

ERP Systems Created to Support Academic Management in Contexts of Geographic Dispersion: A Case Study in Regional Higher Education

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Abstract. In response to extension of coverage goals in higher education, academic programs offering has been growing in regions geographically dispersed which management requires solid information systems able to adapt to the context needs and particularities. This paper presents a descriptive case study conducted in one of the head offices of Corporación Universitaria Minuto de Dios operating in 34 municipalities of cundinamarca department in colombia, highlighting challenges evidenced in the process of design and implementation of a custom ERP system. The case of study provides wide contextual details about selection and design of components, customization, integration and evaluation of the ERP system. Through this analysis are documented (a) the challenges in integration, escalability and interoperability of ERP systems in higher education that are evidenced in a context of regionalization with geographic dispersion variables; and (b) the differential features provided by a custom ERP system respect to the currently used systems in higher education.

1 Introducción

The literature records significant progress regarding research on creation and implementation of ERP systems (enterprise resourcing planning), understood as systems that facilitate decision making thanks to the integration of the information related to all the areas of a company [1]. The studies concerning focus on issues related to implementation procedures, the critical factors of success or failure, the selection of suppliers, among others.

However, research on the implementation of ERP in higher education is still incipient and its studies are related to the issues referred previously. The investigation conducted obeys to the creation and implementation of a custom ERP system for the institution in the frame of a particular context of regionalization of higher education.

This document registers the process of investigation, the analyzed variables, the exercises of participative and collective construction of the modules of the ERP, the challenges in the integration, scalability and interoperability of the modules and the evaluation developed.

It is important to highlight that the developed system constitutes nowadays the mechanism of academic programming in a headquarters of the institution, which attends about 17000 student in 34 places of operation, in a territory of 24.210 km.

2 The research method

In order to describe the process of design and implementation of a custom ERP system, a descriptive case study was developed characterized for being a way of investigating an empirical topic that answers to the questions "how and why", when the researcher has little control over events and when the researcher focuses on a contemporary phenomenon developed within some context of real life.

Data collection for the case study was conducted between august 2014 and december 2015 developed through focus groups with program coordinators and academic managers. Additionally, the reports of Academic Council headquarters and institutional reports generated on the design and implementation of were analyzed. A non-probabilistic and intentional sample

with a targeted selection of information was built, that is to say, the informative content representing the educational leaders who were implementing the designed system.

For the period of the research was necessary to develop a total of 10 focus groups during the process and five reports of Academic Council and three institutional reports were analyzed, which were compared with the literature studied on the design, implementation and adoption of systems in higher education. The information was systematized through association with each of the components or modules of the system matrices, and variables customization, integration and evaluation system.

3 The case study

La Corporación Minuto de Dios is a multi-campus system consisting of seven rectories and vicerectories scattered in various regions of Colombia, whose missionary purpose has been, for twenty-two years, bringing quality education to regions with preferential option for those with access difficulties. It currently has a range of 72 academic programs with face-to-face methodology and 30 traditional distance programs methodology.

Researchers have selected Cundinamarca offices because it contributes with the 19 % coverage of the institution, attending around 17,000 students, in 34 municipalities in the department of Cundinamarca, with an administrative team of approximately 320 employees and 840 teachers, to the date of the study, implying academic management under complex variables of volume and geographic dispersion. Planning, monitoring and control is centralized at the offices of academic affairs which are located in Bogotá, and through an academic-administrative organization divided into four regional centers: Zipaquirá, Soacha, Girardot y Madrid. Each of them attending the operation of municipalities in their respective geographical area of influence.

Since 2001, the institution has used two systems all over the country for its management, BANNER and SAP. The first one, for the registration and academic control of students and teachers and also including prospecting processes, academic record, enrollment, academic history and reports; the second one, used for the administrative and financial management support management functions, accounting, finance, banking, sales, purchasing, inventory control, facilities management, customer relations and reports.

The experience of Cundinamarca during its six years of constitution revealed the absence of mechanisms to support academic planning, whose result should be

recorded periodically in the academic system of the institution called BANNER.

The academic planning process covers the subprocess of registration and selection of teachers from different municipalities of operation; curricular planning (elective and mandatory courses for each academic term); definition of quotas for each course offered with their respective allocation of teachers needed for decision making regarding hiring, schedule planning and decision making for the optimization in the use of facilities. Academic planning was made through Excel with the impossibility of a validation mechanism, consistent and efficient control, and with a centralized administrative and academic organization.

4. Literature review

The literature presents the advantages and challenges registered in the implementation of ERPs and possible areas of research around the implementation of systems in higher education. The ability of to articulate and interconnect different areas and processes within an organization around an integrated solid and shared data system, the importance of proper design, implementation and use of systems in organizations to strengthen the proper decision-making, among other issues have motivated theoretical and empirical research on the subject.

Some of the most determinant results of the investigation developed up to the date go around the context needs, the aspects influencing the decision to adopt this type of systems, and the aspects related to the adoption of systems. [1], [2]–[5]

4.1 ERP systems in higher education

ERP systems have been used in higher education to support the administrative, organizational and accounting functions of the institutions, specially for the administration of students and teachers, the facilities, courses and units administration, the management of schedules, the students monitoring and the financial control of the institution [3], [4], [6].

Some of the main benefits of ERP implementation in higher education are: they register the improvement to the access of information for institution planning and management, better services for students, teachers and leaders, costs reduction. ERP systems enable the aptitude to control all the functions and operations of the institution thanks to the use of unified information architectures. The quality and efficiency increasing of the information needed by diverse stakeholders, communication and coordination, administrative activities centralization are also some of their benefits.

Due to the challenges that the adoption and ERP implementation represents in the universities, it becomes necessary to highlight the complexity of these institutions. There is a high percentage of faults registered associated with the inability to satisfy the expectations and needs of the users of these system. There is a challenge due to the fact that the solutions do not adapt completely to support specific activities. The "better practices" extrapolated of other scenes not necessarily are adapted for the educational field by his high degree of complexity and heterogeneity [7], [8].

4.2 Variables associated with management in contexts of geographical dispersion

The study has addressed the phenomenon of geographical dispersion from the contributions of O’Leary and Cummings. The theoretical dimensions empirically justified for the characterization of the dispersion in work teams and their relationships constitute one of the main differentials in the creation of a modelled system orientated to the academic management, in a context determined by the need of management of at least 34 dispersed work teams in a territory of 24.210 km².

The proposed dimensions are registered in the following table from O’Leary & Cummings[9]:

Characteristic	Description	Example Outcome	Example Mechanism
Spatial	Geographic distance among team members	Reduced spontaneous communication (Burke et al. 1999; Dennis et al. 1988; Saunders et al. 2004)	Decreasing the likelihood of face-to-face interaction
Temporal	Time difference among team members	Reduced real-time problem solving (Grinter et al. 1999; Herbsleb et al. 2000; Malone and Crowston 1994)	Decreasing the likelihood of synchronous interaction
Site (Configurational)	Locations where team members work	Increased coordination complexity (Sarbaugh-Thompson and Feldman 1998; Yoo and Alavi 2001; Zigurs et al. 1988)	Increasing the number of dependencies which must be managed
Isolation (Configurational)	Locations where team members work alone	Decreased awareness (Armstrong and Cole 2002; Dennis 1996; Tan et al. 1998)	Increasing the remoteness of isolated team members
Imbalance (Configurational)	Locations with uneven distribution of team members	Increased intragroup conflict (Allmendinger and Hackman 1995; Kabanoff 1991; Mannix 1993)	Increasing majority influence and the potential for negative subgroup dynamics

Fig. 1. Multidimensional Conception of Geographic Dispersion.

The current academic information system of the institution does not contemplate this analysis of variables, and it was found that it is not parametrized the totality of the tutoring centers. Since the record does not correspond to the reality it has to be included an additional process of unification of information. Now then, only an designed to the needs might addressed these considerations.

4.3 ERP System customization

Studies regarding ERP use in higher education are limited, it does not rely on a comprehensive model that allows to evaluate the impact of the information systems, this fact is reinforced due to the absence of conceptual frames of reference that help to understand better the complexity of the educational sector[10]–[13].

Nevertheless, opposite to the customization of the systems, there is highlighted necessity to recognize that during the implementation of an information system, the management of the human risk and organizational is crucial for its success, even more that the technical risk.

The resistance indicators, the suitable integration of all the sources and the suitable analysis of needs and values of the institutional subcultures must be recognized to resist the barriers that could be generated before the change.

From the technical point of view, the customization involves the development of three steps in the implementation of an : (i) the evaluation of the needs and requirements; (ii) the review of the different available solutions and decision on the system that better adjusts to the needs; (iii) the implementation and customization of the selected system to adapt it to the needs of the institution or the design of the life cycle of the applications for its construction and implementation[3], [4], [7].

It is outlined in the literature as functional and technical factors of success, the strong communication and coherence between the different departments of the university, the adoption of strategies of knowledge management from the conception of a life cycle of the , the modular nature of these systems, problematic for the universities since they must adapt to the system more than the system to the organization [3], [8]

4.4 Financial and operational issues

ERP implementation implies a series of direct and indirect costs such as the software applications and tools, the investment in hardware, the personnel, the trainings and tutorings and the costs associated with the maintenance and future updates of the system.

In case of the modular systems, these costs increase while a new module or package is incorporated. Another factor that can increase the costs consists on the development of the systems or sources of information that the institutions have already had at the moment of the implementation [2][3][10], [11].

For an institution, the adoption or creation of ssystems must allow the reduction of costs.

5 Study results

In this section, the relevant results of the study are registered and they are related to the following areas: (a) decisions according to the adoption and evaluation of the current academic in the institution; (b) procedures of customization for the design of a complementary system; (c) aspects of integration of the modules of the ERP ; (d) benefits and challenges of the implementation of the taylor-made ERP.

5.1 Adoption and evaluation of the current academic ERP in the institution

Since 2001 the institution has implemented information systems to support decision making corresponding to the processes of self assessment and strategic planning. Additionally, it possesses several information systems, two of them corresponding to systems named SAP and BANNER. The last one is a system of academic management of students and teachers (management of planning, admissions, student's record, list of courses, teacher staff, facilities, academic programming, inscription, academic history, grades).

There is not any registration of formal assessments to the actual information system; nevertheless, the self assessment of the management of technological services (gst) have given as a result plans of improvement mainly oriented to strengthen the areas of management for the development and acquisition of new technological applications for the academic management and the investigations, control and audit of the academic information system, follow-up to the processes managed across the academic information system orientated to the quality of the information and functional training of the academic information system.

Banner is an internationally recognized, functional and efficient information system, which adoption was complex with some kind of emptinesses in the information, as well as some absences in the customization. It responds to the nature and structure of the headquarter but it has not achieved the conditions of geographical dispersion in Cundinamarca headquarter cause it does not identify all the operations centers and information must be reprocessed through excel.

Such as manual work consumes administrative time, it has a high risk of human error, it subtracts management capacity and does not allow adequate and timely decisions related to management resulting in high financial costs and low quality.

The exposed considerations have motivated the institution to look for new and innovative applications adequate for the proper context of higher education and the conditions related to the nature of this university.

5.2 Procedure for the customization of a complementary system for the institution.

It was concluded a necessity for the offices of Cundinamarca for a system for academic planning. The custom system needed to integrate the components for the decision making around coverage, facilities disposition, teachers recruiting and selection by municipality with attention to the variables of geographical dispersion, information processing for schedule, allocations management and resources and spaces optimization. In general, all the necessary information processing made previously to the register in banner.

The study gave as a result a proposal of a procedure consisting of three steps to customize an system for an institution with geographical dispersion:

1st. Step: to evaluate needs and requirements of the institution respect to the existing information systems. It's necessary to identify the components, issues and elements which are fulfilling the necessities adequately, the ones which are not covered, and the ones which need adjustments. Product of these evaluation one way is to begin the customization of a new system appropriate to the characteristics of the institution and coherent with conditions like geographical dispersion.

2nd. Step: to develop a custom system covering the software construction process: analysis, design, development, testing, implementation and star up. To achieve this objective the following variables are considered:

a) Dimensions of dispersión: geographical distance among team members, time difference among team members, locations where team members work, locations where team members work alone, locations with uneven distribution of team member. These spatial, temporal, site, isolation, and imbalance dimensions define specific characteristics of the modules, roles and users of the system.

b) Software architecture specification attending the purpose and scope of the product, perspective, components and functions, kinds of users and characteristics, operating environments, desing and implementation restrictions, user interfaces, hardware, software and communication, users documents, assumptions and dependencies.

3rd step: modules testing and permanent software settings. Each component needs periodic testing based on direct fieldwork with each team or users group having in mind the following modules integration aspects:

Academic planning needs at least four integrated modules of *curriculum management* (study programmes with courses, hours and credits); *teachers management*

(teachers recruitment, personal and professional information management, work plans) *pre-planning* (assisted programming of groups and schedules) and *facilities management* (having in mind dispersion dimensions).

6 Conclusions and future research

The research allowed to evaluate the existing and implementable enterprise resourcing planning systems for a higher education institution. It was necessary to create a new complementary and customized ERP because of the conditions of dispersion not satisfied by the evaluated systems. It was necessary to find the mechanisms for a custom software development through institutional research and a software development consulting.

The most important results are related to (i) needs identification and met based on dimensions of dispersion; (ii) practices on saving resources thanks to facilities and human resources management obtained with the system; (iii) significant reduction in planning process time from three months to two weeks with the consequent satisfaction of students thanks to clarity and opportunity in schedules and programming; (iv) capacity of making better decisions related to contracting based on real and controlled information.

The most relevant challenges are around information quality delivered by dispersed teams. It's evident the resistance to change and control. That's why is important to face and enhance capacity of correction *in situ*, technical and functional leadership, teams training and support.

Higher education institutions must make an appropriate data handling and management to enhance quality. Global changing and technologies advance are available for any kind of enterprises, all of them demanded by society to offer services and products more efficient, and education is not an exception.

The results presented show that a custom ERP system can find higher efficiency since it's a system with ability to adapt to the institution instead of wasting efforts in adapting to an existing system. Although it represents similar adaptative challenges, it was demonstrated that minimize frustration risks as the creation is collective, participatory and based on technical rigurocity and necessary support.

Future research could attend a better understanding of intelligence business in education. Interdisciplinary frameworks created by educational management and software engineering experts. It's important to approach high complexity of this kind of institutions and take advantage of systems in the enhancements of education quality.

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