variables in evaluating the efficiency of higher education institutions such as the number of graduates, the number of registered candidates, the number of enrolled students, the number of professors with doctoral degrees, the number of support and administrative staff and the number of majors offered. The importance of performance indicators can be identified by means of Bayesian networks. Fernández et al. (2011, p. 332) recognize the importance of indicators such as the exam performance rate, the number of students in theoretical and practical lectures, lecturer evaluation by students, percentage of full time students etc. An important indicator that affects the student graduation rate is undergraduate retention rate, which can be predicted on the basis of students' demographic data (Ash, 2004).

The biggest responsibility for the efficiency of the study process is on the academic staff of the higher education institution. Management of the institution can have the influence through the process of academic workload management. Comm and Mathaisel (2003) illustrated how information regarding academic workload can be used to improve academic quality. The goal of managers is to achieve maximum efficiency and quality of the study process. One of the more difficult tasks in this process is measuring different components of academic workload (Barlas & Diker, 2000). Houston, Meyer and Paewai (2006) discussed several workload allocation models and their implementation issues. Measuring academic workload to provide equitable workload distribution and adequate compensation, consequently improving academic quality, implies the use of some kind of performance rating system (Burkholder, Golas, & Shapiro, 2007) based on university regulations and policies.

Decision support systems and data warehouses, on which they are based, represent a frequent and appropriate IT solutions for planning and measuring academic workload, see Mansmann and Scholl (2007), Zilli and Trunk-Širca (2009). The main data source for data warehouses represent academic information systems (Sastry, 2007). For systematic implementation of education criteria for performance excellence it is necessary to identify and develop specific key performance indicators (Asif, Raouf, & Searcy, 2012). In any system for measuring the academic workload it is important to consider the faculty perception of effort associated with a variety of teaching assignments (Keys & Devine, 2006). The principles of equity and transparency have to be considered to achieve optimal distribution of workload between faculty staff (Barrett & Barrett, 2010) in order to maximize productivity, quality, funding and grading of higher education institution (Burgess, Lewis, & Mobbs, 2003).

2. SELF-SERVICE BUSINESS INTELLIGENCE

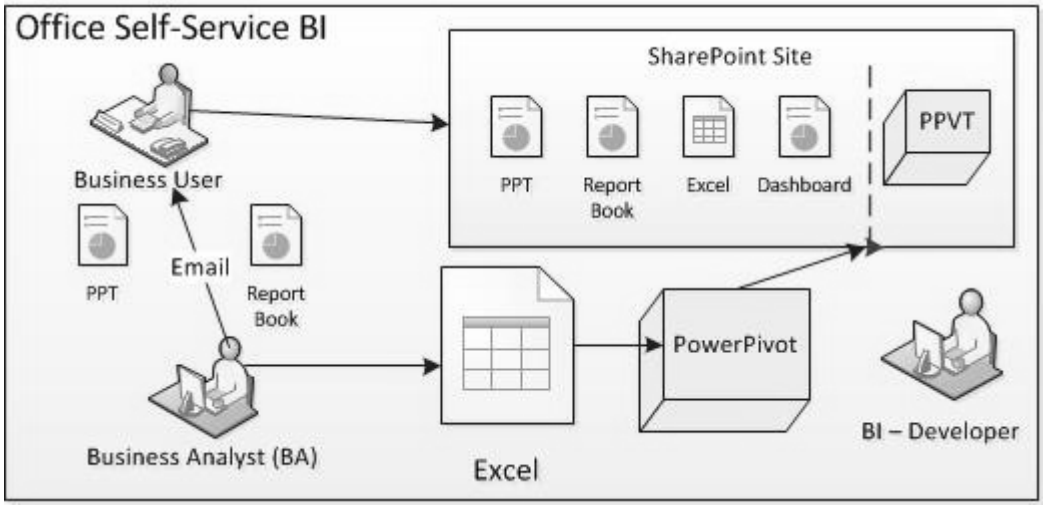
According to Gartner IT Glosary self-service business intelligence (BI) is defined as end users designing and deploying their own reports and analyses within an approved and supported architecture and tools portfolio[1]. The idea behind this is to give individuals and workgroups in

[1] http://www.gartner.com/it-glossary/self-service-business-intelligence

organisations more control and enable them to serve their own reporting needs with as little as possible assistance of IT personal or BI teams.

One of the most complete offerings in this field is part of Microsoft Office 365[2]. Excel provides data discovery, analysis, and visualization capabilities that help users identify deeper business insights from their data. Power BI for Office 365[3] provides an easy-to-deploy cloud-based BI environment for users to share, collaborate, and access data and reports from anywhere. Complete Microsoft BI stack including SharePoint makes an ideal platform for creating and distributing report books. Excel also provides capabilities for predictive analysis with the Data Mining Add-ins.

Picture 1: Microsoft Office Self Service BI



Source: http://blog.bluemetal.com/?p=4771.

3. CASE STUDY METHODOLOGY

A BI solution was proposed by management of a higher education institution as a part of ongoing quality assurance initiative. This paper represents a case study of resulting BI implementation.

Goals set for quality and efficiency were first considered which helped to identify key business problems for BI solution for which management sponsorship was obtained. Focus group was used to identify information requirements for identified business problems as well as for definition of key performance indicators (KPI). Data sources were then analysed for existence and quality of data. Technology for the BI solution was then chosen. Next dimensional modelling was executed and data was warehouse designed. Designed dimensional model was then populated through data transformation and cleansing procedures. Data analysis and visualization tools were used to present key performance indicators to the users, mainly to the management and administrative staff.

4. KEY PERFORMANCE INDICATORS

Employable graduates are the most important goal of every higher education institution. Graduation rate is therefore crucial indicator of institution success. But graduation rate is overall KPI showing final results of the study process. When the result is known it is already late to influence the process to achieve performance improvements. That's why it is better to track undergraduate retention rate, which can be predicted in advance even at the beginning of academic year (Ash, 2004). But better prediction is possible during academic year taking into consideration coursework finished by the

[2] Microsoft is of the leaders according to Gartner's Magic Quadrant for Business Intelligence and Analytics Platforms

[3] http://office.microsoft.com/en-us/office365-sharepoint-online-enterprise-help/power-bi-for-office-365-overview-and-learning-HA104103581.aspx

students. Those students which promptly meet their academic obligations are much more likely to advance to the next year of study than the rest. The type of unfinished coursework measured in credit points can show possible quality and efficiency problems in the study process. Management of the higher education institution can make necessary changes in the study process and assign extra academic workload needed to help students finish their coursework.

In order to allocate academic workload to faculty staff considering principles of equity and transparency some kind of equity weighting measurement system has to be introduced. Equity weights for different workload items transforming workload units into working hours are based upon academic workload policy of the higher education institution. Number of courses, lecturing hours, number of students and similar measures describing the study process are workload items, number of working hours per item are equity weights (Zilli & Trunk-Širca, 2009, p. 183).

Several KPI's and measurements were proposed by management of higher education institution to track intermediate results of study process. Next table shows main KPI's and measures used in case study for evaluation of study process efficiency. Measurement used in most of listed KPI's was average age of students contributing to listed measure (by the time of measurement and by the time of student enrolment into study programme).

Table 1: Study process KPI's

KPI	Measurement	Unit
Students enrolment	Student application	Number of students
	Student acceptance	Number and % of students
	Student enrolment	Number and % of students
Exam performance rate	Percentage of success	% of successful exams
	Exams until success	Number of exams (avg., max.)
	Average grade	1 – 10
	Average positive grade	6 – 10
Coursework	Earned credit points	Credit points
	Missing credit points	Credit points
	Missing credit points for progression*	Credit points
Undergraduate retention rate	Undergraduate student retention	% of students
	Planed enrolment**	Number of students
Graduation rate	On time graduation rate	% of students
	Average time to graduation	Years
	Average extra time to graduation	Years
	Average time of graduation	Months
Academic workload	Course preparation workload	Working hours
	Lecturing workload	Working hours
	Consulting workload	Working hours
	Grading workload	Working hours
	Mentoring workload	Working hours

* - credit points missing for progression to the next year of study (progression requirements)
** - calculated from retention probability derived from other measures (e.g. from missing credit points)

5. DIMENSIONAL MODEL

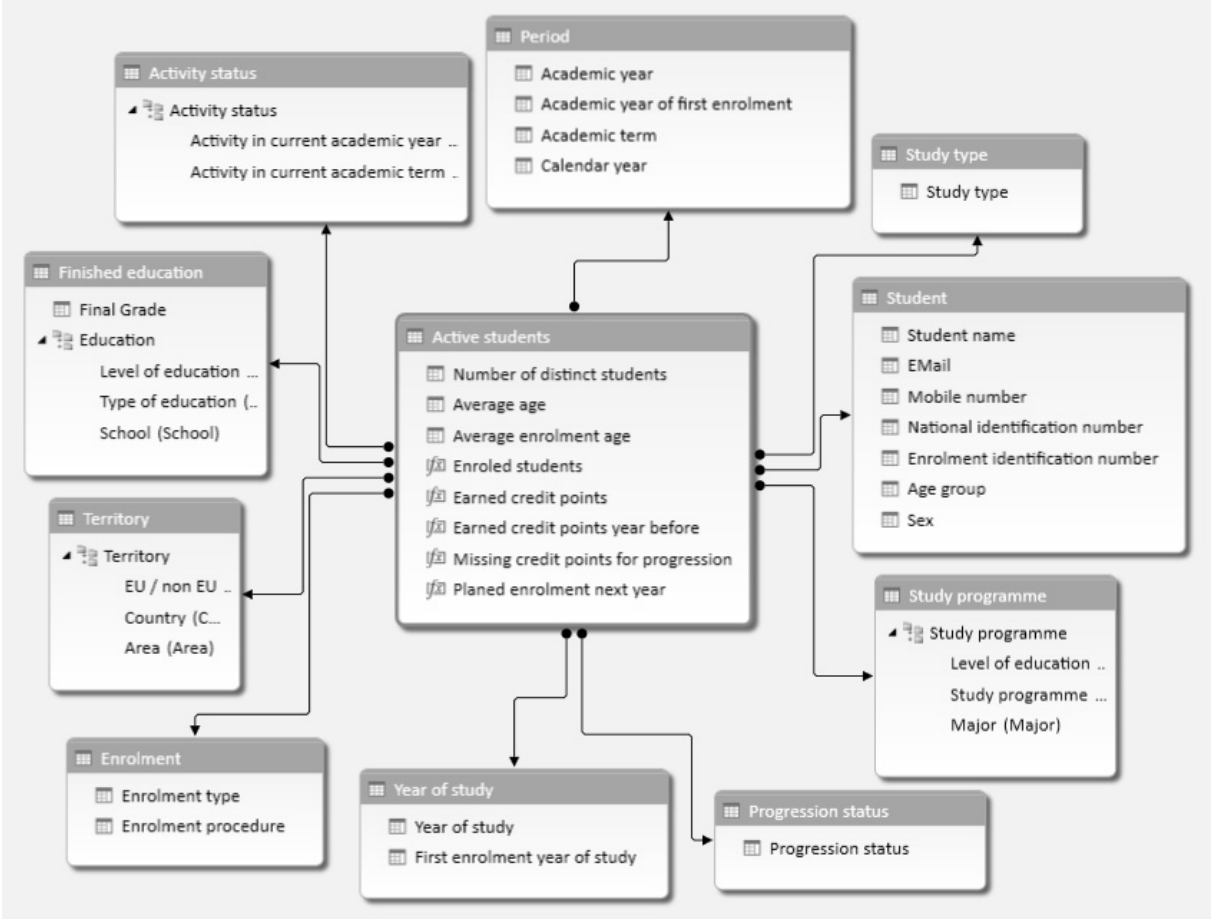
Dimensional model consists of measures and dimensions linked together into measure groups (measures with the same linked dimensions). Dimensional modelling was done within Excel PowerPivot modelling tool. Next table shows main dimensions in dimensional model.

Table 2: Study process dimensions

Dimension	Hierarchy/property
Finished education	Level of prior finished education
	Type of prior finished education
	School of prior finished education
	Grade of prior finished education
Study type	Study type (full time, part time)
Year of study	First enrolment year of study
	Current year of study
	Last enrolment year of study
Student	National identification number
	Enrolment number
	Name
	Sex
	Age (age group)
	Status (enrolled, active, finished)
Study programme	Level of education
	Study programme
	Major
Period	First enrolment academic year
	Current academic year
	Current academic term
	Last enrolment academic year
	Calendar year
Activity status	Activity status in current academic year
	Activity status in current academic term
Progression status	Progression status (progression requirements)
Territory	EU / non EU
	Country
	Area
Study unit (course)	Type of course
	Course
	Coursework
Grade	Type of grade (positive / negative)
	Grade
Graduation type	Graduation type
Enrolment	Enrolment type
	Enrolment procedure
Academic workload	Type of academic workload
	Unit of academic workload
Type of workload measure	Type of workload measure (planed, actual)
Academic staff	Rank
	Name

Combination of measures and dimensions makes dimensional model. Dimensional model is organized into perspectives which correspond approximately with KPI's. There are several perspectives in dimensional model: student admission, student enrolment, coursework, credited coursework (credit points), active students, graduation and academic workload. Next picture shows dimensional model of one of the perspectives.

Picture 2: Active students perspective of dimensional model



Academic workload perspective is different from other perspectives because it focuses on the academic staff, not as much on students. Results of study process from other perspectives are used to measure academic workload. Dimensional model was adopted from prior academic workload management case study, see Zilli and Trunk-Širca (2009, p. 185).

6. FUTURE RESEARCH

Future research will be conducted in two directions. First impact of BI on relative technical efficiency of higher education institution will be assessed. Method of linear programming called DEA (Data Envelopment Analysis) will be used for this purpose (Aristovnik & Obadić, 2011; Sav, 2012). Results from the period without BI support will be compared with results from the period of full use of the BI solution. Other possible influences on efficiency will be assessed using focus group consisted from higher education institution management.

Second part of the research will be focused on prediction of undergraduate retention and detection of obstacles for successful graduation. Data mining methods will be used for prediction and obstacles analysis. Prediction of undergraduate retention rate will help with prediction of next year enrolment, currently done with fixed calculation using variables of missing credit points and corresponding probability of next year enrolment. Probability could be determined out of historic data. Other factors impacting next year enrolment plan could be determined as well.

Findings of the research cannot be generalized for different higher education institutions. Factors as size, study field, funding, regulations and policies of higher education institution, as well as other, undoubtedly influence management information requirements and choice of methods used. Therefore additional research is necessary to extend the use of results to different higher education institutions.

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