Why Do Firms Adopt E-Procurement Systems? Using Logistic Regression to Empirically Test a Conceptual Model

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***Abstract*—Once the factors that foster the adoption of electronic-procurement systems (EPSs) are identified, economic agents may act accordingly and develop better programs in order to achieve their objectives. Toward the identification of such factors, a model that explains the adoption of EPS is developed, considering the technology–organization–environment framework as well as the institutional theory. This model was tested with data collected from the 2500 largest companies operating in Portugal. On the grounds of the *t*-test for equality of means, we found evidence that EPS adoption is positively and significantly associated to: 1) firm size; 2) technology competence; 3) the perception companies have about the EPS success of their competitors; 4) the extent of adoption among competitors; and 5) the readiness of the trading partners to perform electronic transactions. The logistic regression supplied further evidence that technology competence, firm size, extent of adoption among competitors, and trading partner readiness provide a reasonable estimate for each firm's likelihood to adopt EPS. We also found evidence that firms whose main activity is commerce are more likely to adopt EPS than are firms operating on manufacturing or services industries.**

***Index Terms*—Electronic-procurement systems (EPS), institutional theory, Portugal, propensity of adoption, survey method, technology–organization–environment framework.**

I. Introduction

WHY do some organizations adopt electronic–procurement systems (EPS) while others do not? Maybe some organizations need to do so or maybe they know the value an EPS can bring to them. Perhaps some organizations do not have the capacity to implement EPSs and perhaps others simply do not know that competitors are extracting value from the EPSs. Within the topic of technology adoption, there is a model available to predict firms' intention to adopt financial electronic data interchange (FEDI) systems using institutional theory as a lens to understand the factors that explain their adoption [1]. Meanwhile, the technology–organization–environment framework was used to predict e–business adoption by European firms [2]. However, none of these models is totally appropriate to evaluate EPS adoption since they do not take into account some variables that are potentially relevant for EPSs adoption. Institutional theory does not take into account the capacity of the firm's managers to deal with EPS, while the technology–organization–environment framework ignores mimetic pressures that can lead an organization into adopting an EPS. This paper bears in mind both theories while developing a model to predict EPS adoption, and tests the model empirically, with data gathered from the 2500 largest companies operating in Portugal.

The results presented in this paper may be relevant for academics, political agents, and business-to-business (B2B) software vendors and consultants. Indeed, politicians and their policies may foster the development of the information technology (IT) industry and the degree of digitalization of countries [3]. On the other hand, a country's e-business activity is associated with human capital [4]. On the grounds of these results, we posit that politicians, made aware of the results of this study, will be able to define better policies in what concerns the development of programs to support their economies' productivity improvement, while software vendors and consultants will be able to improve the quality of their marketing and sales in what regards B2B markets.

There is an overwhelming consensus regarding electronic commerce growth over the next ten years [5]. However, that depends on the organizations' adoption of IT in general, and more particularly, on the adoption of EPSs. According to the existing literature, EPSs are likely to bring benefits to companies [6], such as an increase on firms' competitiveness through cost reduction [7], [8] or a raise on efficiency at the inbound logistics [9]. Even though some firms are using EPSs, other firms are not doing so. In such circumstances, we aim at ascertaining what makes a difference in what regards to EPS adoption. This leads to the following research questions: 1) What are the factors that foster the adoption of EPSs? What is their relative relevance? 2) How likely is a specific organization to adopt an EPS? 3) What are the features that differentiate EPS adopters from nonadopters? 4) Which are the industries with more propensity to adopt EPSs?

In order to provide the answers for these questions, the existing literature was reviewed to gather the information needed for the development of a research model containing a set of factors capable to explain the firm's likelihood to adopt EPSs. Beyond that, data about EPSs adopters and nonadopters was collected and analyzed, with the purpose of validating the model and finding the answers to the research questions.

This paper is structured as follows. Section I presents the topic, a brief explanation of the problem that led to the research questions, the contribution of the paper to the current body of knowledge, and the paper structure. Section II presents a

Manuscript received February 1, 2006; revised May 1, 2006, July 1, 2006 and September 1, 2006. Review of this manuscript was arranged by Department Editor A. Chakrabarti. The work of A. Soares–Aguiar was supported by the Fudação para a Ciência e Tecnologia (FCT), a Portuguese institution that supports research projects.

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Digital Object Identifier 10.1109/TEM.2007.912806

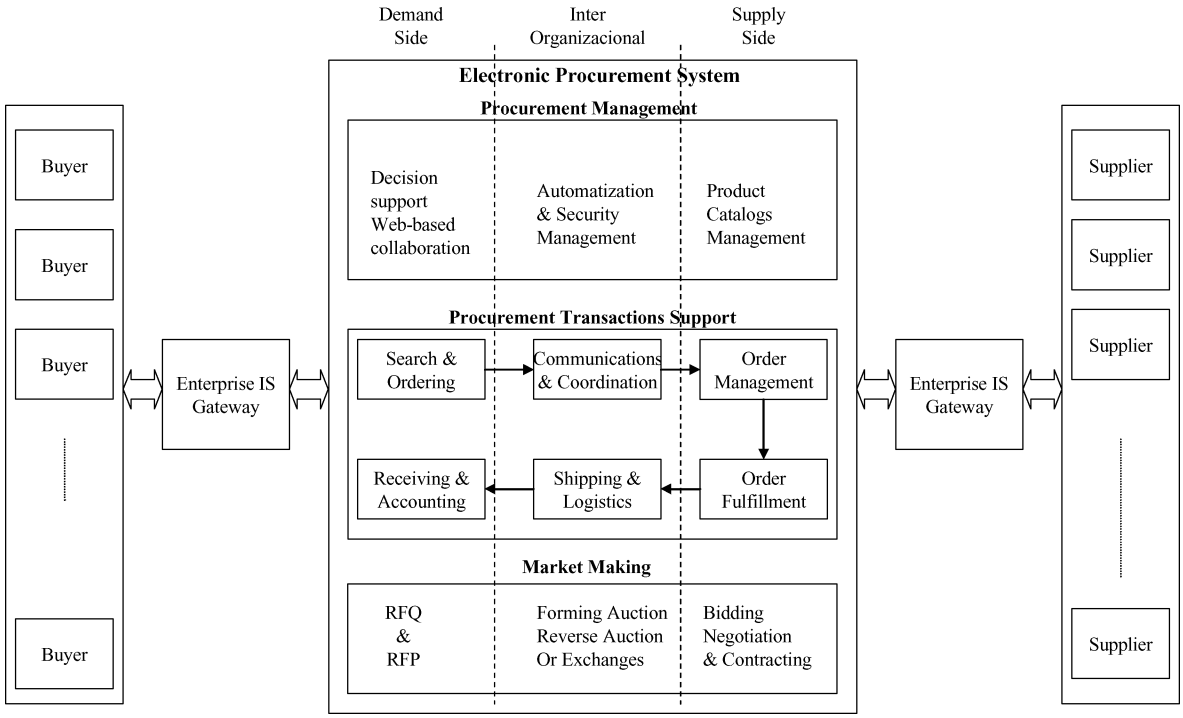

Fig. 1. Main functionalities of an EPS. Adapted from [9].

literature review about EPSs, their importance and impacts, as well as the models addressing the adoption of innovations. Section III develops a conceptual model that includes six research hypotheses. Section IV describes the research methodology that was used in order to answer the research questions. Section V analyzes and discusses the results achieved. Section VI presents the major findings and limitations, and finally, Section VII presents the conclusions and research directions.

II. Literature Review

The literature review includes the analysis of the most relevant studies regarding the definition and functionalities of EPSs (Section II-A), its relevance and impact on organizations (Section II-B), and the existing models that explain the adoption of new technologies (Section II-C).

A. EPS Definition and Its Functionality

An EPS is a Web-based client/server application used to replace the manual procurement process [9]. The EPSs' components, as well as their functionality, are shown in Fig. 1.

Horizontally, EPSs may support three procurement areas: procurement transaction support, procurement management, and market making. Vertically, EPSs may support the demand side, the supply side, and interorganizational modules. Besides these components, EPSs should communicate with both the buyer's information system and the seller's information system through the enterprise information systems gateway.

Ultimately, the transaction support is the most visible part for the end user. The authorized users may, using a browser and a search engine, search and find all the information required to process a requisition according to the firm's procedures. Once the requisition is approved, it turns into an order sent to the supplier that is responsible for order fulfillment and shipping. As soon as the order arrives at the buyer's establishment, financial accounts should be updated.

The electronic catalog, at the heart of the procurement management unit, contains the specifications and prices of all the products being obtained from contracted suppliers. The catalog management component may allow the suppliers to directly access the enterprise server and update the information about their products and services. Analytical tools are used to provide procurement decision support to managers and users. Finally, there is the authorization and security module that implements users' data access and ensures the necessary quality of the messages transmitted between the agents involved in transactions.

Once the firms have adopted the functionalities mentioned before, they can also use a more advanced market-making functionality to carry out some of their human-intensive tasks through the Web, such as managing quotes, bidding, and negotiation. At a higher level of maturity, the firm can also use the EPS to electronically conduct auctions or to run a B2B exchange in which its internal users and suppliers can bid and trade goods.

B. EPS Importance and Impacts

Procurement, a primary determinant for the organization's relationship with suppliers [10], corresponds to one of the three key generic business competencies, which are: 1) the demand management competence—the ability to understand current and future markets and to sell existing and future products and services within them; 2) the transformation competence or the ability of turning supply inputs into more valuable outputs through a value adding process; and 3) the procurement and supply management—the ability to acquire the required supply inputs

with the quality required and at the lowest total cost of ownership [11]. Subsequently, if EPSs can help this activity in becoming more effective and efficient, we can posit that EPSs are quite relevant for most firms performing the procurement activity. Indeed, several case studies have shown that EPSs are relevant to organizations [12]–[14]. Besides, procurement is also strategically important to an organization [15], and manufacturing firms with the greatest degree of integration of the supply chain are likely to yield higher levels of performance [16]. Obviously, the EPSs make a contribution toward improving the degree of integration between a certain firm (the buyer organization) and its suppliers. As a result, firms adopting EPSs are likely to obtain performance gains. Consequently, the topic proposed deserves to be studied and understood.

In general, the introduction of a new information system in an organization requires changes in the way that organization works. Indeed, EPSs lead to changes at different levels: at the organizational level, in the information systems department, on the organizational culture, and at the financial level [17].

Modifications at the organizational level refer to changes in the way people perform their work, particularly, when they want to buy goods and services they need. The availability of an EPS provides employees with the chance of introducing some automatization on specific buying activities, leaving paper forms, telephone calls, and faxes out of the acquisition process, or at least, reducing their use significantly.

Meanwhile, new activities arise as a result of an EPS implementation. For instance, people in the information systems department have to deal with another type of technology, and consequently, new learning processes and maintenance activities have to be developed in order to use and manage the new system. Moreover, we must consider the fact that EPSs maximize the level of operational efficiency when such systems are integrated with legacy systems [16]. Such an electronic integration is a process that requires a great level of expertise, so hiring skilled people for the information systems department may be necessary.

The implementation of an EPS may also induce a change in the organizational culture, due to the new organizational processes. If people are conducted to perform their job in a different way that will cause changes in norms and culture values. For example, if an employee had the habit of going physically to a purchase department in order to request some items, the employee would probably have an informal conversation with people around. Producing the order requisition at the employee's own computer keyboard drastically reduces these unofficial meetings. Even though there is a cultural change in the organization produced by the implementation and use of the EPS, whether such change represents a benefit for the organization or not is an issue that is out of the scope of this paper.

The impact EPSs have on financial accounts is also relevant because of the price reduction of goods and services, the necessary capital investment, and the operational costs of the new system [17]. Indeed, organizations using EPSs have a significant financial advantage over organizations that use manual processes to acquire goods and services [18]. In fact, total administrative costs for firms using EPSs are only 33.2% of the costs supported by organizations using manual processes. The automatization of requisition generation is the most significant contributor for the cost reduction, which has a direct impact on the organization's net income. Indeed, if a firm would try to achieve the same financial impact on net income through an increase on sales, a significant effort would have to be undertaken in order to get the same results, since an increase on sales normally implies an increase on costs.

Additional theories can be put forward to support the importance of EPS, all acknowledging that most IT investment decisions are taken in a continuously changing business environment [19]. A potential framework for grounding the theoretical basis for EPS value is the resource-based view (RBV) of the firm, which explains firm performance based on organizational resources and capabilities. The RBV has been used to explain the successful adoption of information systems in organizations [20]. In fact, firms create performance advantages by assembling resources that work together to create organizational capabilities [21], [22]. In order to create sustainable advantages, these resources, or resource combinations, have to be economically valuable, relatively scarce, difficult to imitate, or imperfectly mobile across firms [23]. The resources available to a firm can be combined and integrated into unique clusters providing the firm with distinctive abilities [24]. RBV has been widely accepted in the strategic management literature. In the information systems literature, the RBV has been used to explain how firms can create competitive value from IT assets, and how sustainability resides more in the organization's skills to leverage IT than in the technology itself. IT payoffs depend heavily on "fitting the pieces together" that is, on exploiting relationships among complementary resources. Computers, databases, technical platforms, and communication networks form the core of a firm's overall IT infrastructure resources. In the same way, EPSs may provide value to a firm, by combining the firms' resources and capabilities, such as manpower, knowledge of suppliers, and the specificities of their products, as well as the firms' organizational procedures, toward a more effective creation of value. Although the individual components that go into the IT infrastructure are commodity-like, the process of integrating the components to develop an infrastructure tailored to a firm's strategic context is complex and imperfectly understood [25]. The RBV has been extended with the dynamic capabilities perspective (DCP) to address the realities of high-velocity markets and rapid technological change. DCP refers to the ability of a firm to achieve new forms of competitive advantage by renewing technological, organizational, and managerial resources toward the achievement of congruence with the changing business environment [24], [26]. In such environment, capabilities that enable rapid and purposeful reconfiguration of a firm's resources are the means through which unique resources can be obtained. This model suggests that dynamic capabilities are essentially change-oriented capabilities that help firms reconfiguring their resource base to meet evolving customer demands and competitor strategies. So, this section shows that the RBV and DCP theories provide support to justify a research aimed at ascertaining what the determinant factors of EPSs adoption are, and at evaluating the differences between EPS adopters and nonadopters.

C. Adoption Models

The technology–organization–environment framework [27] explains the adoption of technological innovations and identifies three aspects of a firm's context that can influence the process by which companies adopt technological innovations: the organizational context, the technological context, and the environmental context. The organizational context is typically defined in terms of several descriptive measures: firm size; the centralization, formalization, and complexity of its managerial structure; the quality of its human resources; and the amount of slack resources available internally. The technological context describes both the internal and external technologies relevant to the firm. This includes technologies existing inside the firm, as well as the pool of available technologies in the market. The environmental context is the arena in which a firm conducts its business—its industry, its competitors, its access to resources supplied by others, and its dealings with the government.

Meanwhile, using institutional theory as a lens to understand FEDI adoption, it is posited in [1] that mimetic, coercive, and normative pressures existing in an institutionalized environment may influence organizations' predisposition toward an IT-based interorganizational system. Mimetic pressures are observed when firms adopt a practice or innovation imitating the competitors. When a firm knows that a competitor has adopted an innovation, and that innovation has been a success, the firm tends to adopt the same innovation [28]. In fact, when facing problems of uncertainty in what concerns an innovation, decision makers choose to minimize search costs [29], save experimental costs [30], and avoid management risks [31]. The existence of mimetic pressures toward the adoption of innovations by organizations is confirmed in [32] and [33]. So, we consider that organizations could check their competition environment in order to evaluate the perspectives regarding EPS adoption. Coercive pressures are a set of formal or informal forces exerted on organizations by other organizations upon which the former organizations depend [34]. For instance, a customer firm, a mother company and a regulatory body may be sources of coercive pressures. In fact, it is understandable that a certain dominant entity, with great bargaining power, may impose to their dependents the adoption of programs, structures, or innovations [35]. Normative pressures come from dyadic relations where companies share some information, rules, and norms. Sharing these norms through relational channels among members of a network facilitates consensus, which, in turn, increases the strength of these norms and their potential influence on organizational behavior [36].

Beyond the results described before, other studies on the adoption of interorganizational information systems provided examples that were considered relevant, while building the research model and designing the research methodology. Such studies focused on electronic data interchange (EDI) [37]–[44], marketplaces [45], and e-business adoption [46]–[49].

III. Conceptual Model and Hypotheses

Even though interorganizational systems may contribute to firm's performance, little attention has been paid to interorganizational innovation [50]. This results in an opportunity to improve the knowledge regarding the EPS adoption phenomenon. Indeed, EPSs are different from other information systems, such as EDI or organizational systems, and consequently, they deserve an independent research to study their adoption. These differences can be explained from two points of view: 1) EPS specificities when compared to information systems in general and 2) EPS specificities when compared to EDI.

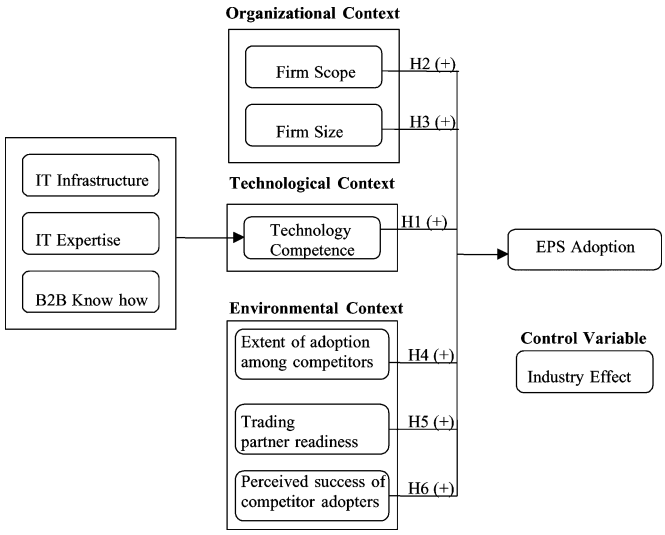

Fig. 2. Conceptual model for EPS adoption.

1) Since EPSs involve multiple organizations, their adoption requires an analysis that goes beyond the firm borders. That is why we consider a variable from outside the firm, such as the trading partner readiness. Indeed, the significance of trading partner readiness corresponds to an expectable consequence of the interorganizational specificity of EPSs, the increased relevance of the environmental context for its adoption.
2) Even though both EDI and EPS are interorganizational systems that are used to improve operational efficiency of the firm, as well as the supply chain where the firm is in, EPSs run over the Internet using protocols such as XML, while EDI is likely to run over older technologies. The technological differences between these two types of system imply that, in order to address EPS adoption, we must evaluate both the employees' capacities to use Internet technology (information gathered on IT expertise variable) and the executive's knowledge to manage online procurement (B2B know-how). These EPSs specificities taken into account in the questionnaire through the items regarding trading partner readiness as well as the executive's knowledge of managing online procurement.

Therefore, as shown in Fig. 2, the conceptual model for electronic procurement adoption is proposed based on the institutional theory, and on the technology–organization–environment framework, theories that were described in Section II-C.

This conceptual model includes three groups of variables, derived from the Tornatzky and Fleischer's organizational technological and environmental framework [27], and is controlled for the industry effect. Additionally, we included in these groups

of variables some variables derived from the institutional theory. Indeed, while trading partner readiness and variables from the organizational and the technological contexts were derived from the Tornatzky and Fleischer model, "extent of adoption among competitors" and "perceived success of competitive adopters" were derived from the institutional theory, previously described in Section II-C. The following sections specify each of the components of the conceptual model in Fig. 2.

A. EPS Adoption

The dependent variable in the conceptual model in Fig. 2 is the EPS adoption (EA). It is a discrete binary variable that is assigned a "1" if the company has already implemented an EPS. Otherwise EA holds a "0."

B. Technological Context

In the existing literature, technological resources have been consistently identified as an important factor for successful information systems adoption [39], [51], [52]. Hence, this study posits technology competence as an adoption driver, which encapsulates three subconstructs: 1) IT infrastructure—technologies that enable Internet-related businesses; 2) IT expertise—employees knowledge of using these technologies; and 3) B2B know-how—executive's knowledge of managing online procurement. On the grounds of these definitions, technology competence includes not only physical assets, but also intangible resources, since IT expertise and B2B know-how are complementary to physical assets [53]. These viewpoints lead to the following hypothesis.

H1: Firms with higher levels of technology competence are more likely to adopt EPSs.

For a more detailed evaluation procedure, H1 is split in three subhypotheses:

H1a: Firms with higher levels of IT infrastructure are more likely to adopt EPSs.

H1b: Firms with higher levels of IT expertise are more likely to adopt EPSs.

H1c: Firms with higher levels of B2B know-how are more likely to adopt EPSs.

C. Organizational Context

The existing literature has proposed that scope and size are important factors for technology adoption [27], [54]. The larger the firm's scope, defined here as the geographical dispersion of a firm's operation [2], the greater the demand for IT investment [55], [56], which suggests that scope can be considered as a predictor for EPS adoption. The role of scope as an adoption predictor can be explained from the following perspective: internal coordination costs increase with business scope due to the increased administrative complexity and information processing [57], while business digitalization can help reducing internal coordination costs [58] and improving inventory management [59]. Since business digitalization can reduce internal coordination costs and B2B can lower search costs for both sellers and buyers [60], firms with greater scopes are more likely to feel motivated to adopt EPS. This perspective leads to the following hypothesis.

H2: Firms with greater scopes are more likely to adopt EPS.

Firm size has also been consistently recognized as a technology adoption facilitator [61]. With regard to EPS adoption, larger firms have several advantages over small firms. Larger firms: 1) tend to have slacker resources to facilitate adoption; 2) are more likely to achieve economies of scale, an important concern due to the substantial investment required for e-business projects; 3) are more capable of bearing the high risk associated with early stage investments in e-business; and 4) possess more power to urge trading partners to adopt the technology. Therefore, it is reasonable to hypothesize the following.

H3: Larger firms are more likely to adopt EPS.

D. Environmental Context

Sociological research on threshold models suggests that decisions to engage in a particular behavior depend on the perceived number of similar others in the environment that have already done so [62]. Hence, if enough similar organizations act in a certain way, getting a particular course of action to become common throughout the sector, other firms will follow to avoid the embarrassment of being perceived as less innovative or less responsive [63]. So, in the context of EPS adoption, we can hypothesize as follows.

H4: Greater perceived extent of EPS adoption among competitors will lead to greater propensity to adopt an EPS.

A firm's EPS adoption decision may also be influenced by how ready its trading partners along the value chain are to adopt an EPS, since, for an electronic trade to take place, it is necessary that all trading partners adopt compatible electronic trading systems and provide Internet-enabled services for each other. Furthermore, EPSs may be more appropriate when there is a tight integration with suppliers' systems, which goes beyond the walls of an individual organization [64]. Conversely, a lack of trading partner readiness may hinder EPS adoption. So, we hypothesize the following.

H5: Firms with higher levels of perceived trading partner readiness are more likely to adopt EPS.

Although we could not find any studies examining mimicry of IT practices, there is implied evidence that followers, due to competitive pressures, imitate pioneers that have successfully exploited IT, especially in the banking and airline industries [65]. Therefore, in the context of EPS adoption, potential adopters will be more likely to adopt it if they perceive that EPS has conferred success to competitors that adopted such technology. Hence, we can hypothesize the following.

H6: Greater perceived success of competitors that have adopted EPS will lead to greater propensity to adopt an EPS.

E. Control Variable

Finally, industry effect recording whether the firm operates mainly on the manufacturing, commerce, or services industries,

TABLE I
MEASUREMENT OF VARIABLES IN THE CONCEPTUAL MODEL

Concept	Dimension	Scale	Study
EPS Adoption (EA)	(EAI = "1" for adopters; "0" to non adopters	Nominal	
Firm Scope (FS)	Number of establishments	Ratio	[64]
Firm Size (FSZ)	Number of effective employees	Ratio	[69]
Extent of adoption among competitors (AOC)	(Perception variable)	Interval; Likert (1 to 7)	[1]
Perceived success of competitor adopters (SOC)	(Perception variable)	Interval; Likert (1 to 7)	Adapted from [1]
Trading partner readiness (TPR)	(Perception variable)	Interval; Likert (1 to 7)	Adapted from [2]
Industry Effect (IE)	Dummy	Nominal	[64]

was used as an independent variable to control data variation not explained by the previous variables.

IV. RESEARCH METHODOLOGY

There are some parameters that should be evaluated to design a research project [66]: the purpose of the study, the type of the research, the unit of analysis, the time schedule, and the research environment. Beyond that, the research methodology section describes the universe of the study, the data collection methods, the survey pretest, and measurement issues.

The *purpose of the study* depends on the stage of knowledge development on the topic under analysis. A study may be either exploratory in nature, descriptive, or it may test hypotheses [66]. As described in Section IV, the purpose of this study is to validate a model to explain EPS adoption. The validation of the model depends on the test of six hypotheses proposing the relationships between the model's variables presented in Fig. 2.

The *research type* can be causal or correlational [66]. A causal research is supposed to meet the following criteria: 1) the cause must happen before the effect; 2) variations observed in causes should lead to systematic variations on effects; 3) variations on the effects should not be assigned to other factors except the causes [67]. Since the present research may not warrant these conditions, the study developed must be considered correlational.

The *unit of analysis* is a research design choice that is associated with the level of data aggregation [65]. In this research, the unit of analysis is the firm.

In what concerns the *time schedule*, a study may be longitudinal or cross-sectional [66]. The study is longitudinal when the data about the unit of analysis are collected from multiple points in time. When the data regarding the unit of analysis are collected on a single moment in time, the study is cross-sectional. Since the data for this research were collected just once and refer to just one moment in time, this study is cross–sectional.

The *research environment* refers to the extent of interference of the researcher in the place where the phenomena occur [66]. Therefore, we can have a field study, a field experiment, or a laboratory experiment. Field experiments and laboratory experiments should be carried out when the purpose of the research is to establish casual relationships. In such research environment, the interference of the researcher is moderate and high, respectively. Field studies are conducted when the researcher intends to perform correlational studies with minimal interference of the researcher, which is the present case.

Regarding the *universe of the study,* we think that a given phenomenon should be analyzed where it occurs. EPS is nowadays a phenomenon of the large companies. So, we have selected the 2500 largest companies operating in Portugal to empirically test the model developed in Section III.

In what concerns to *data collection methods* we used two categories of data sources: 1) a secondary source [68] that supplied the identification of the largest companies operating in Portugal, sorted by their total sales, as well as the data regarding dimension, measured by the number of employees, and the industry the firms belong to and 2) a primary data source collected through a questionnaire that was available on the Web, whose topics are listed in the Appendix. Beyond the Web site, we also developed a database with information that allowed us to send emails to chief information officers and chief purchasing officers from 1500 companies, chosen randomly from the list of the 2500 largest companies operating in Portugal.

The *questionnaire was pretested* through interviews with managers, academics, and EPS suppliers that assessed its overall quality. Based on the results of the pretest, the questionnaire was slightly adjusted toward improving the response rate as well as the data validity and reliability.

The *measurement of constructs* was done by looking at the behavioral dimensions, facets, or properties denoted by the concept. These are then translated into observable elements (indicators) to develop a measurement of the concept. Tables I and Tables II present the different concepts, dimensions, and indicators as well as the existing validated scales and the sources where we got their definitions.

V. RESULTS

About 80% of the respondents were people in relatively high positions in their companies (Table III), suggesting that the quality of the data source is appropriate for this research. Out of 1500 questionnaires sent, 300 companies responded, even though 60 responses were rejected since they contained errors or missing data. These figures correspond to a 16% of effective response rate.

Nonresponse is a potential source of bias in survey studies that needs to be properly addressed [69]. The potential bias in this study was evaluated by comparing responses between early and late respondents. Early respondents were defined as those

TABLE II
TECHNOLOGY COMPETENCE MEASUREMENT

Concept	Dimension	Indicators	Scale	Source
Technology Competence (TC)	IT Infrastructure (ITI)	*Company uses:* EDI; Internet; Intranet; E-mail; Groupware tools; Video-conference.	Nominal (Yes / No)	[2]
	IT Expertise (ITE)	*% of employees who can:* Send email internally; Send email externally; Browse internet sites; Browse intranet; Communicate via video-conferencing	Interval Likert (1 to 5)	
	B2B Know How (BKH)	(perception variable)	Interval Likert (1 to 7)	

TABLE III
SAMPLE CHARACTERISTICS: RESPONDENT POSITION AND INDUSTRY PROFILES

Respondent Position	Number of observations	Percentage	Industry	Number of observations	Percentage
CEO / Board Member	19	7.9 %	Manufacturing	119	49.4 %
Managing Director	8	3.3 %	Commerce	57	23.2 %
Chief Purchasing Officer	40	16,6 %	Services	64	27.4 %
Chief Information Officer	100	41.7 %	Total	240	100 %
Chief Financial Officer	25	10.4 %			
Other	48	20 %			
Total	240	100 %			

TABLE IV
PRELIMINARY EVALUATION OF HYPOTHESES

Variables hypothesized as EPS adoption related	Levene's Test for Equality of Variances			t-Test for Equality of Means (EPS Adopters - Non Adopters)			
	F	Sig.	Equal Var. Assumed	t-stat	df	Sig. (1-tailed)	Mean Difference
H1a - IT Infrastructure	0,005	0.946	Yes	4.031	238	0.000	0,708
H1b - IT Expertise	0.305	0.581	Yes	4.154	238	0.000	0.524
H1c - B2B Know How	0.040	0.842	Yes	6.730	238	0.000	1.681
H2 – Firm scope	4.026	0.046	No	0.851	51.8	0.199	27.16
H3 – Firm size	36.72	0.000	No	1.899	47.9	0.032	0.769
H4 – Adoption by competitors	64.70	0.000	No	6.834	52.2	0.000	1.790
H5 – Trading partner readiness	0.005	0.946	Yes	4.033	238	0.000	0.789
H6 – Perceived success of competitive adopters	39.57	0.000	No	4.062	57.1	0.000	0.953

who had completed the survey within the initial two weeks while late respondents were those who completed the survey after the specified response period. Around 65% of the responses were from early respondents. The tests for early and late respondents' homogeneity considered the firm's number of employees, the firm's industry, the respondent's position, and the sales volume of the company. No significant differences were found between the early and late respondent groups, suggesting that there was not a significant response bias.

A. Analysis

The data analysis evaluates the hypotheses proposed at two levels: 1) it evaluates the direction and the significance of the differences between the average value of each variable for the EPS adopters and nonadopters and 2) it combines the contribution of the various independent variables to explain EPS adoption using a logistic regression.

Once the sign of the difference is consistent with the hypothesis proposed and the value of the difference significant, that is, its p-value is below 0.05, we consider that there is a statistically significant relationship between the hypothesized variable or construct and the adoption of EPSs. The results of the t-test for homogeneity of means are shown in Table IV, together with the Levene's test for equality of variances. Note that the average differences that are shown in Table IV refer to the difference between the average value of the group of EPS adopters and the average value of the group of nonadopters, so the differences presented are positive when the statistic is higher for EPS adopters.

In order to decide to which hypotheses should we apply the heteroscedastic t-test versus the homocedastic t-test, we computed Levene's test for equality of variances. The independent variables that did not reject the null hypothesis of variance homogeneity were IT infrastructure, IT expertise, B2B know-how, and trading partner readiness. So, the homocedastic t-test is used only for these variables.

Since all hypotheses specified the direction of the expected relationship between the adoption of EPSs and each of the independent variables, the t-test is performed considering a single tail area of rejection. The differences of the independent variables' average values were statistically significant for all independent variables, except for the scope of the firm. So, we have to give

up on this variable and consider that, in what refers to the impact of firm scope on the likelihood of EPS adoption, this research is inconclusive.

On the other hand, the statistically significant differences of the average of the independent variables' values for the firms that have adopted EPS, from the firms that do not, provide evidence that there is a statistically significant relationship between each of the independent variables and the likelihood of adopting EPSs. So, we realized that the firms that adopted EPSs have, on average, a better IT infrastructure, more IT expertise, more B2B know-how, larger firm size, more competitors adopting this technology, suppliers better prepared to use an EPS, and perceive more success on the competitors that adopted EPSs. Since the firms that adopted EPSs have, on average, higher values on the independent variables mentioned, then the firms with higher values on these independent variables are more likely to adopt an EPS. So, we have preliminary support for the following hypotheses: firms with higher levels of IT infrastructure are more likely to adopt EPS (H1a); firms with higher levels of IT expertise are more likely to adopt EPS (H1b); firms with higher levels of B2B know-how are more likely to adopt EPS (H1c). The confirmation of these three subhypotheses leads to the confirmation of (H1). Firms with higher levels of technology competence are more likely to adopt EPS. Additionally, we affirm the following: (H3) larger firms are more likely to adopt EPS; (H4) firms perceiving that competitors are adopting or using EPS are more likely to adopt EPS; (H5) firms perceiving that trading partners are ready to adopt EPS are more likely to adopt EPS; and (H6) firms perceiving success of competitors that have adopted EPS are more likely to adopt EPS.

The former analysis does establish a set of relationships between the dependent variable, EPS adoption, and these independent variables. However, it does not attribute a weight to each of the independent variables, and does not combine the contribution of each of the independent variables toward explaining EPS adoption. According to [70], when we want to find a relationship between one dependent binary variable and a set of independent variables, we can use logistic regression or discriminant analysis. However, since the independent variables are a mixture of categorical and continuous variables, the multivariate normality assumption, required for discriminant analysis, will not hold [70]. So, logistic regression stands as the adequate option, as it does not make any assumptions regarding the distribution of the independent variables. The equation for the logistic regression is

$$\begin{aligned}\text{logit}(p) = \ln\left(\frac{p}{1-p}\right) &= \beta_0 + \beta_1 \times \text{FSZ} + \beta_2 \times \text{AOC} \\ &+ \beta_3 \times \text{SOC} + \beta_4 \times \text{TPR} + \beta_5 \times \text{ITI} + \beta_6 \times \text{ITE} \\ &+ \beta_7 \times \text{BKH} + \sum\nolimits_{i=1}^{3} (a_i \times \text{IE}_i) \qquad (1)\end{aligned}$$

where ln is the natural logarithm, $p = \Pr(\text{EA} = 1)$ is the probability of EPS adoption, $p/(1-p)$ is the "odds ratio—the probability of the event divided by the probability of the nonevent" [70], EA the EPS adoption, FSZ the firm size, AOC the extent of adoption among competitors, SOC the success of competitor adopters, TPR the trading partner readiness, ITI the IT infrastructure, ITE the IT expertise, BKH the B2B know-how, and IE is the industry effect. The a_i's ($i = 1, 2, 3$) are the regression coefficients for the control variables, where i represents each one of the economic sectors considered on the analysis (manufacturing, commerce, and services) and the β_j's (j = 0–7) are the regression coefficients of the independent variables.

TABLE V
DESCRIPTIVE STATISTICS OF THE VARIABLES USED IN THE LOGIT MODEL

Variable	N	Minimum	Maximum	Mean	Std. Deviation
EPS Adoption	240	0	1	0.20	0.41
Extent of Adoption Among Competitors	240	1	7	2.48	1.29
Trading Partner Readiness	240	1	7	3.02	1.25
IT Infrastructure	240	2	6	4.07	1,12
IT Expertise	240	1,2	4,1	3.16	0.75
B2B Know How	240	1	7	3,63	1.68
Firm Size (thousands of employees)	240	0.005	16.4	0.50	1.37

Based on this, we computed a logistic regression to explain the EPS adoption, taking into account the independent variables that are shown to be correlated with the dependent variable. Table V shows the descriptive statistics used on statistic tests, including the logit model.

However, one of the coefficients, SOC, the impact of the perceived success of competitors that have adopted EPS on the likelihood of adopting EPS, showed a sign opposite to what the hypothesis and the correlation coefficient would suggest. Such situation led us to carry out a multicollinearity analysis. In order to perform such analysis, we computed the correlation matrix (see Table VI), the variance inflation factors (VIFs) and the condition indexes that are presented in Table VII.

Since all VIFs are less than 10 [71], and all condition indexes are below 30 [72], it seems that these indicators are not reporting multicollinearity problems. However, as we can see from Table VI, Pearson correlation coefficient between SOC (success of competitor adopters) and AOC (extent of adoption among competitors) is 0.511, with a p-value less than 0.001 suggesting a significant correlation between these two variables.

So, we had to choose between SOC and AOC to run the logistic regression since the coexistence of the two variables on the logit model results in excessive multicollinearity. After an analysis of the model using each one of the variables, we choose AOC rather than SOC.[1]

B. Logit Model's Goodness-of-Fit

The overall logit model in (1) is assessed in three ways: first, the likelihood ratio (LR) test, which is similar to the F-test in linear regressions, examined the global explanation power of the independent variables. As this statistic is equal to 240.194 − 112.115 = 128.079 and the corresponding p-value <0.001,

[1]If the SOC variable is used instead of AOC, we get a regression coefficient for SOC less significant than for AOC; trading partner readiness loses its significance, and even though the regression coefficient of B2B know-how improves its significance, all the other coefficients lose or maintain their significance. Furthermore, when using SOC rather than AOC, the classification table presents only 79.2% of correct cases instead of 87.1% and the Nagelkerke's-R^2 decreases from 0.654 to 0.490. So, the comparison of the statistics of both alternatives recommends the usage of AOC rather than SOC on the logit model.

TABLE VI
COLLINEARITY DIAGNOSTICS: SIGNIFICANCE AND PEARSON CORRELATION COEFFICIENTS BETWEEN INDEPENDENT VARIABLES

	FSZ	AOC	TPR	ITI	ITE	BKH	SOC	FS
FSZ	1	0.019	.031	0.200	0.093	0.093	0.141	0.640
Sig.		0.775	0.629	0.002	0.152	0.149	0.029	0.000
AOC		1	0.274	0.063	0.032	0.319	0.511	-0.007
Sig.			0.000	0.330	0.624	0.000	0.000	0.912
TPR			1	-0.018	0.050	0.274	0.275	0.100
Sig.				0.787	0.436	0.000	0.000	0.123
ITI				1	0.553	0.268	0.102	0.119
Sig.					0.000	0.000	0.116	0.065
ITE					1	0.250	0.078	0.047
Sig.						0.000	0.231	0.473
BKH						1	0.194	0.122
Sig.							0.003	0.059
SOC							1	0.117
Sig.								0.071
FS								1

TABLE VII
COLLINEARITY DIAGNOSTICS: VIFS AND CONDITION INDEXES

	Variance Inflation Factor	Dimension	Condition Index
FSZ	1.756	1	1.000
AOC	1.497	2	2.154
TPR	1.183	3	4.479
ITI	1.545	4	6.119
ITE	1.475	5	7.311
BKH	1.287	6	7.553
SOC	1.440	7	11.720
FS	1.732	8	15.521
		9	18.005

it implies a strong relationship between the dependent variable and the independent variables considered in the model.

Second, the Hosmer–Lemeshow test [73] was also used to evaluate the model's goodness-of-fit. This test divides subjects into deciles based on predicted probabilities and computes a chi-square from observed and expected frequencies. The value of the Hosmer–Lemeshow statistic, which is 6.417, was computed from the chi-square distribution with eight degrees of freedom, resulting in a p-value of 0.601. Since this p-value refers to how significant the departure of the data from the model is, we may not reject the null hypothesis that the model fits the data, because it does not depart significantly from the model at any conventional significance level.

Therefore, the model's estimates fit the data at an acceptable level. As we can see in the next paragraph, this does not mean that the model explains much of the variance in the dependent variable, only that it does so to a significant degree.

Third, two pseudo-R^2 measure the proportion of data variation explained by the independent variables in the logit model: Nagelkerke's-R^2 and McFadden-R^2. The Nagelkerke's-R^2 was collected directly from SPSS output and its value is 0.654, while the McFadden-R^2 holds a value of 0.533. Taking into account the average value of both indicators, we have a pseudo-R^2 of 0.594, indicating that about 59.4% of data variation is explained by the logit model.

C. Discriminating Power

In order to evaluate the discriminating power of the logit model, we compared three indicators, the random guess ratio, the correct prediction value given in the classification table (see Table VIII), and the relative entropy, according to [74] and [75].

The classification table shows correct and incorrect estimates where the columns correspond to the two predicted values of the dependent variable, while the rows correspond to the two observed (actual) values of the dependent. With a perfect fit, all cases would be on the diagonal and the percentage of correct estimates would be 100%. Since the sample is unbalanced, the cutoff value in the classification table has to be set to $48/240 = 0.2$ [76]. As we can see from Table VIII, the observed percentage of correct estimates is 87.1% while the random guess ratio is 80% or 68% depending on the method of its calculation. Indeed, if we assume the naive hypothesis of having all predictions as nonadopters, since that is the most common case in the population, then we would have a correct prediction rate of $(192/240 = 80\%)$. On the other hand, if we compute the random guess ratio according to Zhu *et al*. [2], distributing predictions according to the weights of adopters and nonadopters and using the formula $(\mathrm{nA}/N)^2 + (A/N)^2$, where $\mathrm{nA} = 192$ is the number of nonadopters, $A = 48$ is the number of EPS adopters, and $N = \mathrm{nA} + A = 240$, then a 68% correct prediction rate is obtained for the random guess ratio. So, the classification accuracy by random guess (80% or 68%) is poorer than the value obtained from the classification table of the logit model (87.1%), indicating that the logit model has higher discriminating power.

Additionally, we computed the relative entropy between the distribution of the estimates and the distribution of the observed values of the dependent variable that holds the value of 0.0046. Since the relative entropy is close to zero, and according to [75], identical distributions hold zero relative entropy, these probability distributions are somewhat close.

In summary, the logit model shows substantive model fit and good discriminating power. The signs of all betas are according

TABLE VIII
CLASSIFICATION TABLE—COMPARING THE PREDICTED AND OBSERVED OUTCOMES

Observed	Predicted		
	0	1	Percentage Correct
0	169	23	88.0
1	8	40	83.3
Overall Percentage			87.1

TABLE IX
LOGISTIC REGRESSION COEFFICIENTS AND THEIR SIGNIFICANCE LEVELS

Independent variables on the logistic regression	**Regression Coefficients (β_i and a_i)**	**Sig.**	**exp (β_i) and exp (a_i)**
H1a – IT Infrastructure	0.720	0.012	2.054
H1b – IT Expertise	1.317	0.004	3.734
H1c – B2B Know How	0.380	0.019	1.462
H3 – Firm size	0.585	0.009	1.795
H4 – Perceived extent of adoption among competitors	1.286	0.000	3.619
H5 – Trading partner readiness	0.339	0.093	1.403
Control binary variable – firm operating in the manufacturing industry	-0.735	0.231	0.479
Control binary variable – firm operating in the commerce area	2.391	0.000	10,92

to the hypotheses and preliminary testing with the correlation, except for the belonging to the industry sector variable. Note that all the regression coefficients are significant at the 0.005 level, except the trading partner readiness variable that is significant at the 0.1 level. Since the nonsignificance of beta for belonging to the industry sector variable does not raise a major problem to the reliability of the regression results, we accepted these results whose betas and significances are shown in Table IX.

These results provide further evidence to support the following hypotheses: firms with higher levels of IT infrastructure are more likely to adopt EPS (H1a); firms with higher levels of IT expertise are more likely to adopt EPS (H1b); firms with higher levels of B2B know-how are more likely to adopt EPS (H1c). Additionally, we affirm the following: (H3) larger firms are more likely to adopt EPS; (H4) firms perceiving that competitors are adopting or using EPS are more likely to adopt EPS; and (H5) firms perceiving that trading partners are ready to adopt EPS are more likely to adopt EPS.

This also confirms most of the results of the preliminary testing and integrates the impact of this set of variables in a model, a logistic regression that, based on the variables mentioned earlier, classified correctly 90.4% of the sample cases and provided a pseudo-R^2 of 59.4%.

D. Interpreting the Regression Coefficients

The logit regression coefficients refer to the rate of change in the "ln(odds ratio)" as independent variables change rather than to the rate of change in EA (EPS adoption). So, $\exp(\beta)$ is the effect of the independent variable on the "odds ratio." For instance, as $\exp(\beta_5) = 2.054$, then a one-unit change in IT infrastructure would make the EPS adoption around two times as likely to occur. Negative regression coefficients lead to odds ratios less than 1. For example, if $a_1 = -0.735$ and $\exp(a_1) = 0.479$, then a company whose main activity is manufacturing has less chances of adopting an EPS than a company that does not belong to the same industry.

VI. DISCUSSION

A. Major Findings

Finding 1: IT infrastructure, IT expertise, B2B know-how, firm size, trading partner readiness, perceived success of competitor adopters, and extent of adoption among competitors are significant EPS adoption facilitators. This finding is grounded on the significant differences of the variables, when the two groups are compared, the EPS adopters and the non-EPS adopters (Table IV). The significant *t*-test statistics provide strong support for hypotheses H1a, H1b, H1c, which confirms H1. Additionally, we got evidence to confirm H3–H6. These results are consistent with the theoretical reasoning based on the technology–organization–environment framework and on the institutional theory.

Finding 2: With the data collected, firm scope does not differentiate EPS adopters from nonadopters, since the scope difference between EPS adopters and nonadopters is not significant (Table IV). This result is not consistent with the theory developed in Section III-C that hypothesizes scope as an EPS adoption facilitator.

Finding 3: The factors facilitating adoption that are mentioned before are not equal in importance toward explaining the firms' adoption of EPSs. Indeed, the results presented in Table IX provide the highest significance (0.000) to the perceived extent of adoption among competitors, while IT expertise and firm size are significant at the 0.01 level. The other two components of technology competence, IT infrastructure and B2B know-how, are significant at the 0.05 level, while trading partner readiness is significant only at the 0.10 level.

Finding 4: Firms whose main activity is commerce have more propensity to adopt EPSs than that of firms belonging to manufacturing or services industries. This result is suggested by the

significance (0.000) of the coefficient of the control binary variable firm whose main activity is in commerce (2.391), which is presented in Table IX.

B. Limitations

Our results are constrained by missing answers to some questions. When asked about their perception regarding EPSs penetration on competitors, a great number of people responded that they did not know. The same happened for their perception of EPSs success on competitors. However, we tried to minimize this limitation in two ways: 1) calling people when possible in order to get that information and 2) calculating and using the average value of the variable when running statistical tests. Additionally, we did not get empirical data from small and medium companies, so readers should be cautious in generalizing these results.

C. Managerial Implications

The findings mentioned in Section VI-A constitute important results, not only for academics, who may be interested in the conceptual model to explain EPS adoption, but also for other economic agents. Indeed, once the factors that foster EPS adoption are identified, economic agents may act accordingly and develop better programs in order to achieve their objectives. The governments can use these results as an input to design more appropriate policies and programs toward the firms' technological development. The implementation of better programs may have a positive effect on the percentage of firms using EPS, resulting in efficiency gains in the economy as a whole. Furthermore, EPS's vendors and consultants can use these results to develop better marketing and sales plans and focus their strategies on companies whose propensity to adopt EPS is large enough to deserve a sales effort.

VII. Conclusion and Future Research

Any technology adoption process is influenced by some factors that make the difference between the firms that adopt an EPS and those that do not. This paper focuses on identifying the factors that influence the adoption of EPS. The literature review provided a set of factors that are likely to influence EPS adoption, factors that were gathered in the research model from which the hypotheses were derived. The research hypotheses raised are the following: (H1) firms with higher levels of technology competence are more likely to adopt EPS, which is split as follows: (H1a) firms with higher levels of IT infrastructure are more likely to adopt EPS, (H1b) firms with higher levels of IT expertise are more likely to adopt EPS, and (H1c) firms with higher levels of B2B know-how are more likely to adopt EPS; (H2) firms with greater scope are more likely to adopt EPS; (H3) larger firms are more likely to adopt EPS; (H4) greater perceived extent of EPS adoption among competitors will lead to greater intent to adopt EPS; (H5) firms with higher levels of perception of trading partner readiness are more likely to adopt EPS; and (H6) greater perceived success of competitors that have adopted EPS will lead to greater propensity to adopt an EPS. Out of these hypotheses, H1a, H1b, H1c, H3, H4, H5, and H6 are confirmed. However, H2 (firms with greater scope are more likely to adopt EPS) was not confirmed because of its low significance level (0.199).

In order to address the second research question, "How likely is a specific organization to adopt an EPS?" as well as the second part of the first research question, we used a logistic regression that provided evidence on two relevant issues: 1) IT infrastructure, IT expertise, B2B know-how, firm size, perceived extent of adoption among competitors, and trading partner readiness are a set of factors that can be used to estimate each firm's likelihood of adopting EPS and 2) based on the significance of the logistic regression coefficients, the independent variables may be organized in three groups according to their relative relevance to explain EPS adoption. The group of the most important variables to determine EPS adoption includes the "perceived extent of adoption among competitors" and the fact that a firm belongs to the commerce industry. The group composed of "IT expertise," and "firm size" comes in second place in what refers to relevance toward explaining EPS adoption. Finally, the third group includes the "IT infrastructure," "B2B know-how," and the "trading partner readiness."

Beyond the test of hypotheses, this research also identifies the differences between EPS adopters and nonadopters. Indeed, EPS adopters present a better IT infrastructure than do nonadopters since the difference between the average values of the two groups is significant at 0.001 level, as we can see in Table IV. Additionally, EPS adopters have, on average, more employees than do nonadopters, higher levels of IT expertise and B2B know-how, higher perception of extent of EPS adoption among competitors, and superior levels of expectations regarding their trading partners' ability to do business electronically since all these differences are significant at least at the 0.05 level, as shown in Table IV.

Finally, based on Table IX, only one of the control variables is significant, the variable identifying firms operating in commerce, $a_2 = 2.391$ with p-value <0.001, suggesting that firms operating in the commerce area are more likely to adopt EPSs than organizations from manufacturing or service industries.

This study is only a first step toward understanding factors influencing the EPS adoption. For a holistic understanding of the EPS phenomenon, EPS implementation and its impact on firms' performance should be studied. Such study would be longitudinal rather than cross-sectional, in order to allow the analysis of early versus late EPS adopters.

Taking into account the finding that firm scope was inconclusive regarding the differentiation between EPS adopters and nonadopters, it is also recommended that additional research be developed toward understanding why firm scope was not confirmed as an EPS adoption facilitator.

Since we do not know whether the results would apply if we extend the sample to smaller firms, there is an opportunity to broaden this research in the future. It is also uncertain that these results would apply if we extend the sample to other countries. Indeed, smaller firms and different countries have specificities

that must be addressed in order to extend to them the current research model.

APPENDIX A

MEASUREMENT ITEMS FOR KEY RESEARCH VARIABLES

Identification Code _____

Organization Name: _____

Respondent Name: _____

Company Position:

President or Vice-President __

Purchase Manager __

Chief Information Officer __

Financial Manager __

Other __

Is there an Electronic Procurement System (EPS) running in your Organization? (EAI)

Yes ____

No ____

We have a plan to implement it within 18 months. ____

Which is the number of physical establishments (buildings, offices, stores, warehouses, etc) where the organization develops business activities? (FS) _____

EPS perceived extent of adoption by competitors (AOC)

1: None has adopted; 7: All have adopted; Don't know

EPS perceived success of competitors that have adopted EPS (SOC)

1:Strongly disagree; 7: Strongly agree; Don't know

Perceived trading partner readiness of suppliers (TPR)

1:Absolutly not prepared; 7: Completely prepared; Don't know

IT Infrastructure (ITI)

Does the firm use EDI? (Yes / No)

Does the firm have access to internet?(Yes / No)

Does the firm have an intranet? (Yes / No)

Does the firm use email? (Yes / No)

Does the firm use groupware tools? (Yes / No)

Does the firm have video-conference? (Yes / No)

IT Expertise (ITE)

Which is the percentage of employees who can send email to internal addresses?

(1: All employees; 5: None)

Which is the percentage of employees who can send email to external addresses?

(1: All employees; 5: None)

Which is the percentage of employees who can browse internet sites?

(1: All employees; 5: None)

Which is the percentage of employees who can browse intranet sites?

(1: All employees; 5: None)

Which is the percentage of employees who can communicate via video-conference?

(1: All employees; 5: None)

B2B Know How

The executives of the firm have sufficient know how to implement an EPS.

1:Strongly disagree; 7: Strongly agree; Don't know

ACKNOWLEDGMENT

The authors would like to thank the valuable contributions of the anonymous reviewers that helped in major improvements of this paper and Dr. A. Silvestre for discussing some issues of the statistical approach.

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