Factors Affecting the Purchasing of a Learning Management System in Madrid Region Universities

C. A. Lastras Rodríguez(✉)

CUNEF University, Madrid, Spain
carlos.lastras@cunef.edu

Abstract. Learning Management System (LMS) is the engine of knowledge at universities. LMSs acquire, save, share, distribute content among different players at universities. Due to COVID-19 pandemic LMS has become more important not only for content management, but also as an integration tool with video-conference solutions, digital blackboards, and academic management systems. This research explains the main factors affecting the purchasing decision making of an LMS. The research is focused in public and private universities in Madrid Region, Spain. The methodology used to carry out this research is Principal Component Analysis (PCA). This multivariate technique lets us analyse different purchasing patterns. With the aid of PCA the author can extract relevant factors affecting the purchasing decision-making. In the research the author distinguishes between traditional factors affecting institutions when they purchase corporate software, such as Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), Supply Chain Management (SCM), and educational factors affecting universities when they purchase a strategic tool. The research also determines the weight of each factor in the purchasing decision making of public and private universities in Madrid Region. Universities are classified as public and private for a better understanding of the purchasing decision-making. The article concludes that public universities in Madrid are bigger, more stable, and mature than private universities, and the decision-making process is more related to traditional factors affecting software purchasing, such as, systems reliability, systems functionality, or maintenance costs. On the other hand, private universities are keen on learning processes, internationalisation, and hybridisation.

Research Contribution: To obtain insights about the internationalisation process of private universities, with the aid of principal component analysis. In the adoption of a Learning Management System, 42 variables are reduced to three components, each component reveals trends and insights of public and private universities.

Keywords: Learning Management System · Principal Component Analysis · Purchasing Decision-Making · Internationalisation · Hybridisation

1 Introduction

A Learning Management System (LMS) is the core for educational institution in order to collect and share content between professors and students, as a communication tool.

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Activities are programmed in the LMS, the grading is also provided in the system. The LMS is a web-based software application that is designed to handle learning content, student interaction, assessment tools and reports of learning progress and student activities [1]. Usually is administered by the Information Technology Departments of the Educational Institution, in this case the IT Department of each University and Professors acts as Content Managers of each own courses, uploading materials, managing the grading, sending new tasks to students, giving feedback to students. At the universities there are different types of profiles in a LMS, such as the administrator (IT Department), administrative users, professors and students. All of them have access to the system through computers, mobile devices and tablets. LMS develops mobile applications, that are tailored-designed for professors and also for students. Student views are different than professors'. Professors have the control of their own courses and views. Student's LMS views are constrained by professors. LMS integrates easily with content providers, open-source content, and commercial software like Office365 or Adobe, among others.

In a LMS we can find three types of tools: learning skills tools, communication tools, and productivity tools [2]. Learning skills tools include modules that create activities and learning content, such as quizzes and assignments that are going to be consumed by students. Communication tools facilitate interaction between professors and students and between students, including messaging and forums. Productivity tools include document management system, calendars, proctoring.

Some features that are common for a competitive LMS include enhanced mobile learning, on-the-job training, event management, vertical customisation, compliance management, video courses, social sharing, scalability, SMS and e-mail notifications and integrated web conference.

There are several leading LMSs vendors for higher education that include Adobe Inc., AlphaLearn, Blackboard Inc., Cornerstone OnDemand Inc., D2L Corp., Docebo Inc., Epignosis, Instructure Inc., International Business Machines Corp., John Wiley and Sons Inc., Jzero Solutions Ltd., Learning Technologies Group Plc, Oracle Corp., Paradiso Solutions, PowerSchool Holdings Inc., SAP SE, ByteparityTechnologies LLP, and Kochar Infotech Ltd [3].

Many of the LMSs were developed during the past two decades. The most important LMSs are Blackboard™, Moodle™ and Canvas™.

Blackboard™ was born in 1997 offering learning software applications and other teaching and learning services. Currently offers different platforms to improve different aspects of education, such as Blackboard Collaborate™ (enables a virtual classroom for synchronous and asynchronous instruction at a distance) or Blackboard Analytics™ (make the universities obtain relevant insights) [4].

Modular Object-Oriented Dynamic Learning Environment (Moodle) is a free open-source system designed using pedagogical principles helping professors to create an effective online learning environment. It is a global development project designed to support a social-constructionist framework of education [5]. Its origins are a Ph.D. research project by Martin Dougiamas in 1999 at the Curtin University of Technology in Perth, Australia. Although the system is open-source, customers should pay to use upgrade advanced system functionality.

Canvas™ is a web-based learning and assessment management system. The origins of Canvas™ are in Instructure Inc., an educational technology company based in Salt Lake City, Utah, United States. Instructure Inc. is the developer and publisher of Canvas. The company was founded in 2008 and is currently owned by private-equity firm Thoma Bravo. Instructure launched its Canvas iOS application in 2011 and the Android application in 2013, enabling support for mobile access to the platform. The applications are adapted for students, Canvas Student and professors, Canvas Teacher [6].

During the COVID-19 pandemic LMSs covered the need of students and professors to develop virtual learning. LMSs provide benefits on learning as sustainability engagement. Lockdowns created a need for closeness, peer references and subjective well-being that increased the perceived ease of use and perceived usefulness, influencing students to work with LMSs, creating an engagement [7]. COVID-19 fostered the use of LMSs as a key driver not only in virtual learning, but also in the physical classroom.

The objective of this study was to find the relevant factors affecting the purchasing decision-making and the differences of this process between private and public universities in Madrid Region, Spain. Specifically, it aimed to achieve the following:

– To create components delivering differentiated patterns between private and public universities.
– Determine if a LMS could be a distinctive competence in order the internationalization of a university.

Five universities of Madrid Region, three privates and two publics are selected to develop this research. Among these five universities we obtained 78 answers. In the methodology, principal component analysis is applied. This tool lets the researcher transform 42 variables into 3 components, which show insights and trends of these types of universities.

2 LMS Selection Process. Factors Affecting the Selection

In order to select Managing Applications, such as Enterprise Resource Planning there are some factors that are relevant such as: price, maintenance costs, consultancy costs, infrastructure costs, complete modular solution, functional fit, security, easy to operate, easy to learn, easy to update, easy to integrate, easy to customize internally, stability, easy to recover, vendor's financial statements, vendor's size, vendor's market share, vendor's research and development capability, vendor's technical support capability, implementation skills, warranties, consulting services, training services, service speed [8]. In order to adopt a LMS some authors distinguish as main factors: organisational, social, individual and technological [9], another author distinguishes between learner, instructor, LMS, classmates, course and organisation characteristics [10].

Given the competitive market of private universities at a mature stage, the author also values the opportunity that LMSs provide to private universities to conquer new markets through internationalisation. There are several researches that studied the relationship between software as a distinctive competence in favour of internationalisation [11, 12]. According to software and internationalisation the main factors are: generic software,

a domestic market base, technical internationalisation and localisation, entrepreneurial management, personal customer contact, and usage of specific market selection criteria such as high IT penetration and maturity levels and psychical proximity.

In this case, in this research, the author is going to study variables that are relevant to Managing Applications, adding organisational (facilitating condition, top management support, top management policy), social (subjective norm), individual (resistance to change and self-efficiency) and technological (service quality, system quality) variables and also including variables related to internationalisation. The total list of variables is as follows:

- Dummy variables: Type of university: Public (0), Private (1). Type of respondent: Administrative (0), professor (1), member of the Information and Technology department (2), executive (3). Type of learning management system: Moodle™ (0), Blackboard™ (1), Canvas™ (2).
- Variables on a seven-point importance Likert scale: Price, maintenance costs, consultancy costs, infrastructure costs, complete modular solution, functional fit, security, easy to operate, easy to learn, easy to update, easy to integrate, easy to customise internally, stability, easy to recover, vendor's financial statements, vendor's size, vendor's market share, vendor's research and development capability, vendor's technical support capability, implementation skills, warranties, consulting services, training services, service speed, facilitating condition, top management support, top management policy, subjective norm, resistance to change, self-efficiency, service quality, system quality, generic software, domestic market base, technical internationalisation and localisation, entrepreneurial management, personal customer contact, IT penetration and maturity levels and psychological proximity.

A total of 42 variables are chosen.

3 The Case of Madrid Universities

In Madrid at universities were 321261 students enrolled in course 2020/2021, 195289 in public universities and 65201 in private universities [13]. 3 private and 2 public universities participated in this research.

- Private University 1: Founded in 1962 as an educational institution with agreements to obtain official degrees with public universities, working independently as a private university since 2021. It is specialised in Marketing, Digital Economy and Business Administration. LMS: Canva.
- Private University 2: Founded and working independently as a private university since 1995. It is not specialised in any knowledge field, offers a wide range of degrees, masters and doctoral studies. LMS: Blackboard™.
- Private University 3: Founded in 1973 as an educational institution with agreements to obtain official degrees with public universities, working independently as a private university since 2021. It is specialised in Business Administration and Science, Technology, Engineering and Mathematics (STEM) degrees, masters and doctoral studies. LMS: Canvas™

– Public University 1: Founded in 1990 is one of the universities with the highest entry grades in Spain. LMS: Moodle™.
– Public University 2: Founded in 1996 and with more than 45000 students is the second university with the highest number of students in Madrid Region and sixth in Spain. LMS: Moodle™.

4 Methodology

The author designs a survey to obtain answers of 39 variables in a seven-point Likert scale [14]. The Likert scale is useful to measure opinions and attitudes. In this case we are going to use a scale from 1 to 7 to measure the level of importance of each variable where: 1) Not at all important, 2) Low importance, 3) Slightly important, 4) Neutral, 5) Moderately Important, 6) Very Important, 7) Extremely Important. There are three other dummy variables: type of university (public, private), type of respondent (administrative, professor, member of the Information and Technology department, executive), type of learning management system (Moodle™, Blackboard™, Canvas™). The author has obtained answers of 78 participants. In order to build the principal component analysis, the author has worked with SPSS™, a product of IBM. There is no rotation of the factor solution. There are no missing values. Small coefficients with absolute value smaller than 0.1 have been suppressed, empty cells in Table 2 Component Matrix.

Principal component analysis was proposed by Karl Pearson in 1901. He applied it to non-random variables [15]. The extension to random variables was made in 1930 by Harold Hotelling [16, 17]. This technique is applied in some fields, such as economics, medicine, technology and neuroscience. Principal component analysis is used in computer science as a data dimension reduction tool. We often process complex and huge data, then we need to reduce the complexity with the aid of principal component analysis. With this method the higher dimension of the original data is reduced to a lower dimension subspace through linear transformation. Those dimensions that are reduced are redundant. The goal of principal component analysis is refining data, removing a redundant and noisy part. The model only retains the useful part. This is the reason principal components can be implemented in a software selection process. All the adoption variables are represented in a high dimensional matrix. Removing redundancy and noise is needed to refine the data.

Principal component analysis begins with the Pearson correlation matrix of the variables. The goal is to calculate the variance in the matrix by fitting a series of weighted linear functions, the components, to the variables within the multidimensional space that they occupy. Principal component analysis is composed of two phases, the extraction and the rotation.

The extraction of the dimensions is sequential. Each component is represented by a straight line fit function to correlate maximally with the variables. Components are independent of each other, statistically they are orthogonal. The first component explains the largest variance. The second component targets the remaining variance to explain. The third component then addresses the variance that is not explained by the first two components, and so on. Orthogonality means that we can add the amount of explained variance

across the components that determine the cumulative amount of variance accounted for by the first d number of dimensions.

The way that components are extracted, produces that each successively extracted component will explain less variance than those extracted before it. The first few components will cumulatively have accounted for a relatively large percentage of the variance, reaching a point of diminishing returns. To plot the amount of the variance explained on the Y-axis as a function of components extracted on the X-axis we would see a backwards J-shaped function, popularized by Raymond Cattell (1966) as a scree plot [18]. The goal is to select a relatively few components that cumulatively explain a fair amount of variance. The first component is the strongest, the second next strongest, and so on. Many variables will correlate most strongly with the first component, with the other components falling off quickly in the order they were extracted.

5 Results and Discussion

The results and discussions on the findings relative to this research are arranged in the following order: number of components that are explaining the variance of the model and the interpretation of each component. As it is detailed in Table 1 and Fig. 1, three components explained 57,47% of the variance.

The total of each component reflects the eigenvalues of the covariance matrix sorted in descending order. We can see the value of each component in Fig. 1 Scree Plot. Three components are enough to obtain findings. The percentage of variance of each component is the value of the eigenvalue divided into the sum of all eigenvalues.

In Table 2 is represented the component matrix. In the first component the order of the variables from the highest weight to the lowest fell on IT penetration and maturity levels (0.894), stability (0.806), service speed (0.801), psychical proximity (0.776), subjective norm (0.730), functional fit (0.699), resistance to change (0.679), vendor's research and development capability (0.662), consulting services (0.646), service quality (0.644), personal customer contact (0.639), easy to customise internally (0.632), type of respondent (0.625), technical internationalisation and localisation (0.603), type of learning management system (0.595), entrepreneurial management (0.575), warranties (0.567), top management support (0.565), type of university (0.563), top management policy (0.549), easy to recover (0.524), easy to update (0.516). The smallest weights fell

Table 1. Total Variance Explained

Component	Total	% of Variance	Cumulative%
1	11,542	27,480	27,480
2	7,709	18,355	45,835
3	4,888	11,637	57,472

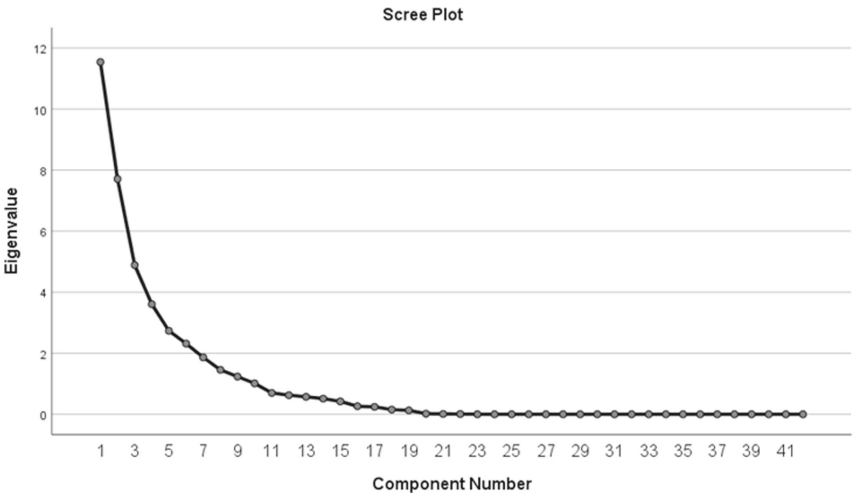

Fig. 1. Scree Plot

on maintenance costs (-0.585), infrastructure costs, (-0.501), price (-0.454), and consultancy costs (-0.450), these three variables with the smallest weights are representing life cycle costs. The we can interpret this component as to be related to private universities, the performance of the LMS (functional fit, easy to update, easy to customise internally, stability), the vendor (research and development, warranties, consulting services, service speed), top management (support, policy) and internalisation (technical internalisation and psychical proximity).

In the second component the order of the variables from the highest to the lowest weight fell on vendor's size (0.862), complete modular solution (0.769), vendor's market share (0.735), consultancy costs (0.726), infrastructure costs (0.702), vendor's financial statements (0.700), price (0.678), maintenance costs (0.603), to management policy (0.595), resistance to change (0.575) and domestic market base (0.509). The smallest values fell on easy to integrate (-0.760), easy to customize internally (-0.475), easy to learn (-0.440), easy to update (-0.404). This component is interpreted as related to public universities, life cycle costs (price, maintenance, infrastructure), the vendor (size, market share, domestic market base) and top management policy.

In the third component the order of the variables from the highest to the lowest weight fell on entrepreneurial management (0.648), technical internationalization and localization (0.599), type of university (0.583), type of learning management system (0.556). The smallest values fell on consulting services (-0.675), implementation skills (-0.598), easy to recover (-0.569), easy to update (-0.525) The third component is related to private universities, technical internationalisation and entrepreneurial management.

Table 2. Component Matrix

	Component 1	Component 2	Component 3
Type of University: Public (0) or Private (1)	0.563	−0.254	0.583
Type of respondant: Administrative (0), Professor (1), IT department (2), Executive (3)	0.625		−0.175
Type of learning management system: Moodle (0), Blackboard (1), Canvas (2)	0.595	−0.296	0.556
Price	−0.454	0.678	
Maintenance Costs	−0.585	0.603	0.128
Consultancy Costs	−0.450	0.726	
Infraestructure Costs	−0.501	0.702	
Complete Modular Solution	0.276	0.769	−0.284
Functional Fit	0.699	0.233	−0.260
Security			−0.372
Easy to Operate	−0.117	−0.324	0.197
Easy to learn	−0.126	−0.440	0.387
Easy to update	0.516	−0.404	−0.525
Easy to integrate	0.422	−0.760	−0.402
Easy to customise internally	0.632	−0.475	−0.468
Stability	0.806	−0.178	−0.244
Easy to recover	0.524	0.151	−0.569
Vendor's financial statements	0.186	0.700	
Vendor's size	0.138	0.862	−0.101
Vendor's market share	0.181	0.735	0.135
Vendor's research and development capability	0.662	0.160	−0.427
Vendor's technical support capability	0.337	0.165	−0.355
Implementation skills	0.275	0.407	−0.598
Warranties	0.567	0.226	
Consulting services	0.646		−0.675
Training services	0.345	0.322	
Service speed	0.801	−0.336	0.145
Facilitating condition			0.159
Top management support	0.565	0.340	0.407
Top management policy	0.549	0.595	0.223
Subjective norm	0.730	0.355	0.108

(*continued*)

Table 2. (*continued*)

	Component 1	Component 2	Component 3
Resistance to change	0.679	0.575	
Self-efficiency		0.298	0.239
Service quality	0.644		0.260
System quality	0.457	−0.153	0.369
Generic software	0.259	0.214	
Domestic Market Base	0.288	0.509	0.133
Technical internationalisation and localisation	0.603		0.599
Entrepreneurial management	0.575	0.111	0.648
Personal customer contact	0.639	−0.236	
IT penetration and maturity levels	0.894	0.218	0.129
Psychical proximity	0.776		0.369

6 Conclusions

The principal component analysis suggests that there are different trends in the adoption of a LMS between private and public universities. Private universities are more concerned in the performance of the LMS and internationalisation. Public universities are more concerned about the price and the costs of the system. Public universities are bigger and have more budgetary constraints than private universities. For public universities there is no need to continue growing, that is why they are focused on the price and costs associated with the LMS. Both private and public, value the vendor and top management. For private universities, top management support is a decisive factor. LMSs allow private universities to widen the scope. They can be considered as a capability to obtain this internationalisation and hybridisation.

7 Limitations and Future Lines of Research

Limitations of this study are that the author has worked with a limited number of universities. In the future, it is proposed to study more public and private universities. The study is also limited to five universities in Madrid Region, in the future, it is of interest to study these implications at a national level. It is of interest to see in which degree a LMS can be considered for a private university as a distinctive competence. A distinctive competence are those competences that provide a competitive advantage to a firm [19]. In this case in future research the author may study if a LMS can provide a competitive advantage for a private university.

Another topic to be studied is the influence of extended LMS in virtual or extended universities and the creation of a learning supply chain with students worldwide.

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