

# IMPLEMENTING A BUSINESS INFORMATION SYSTEM TO IMPROVE THE QUALITY ASSURANCE MECHANISMS IN A PORTUGUESE HIGHER EDUCATION INSTITUTION

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## Abstract

Higher education institutions (HEIs) face, nowadays, enormous challenges to be competitive in a global world. The competitive environment means that HEIs, like other organizations, must be concerned with evaluating and monitoring their strategic objectives.

Business Information (BI) systems combine different sources of information, from different information systems (IS), with analytical tools to present competitive information to planners and decision makers. In this way, BI systems emerge as tools that allow institutions to create future competitive advantages.

This paper presents a case study of a Portuguese HEI, describing the implementation of a BI system to support the quality assurance system, and to improve its future strategy. This study focuses on one of the three HEI mission vectors: Teaching and Learning.

As a result of this work, it was possible to parameterize the BI system, and to identify the digital information missing in the IS, and the necessary developments to collect it.

Keywords: Business Intelligence Systems, KPI, BI, HEI, performance indicators, learning and teaching.

## 1 INTRODUCTION

The interest in using key performance indicators (KPIs) by HEIs has grown in the last two decades, based on the HEIs self-awareness that quality is a holistic and critical success factor that needs to be measured. KPIs are quantifiable values that can show how HEIs are achieving their institutional objectives.

Some guidelines and rules about KPIs in HEIs have been developed by different organizations [1]–[3]. Although each institution should select the right set of KPI according to its specific strategy, two general points warrant emphasis:

First, HEIs should use KPIs for different purposes:

- 1) to monitor their performance and strategy;
- 2) to assist the assessment and evaluation of their processes in a holistic way;
- 3) to provide information for external quality assurance audits;
- 4) to inform all the stakeholders about the status of the institution.

Second, that there are two prerequisites for developing a successful KPIs system:

- 1) an explicit institutional quality policy and plan;
- 2) the existence of IS that can provide the necessary information to feed the indicators.

The efficient use of KPIs should be supported by dashboard reporting information systems (IS). There are different types of IS to monitor organizational performance and support decision-making. In the last years, Business Intelligence (BI) systems have been adopted by different kinds of organizations, allowing the collection of pertinent information and its conversion into knowledge upon which actions can be taken. HEIs are using BI systems in different contexts to create KPIs dashboards supporting the decision process at different institutional levels.

This paper presents a case study of a Portuguese HEI, describing the implementation of a BI system to support the quality assurance system, and to improve its future strategy. This study focuses on one of the three HEI mission vectors: Teaching and Learning.

The project followed different steps: mission, strategy and processes analysis, KPIs identification, KPIs validation by the process owners, identification of the IS in use in the institution, identification of the existence of the necessary information in these systems, definition of the access profiles, according to the different process users and the selection and implementation of the BI technological solution.

A set of KPIs was defined through a literature review, the guidelines and rules from different organizations (EUA, UNESCO and the national HEI Evaluation and Accreditation Agencies), international standards, and the institution's vision and mission, as well as the first-hand knowledge and personal experience of the authors, owing to 12 years of management roles in the Teaching and Learning vector processes.

The paper is divided into six sections. The second section presents a literature review of KPIs in HEIs. The third one discusses the use and advantages of BI systems. The HEI is described in the fourth section, and the case study is detailed in the fifth section. The last section presents the main conclusion and ideas for future work.

## **2 KPI IN HIGHER EDUCATION INSTITUTIONS**

The use of KPIs in HEIs is not new and in the 1980s much work was done on this subject [4], [5]. In 2001, UNESCO produced a study on higher education performance indicators, following the 1998 World Conference on Higher Education [2].

In Europe, the subject of quality assurance in HEIs gained particular relevance with the recommendation 98/561/EC, adopted in 1998 by the Council of the European Union, on the introduction of quality assurance mechanisms in all European Union countries.

The interest in this theme has grown in the last two decades, based on the HEIs self-awareness that quality is a holistic critical success factor that needs to be measured, also due to the increasing demand for quantifiable evidence that higher education is worth the cost.

Today many countries possess a set of indicators, which allow the assessment of the degree to which HEIs reach their goals; these dashboards result from guidelines and rules from different organizations (EUA, ENQA, UNESCO, HEIs Evaluation and Accreditation Agencies) and international standards [6]–[10].

Although having different characteristics, an indicator system aims to inform all the stakeholders on the status of the HEI, monitor its progress and manage it [1], [11]. Furthermore, it should cover all the processes supporting the HEI mission: teaching and learning, research and interaction with society.

When developing KPIs systems, different factors should be considered to ensure that, they really bring value to the institution: they must be aligned with the institutional strategy and its objectives; they should require data that can be easily obtained; such data should be reliable and accurate; and they must be actionable.

## **3 ADVANTAGES OF BI SYSTEMS**

IS have been shown to be relevant for organizations to monitor organizational performance and support decision-making, existing different types of systems: from the early MIS (Management Information Systems) through DSS (Decision Support Systems), EIS (Executive Information Systems), GDSS (Groupware Decision Support Systems) and the more recent Business Intelligence (BI) systems.

Initially, MIS treated operational data and arranged them into predefined reports, DDS already incorporated decision models to help decision-making, and EIS related the operational data resulting from the day-to-day activity of organizations with external data to support executive decision-making.

BI is a broad category of applications and technologies for gathering, providing access to, and analyzing data for helping enterprise users make better business decisions [12]–[16].

BI systems stand out from the aforementioned systems by using simple or complex techniques of data statistical analysis, neural network techniques, techniques to access large volumes of data from various types of sources in real time, and databases with dimensions of aggregation and navigation, as well as graphic and web interfaces with the end user.

In BI systems, data from different sources are stored in an integrated data warehousing. This data can come from databases of the organization's other information systems, spreadsheets, external files from other organizations, or partners and the Internet.

The analytical capabilities of BI systems can revolutionize organizations and enable them to leverage the potential of historically stored data

These systems are also characterized by the fact that end-users can have a non-technical profile and be able to perform the analytical analysis of the data autonomously, providing them with the knowledge they need.

BI systems are changing the ways organizations manage and make decisions and carry out their tasks [16]. According to Gartner Group, analytical capabilities will remain a strategic technological trend in providing organizations with intelligence (<https://looker.com/gartner-magic-quadrant>), which attests to the usefulness of systems with such capabilities.

## **4 HEI CHARACTERIZATION**

*Universidade Portucalense* (UPT) is a private HEI created in June of 1986, located in Porto (Portugal). UPT is organized into five Departments: Law; Economics and Management, Science and Technology; Heritage and Tourism; and Psychology and Education, teaching 1st, 2nd and 3rd cycle, as well as non-degree programs. Today UPT has 3000 students. As a private institution, its main governance structure is divided into a Board and a Rector.

The University has unambiguously assumed the principle that quality and quality assurance are one of the fundamental vectors for its operation and development.

Having its continuous improvement in mind, the University has implemented an internal quality assurance system (IQAS). In this context, the University decided, at first, to focus on Quality Certification through the implementation of NP EN ISO 9001:2008. The system was certified in December 2014. During the year 2017, the new NP EN ISO 9001: 2015 was implemented, and the system is now certified by this standard.

In 2017 UPT submitted its IQAS to a certification process by the Portuguese Agency for Assessment and Accreditation of Higher Education - A3ES; the system was certified for six years, in December 2017.

The IQAS includes, among others, the monitoring of processes as a way of continuously improving UPT's activities. UPT has identified its processes and has established methods for their operation, control and monitoring, which are reflected in the process map contained in the quality management manual and in the performance monitoring plan which already includes a set of KPI. The processes are the matrix of the structure of the IQAS, and its performance measure is decisive for UPT quality assurance.

The process map was built following the Porter idea of the value chain, and is divided into primary and support processes. There are seven primary processes: Marketing and Communication, Design and Development, Teaching Management, Innovation, Research and Development, Application Management, Enrollment Management, and Skills and Careers Management.

## **5 CASE STUDY DESCRIPTION**

The BI implementation process went through several stages: i) analysis of the business processes, as well as of the HEI's mission and strategy; ii) analysis of the pre-existing indicators for each processes; iii) literature review to identify and define the KPIs; iv) KPI validation by the members of staff responsible for each process and ensuing adjustments to the list of KPIs resulting from the validation; v) identification of the information systems implemented by the institution; vi) analysis of the information systems to identify the necessary information sources for the KPIs; vii) definition of the users access profile, and viii) selection and implementation of BI technological solution.

### 1. Analysis of business processes and the institution's mission and strategy

All the processes are already properly modeled in accordance with the IQAS. Therefore, this phase consisted in the detailed analysis of the five processes supporting the Teacher and Learning vector, selected to start the BI implementation, which are: Design and Development, Application Management, Enrollment Management, Teaching Management, and Skills and Career Management.

### 2. Analysis of existing indicators

The authors analyzed several existing internal documents, such as performance monitoring plan, activity plans and reports, rectory decrees and regulations to identify the KPIs already used by the institution. The identified KPIs were associated with their specific process and goals.

### 3. Literature review and definition of the KPIs

The existent KPIs list was updated based on the literature review, the HEI KPIs purpose and taking into account the authors' management and teacher experience. This work resulted in a list of KPIs for each process under analysis in this case, showing also its goals.

### 4. Validation and redefinition of KPIs

The list of KPIs was sent to the institutional CEO for distribution to the staff members responsible for each process, to ensure that they cover all present and future needs of the institution. After reflection and individual analysis, the CEO met with the authors to approve the final list of KPIs that will be implemented. The discussion led to the introduction of two new KPIs, the elimination of one KPI and the change of the designation of three. The final list is presented in Tables 1 to 5.

### 5. Identification of the information systems implemented by the institution

The authors met with the director of the information systems area, and all the information systems currently implemented in the institution were inventoried. Only three (SIUPT, MOODLE and PHC) give support to the Teaching and Learning vector.

### 6. Analysis of the sources of information needed

Following the validation and reset phase of the KPIs, together with the IS director, the authors identified which systems feed each of the considered KPIs. Tables 1 to 5 present this information.

### 7. Definition of the user's access profile

The responsible for each process/activity are defined in the IQAS. Those are: CEO, Rectory, Pedagogical and Scientific Councils, Head of Departments, Course Coordinators, Teachers, Admissions Office Coordinator, Enrollment Office Coordinator, and Student Support Office Coordinator. According to the different roles, the access permissions to the BI systems were defined.

### 8. Selection and implementation of BI technological solution

There are several technologies in the BI domain that could be used for the implementation of this project. Qlik Sense software was selected based on two factors: Gartner's magic quadrant for BI solutions and the knowledge of UPT's IS development team. Some dashboards have already been developed, and a first presentation was made to the CEO.

*Table 1. Design and Development process: KPIs list by goal, showing IS support.*

Goal	KPI	IS
Enhance effectiveness and profitability in the development of new course offerings	Number of new degree courses	SIUPT
	% of weight of the new course in total applicants	SIUPT
	Number of new non-degree courses	--
	% of evolution of applicants in the new courses in years N and N-1	SIUPT
	% of courses accredited by A3ES	Excel
	Number of undergraduate degree courses discontinued	SIUPT
	Number of non-degree courses discontinued	--
	Number of degree courses	SIUPT
	Number of non-degree courses	SIUPT
	Nº of courses offered by more than one Organic Unit	SIUPT

Goal	KPI	IS
	Number of contact hours per course	SIUPT
	Number of Curricular Units (CU) taught by teacher per course	SIUPT
	Number of courses taught in English	SIUPT
	% of courses in association with other national HEIs	--
	% of courses in association with other international HEIs	--
	Curriculum Flexibility Rate	SIUPT

*Table 2. Application Management process: KPIs list by goal, showing IS support.*

Goal	KPI	IS
Enhance the search and entry qualification in the course	Number of vacancies by access type	SIUPT
	Nº candidates by access type	SIUPT
	% of candidates by access type	SIUPT
	% of candidates relative to the number of students	SIUPT
	% of evolution of applicants in each course in years N and N-1	SIUPT
	Minimum entrance mark by course	SIUPT
	Average entrance mark by course	SIUPT
	Maximum entrance mark by course	SIUPT
	% of 1st cycle candidates by entrance exam	SIUPT
	% of 1st option candidates	SIUPT
	% of candidates by geographic origin	SIUPT
	% of candidates for non-degree courses by geographical origin	--
	Number of candidates by non-degree course	SIUPT
	% of candidates for non-degree course by qualification	--

*Table 3. Enrollment Management process: KPIs list by goal, showing IS support.*

Goal	KPI	IS
Maximize the filling of vacancies by course	% vacancies filled by access type	SIUPT
	% of 1st option enrollment	SIUPT
	% of new 1st year students	SIUPT
	% of new 1st year students at UPT	SIUPT
	Nº of enrollments by access type	SIUPT
	Total number of 1st year students by entrance exam	SIUPT
	Enrollment Fee Rate	SIUPT
	Number of 1st time enrollments	SIUPT
	Number of students enrolled in cycle n + 1 who completed cycle n at UPT	SIUPT
	Number of students by non-degree course	SIUPT
Knowing students' characteristics	Number of students enrolled by gender	SIUPT
	Number of students by age	SIUPT
	Number of students by geographic origin in Portugal	SIUPT
	Number of students by nationality	SIUPT
	Number of students by socioeconomic origin of parents - schooling	SIUPT
	Number of students by socio-economic origin of the parents - professional situation	SIUPT
	Number of students displaced from their permanent residence	SIUPT
	Number of students with special needs	--
	Number of students enrolled per curricular year	SIUPT
	Number of students who canceled the enrollment	SIUPT
	Number of students due to cancellation of enrollment	Excel

Goal	KPI	IS
	reason	
	Abandonment rate per curricular year	SIUPT
	Number of students who suspended their enrollment	SIUPT
	Number of students due to suspension of enrollment	Excel
	reason	
	Number of students returning	SIUPT
	Average returning time	SIUPT
	% of students with worker-student status	SIUPT
	% of students on a part-time basis	SIUPT
	% of post-work students	SIUPT
	% of students in e-learning regime	--

*Table 4. Teaching Management process: KPIs list by goal, showing IS support.*

Goal	KPI	IS
Availability of teachers	% of students by full-time equivalent (FTE) teacher	SIUPT
	% of students by FTE PhD teacher	SIUPT
	% of students by non-teaching staff	SIUPT
	Total number of teachers	SIUPT; PHC
	Total number of full-time teachers	SIUPT
	Total number of FTE teachers	SIUPT
	% own teaching staff	SIUPT
	% full-time PhD teachers in the fundamental training area(s) of the study programme	Excel
	% part-time PhD teachers in the fundamental training area(s) of the study programme	Excel
	% full-time teachers with doctorates in other areas of the study programme	Excel
	% part-time teachers with doctorates in other areas of the study programme	Excel
	% PhDs specialized in the fundamental areas of the study programme	Excel
	% of full-time teachers in the study programme, with a UPT link for more than 3 years	PHC
	% of faculty members enrolled in doctoral programs for more than 1 year	Excel
Enhancing Student Performance	Average number of enrollments by curricular year	SIUPT
	Average number of registrations up to the end of the course	SIUPT
	% of approvals by CU (relative to the total number of students enrolled)	SIUPT
	% of approvals by CU (relative to the total number of students who completed evaluation)	SIUPT
	% of students enrolled in the first year, for the first time, with approval in at least 75% of the number of ECTS in which they were enrolled	SIUPT
	Average grade per CU	SIUPT
	% students by grade range, per CU	SIUPT
	% of students assessed, per CU	SIUPT
	Number of 2nd cycle projects / dissertations / internships started	SIUPT
	Number of 2nd cycle projects / dissertations / internships completed	SIUPT
	Average number of years to finish 2nd cycle project/ dissertation /internship	SIUPT
	Number of 3rd cycle thesis started	SIUPT
	Number of 3rd cycle thesis completed	SIUPT
	Average number of years to finish 3rd cycle thesis	SIUPT

Goal	KPI	IS
Promoting complete student education	Number of students participating in extracurricular activities Number of extra-curricular activities offered % students participating in volunteer projects	--  Excel Excel
Maximize teaching efficiency	% of graduates in N years % of graduates in N + 1 years % of graduates in N + 2 years % of graduates in > N + 2 years Total number of graduates Average course grade % graduates at each range of the European ECTS scale	SIUPT SIUPT SIUPT SIUPT SIUPT SIUPT --
Pedagogical performance	% CU in mixed evaluation % CUs under continuous evaluation % CUs in final evaluation CU Student Satisfaction degree Teachers Student Satisfaction degree CU overall satisfaction index Teacher satisfaction index % of CUs with very favorable evaluation by students % of CUs with less favorable evaluation by students % of teachers with very favorable evaluation by students % of teachers with less favorable evaluation by students Number of students enrolled by CU Number of students per class Number of students per teacher per CU % CUs using MOODLE Average number of students attending classes No. of orientations in projects / dissertations / theses by teacher % classes taught by CU and teacher % of re-scheduled classes by teacher and CU % of classification terms issued on time % of summaries registered % of summaries registered on -time % of completed CU self-assessment surveys % of CU self-assessment completed on time Rate of success of learning objectives by course Degree of adequacy of teaching methodologies	SIUPT; MOODLE SIUPT; MOODLE SIUPT; MOODLE SIUPT SIUPT SIUPT SIUPT SIUPT SIUPT SIUPT  SIUPT  SIUPT SIUPT SIUPT MOODLE SIUPT SIUPT  SIUPT SIUPT SIUPT SIUPT SIUPT SIUPT SIUPT -- --
Maximizing graduates employability	% of graduates who obtained employment in the study area % of graduates who have obtained employment in other areas % of graduates who have been employed for up to 1 year after completing their studies % of graduates who obtained employment at the time of completion of their studies Number unemployed versus graduates Average time for 1st place after graduation (months) Average value of remuneration in 1st job % of employability by graduation job Number of registered graduates in the employment center Employer satisfaction level	Excel  Excel Excel Excel -- Excel -- -- -- --

*Table 5. Skills and Careers Management process: KPIs list by goal, showing IS support.*

Goal	KPI	IS
Ensure the necessary quality skills for teaching	% full-time professors by category	SIUPT; PHC
	% FTE professors by category	SIUPT; PHC
	% career faculty	--
	% invited professors	--
	Number of non-teaching staff	PHC
	Number of non-teaching staff per academic degree	--
	Number of non-teaching staff by age group	PHC
	Number of non-teaching staff per service	Excel
	Number of non-teaching staff by category	PHC
	% of hours of training per full-time teacher	Excel
	% of hours of training per non-teaching staff	Excel
	% of full-time teachers who attended at least one training course each year	Excel
	% of non-teaching staff who attended at least one training course each year	Excel

## 6 CONCLUSIONS

The development of this project has revealed some difficulties and limitations.

The first difficulty regards the identification of the systems that feed each KPI. The institution does not have a completely integrated IS, and many different systems, using different data formats, coexist. Moreover, some activities are still supported by personal Excel sheets. This analysis enabled the identification of IS development needs.

As usual in any BI implementation, the need to clean the data arises. Accordingly, policies were defined to minimize data errors, such as the typification of data, wherever possible.

It was also observed that the institution does not collect the necessary information to support some of the identified KPIs. This limitation highlighted the need to redesign some processes and simultaneously create the necessary digital support.

Despite these constraints, it can be argued that the implementation of BI has been a success because, first, it has already provided useful dashboards for management and, second, the initial outcomes have contributed to identifying possible improvements to the quality assurance mechanisms, which should, in turn, facilitate the institution's continuous improvement process.

In short time, the future work includes the parametrization of all the other processes in Qlik Sense and the presentation to all the users. Considering that, the process of Social Responsibility and Sustainability is not, yet, modeled in IQAS, the full process KPIs identification will take place as soon as possible.

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