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EVALUATING THE FIRM'S LIKELIHOOD TO ADOPT AN E-PROCUREMENT SYSTEM

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Abstract

Towards identifying the factors that foster electronic procurement systems adoption, we reviewed the literature and developed a model that explains electronic-procurement systems (EPS) adoption, 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. Based on 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 trading partner readiness 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 which main activity is commerce are more likely to adopt EPSs than firms operating on manufacturing or services industries.

Index Terms— electronic procurement systems, institutional theory, likelihood of adoption, Portugal, survey method, technology-organization-environment framework.

I. INTRODUCTION

Why do some organizations adopt electronic procurement systems (EPS) while others do not? May be some organizations need it or know the value an EPS can bring to them. Perhaps some organizations do not have the capacity to implement it and 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 EDI (Electronic Data Interchange) 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 consider some variables which are potentially relevant for EPSs adoption. Institutional theory does not consider the capacity of the firm's managers to deal with EPS, while the technology-organization-environment framework does not consider mimetic pressures that can influence an organization to adopt an EPS. The present paper considers both theories in 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]. Based on these results, we posit that politicians, knowing the results of this study, will be able to define better policies in what concerns to developing 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 to 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 to ascertain what makes a difference in what regards to EPS adoption. This leads to the following research questions: (i) What are the factors that foster the adoption of EPSs? What is their relative relevance? (ii) How likely is a specific organization to adopt an EPS? (iii) What are the features that differentiate EPS adopters from non-adopters? (iv) Which are the industries with more propensity to adopt EPSs?

In order to ascertain the answers for these questions, the existing literature was reviewed to gather the information needed for developing a research model containing a set of factors for explaining the firm's likelihood to adopt EPSs. Beyond that, data about EPSs adopters and non-adopters 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; The second Section presents a literature review about EPSs, their importance and impacts as well as the models addressing the adoption of innovations; Section IV develops a conceptual model that includes six research hypotheses; The fifth Section describes the research methodology that was used in order to answer the research questions; Section VI analyses and discusses the results achieved 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 (subsection A), its relevance and impacts on organizations (subsection B), and the existing models explaining the adoption of new technologies (subsection 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.

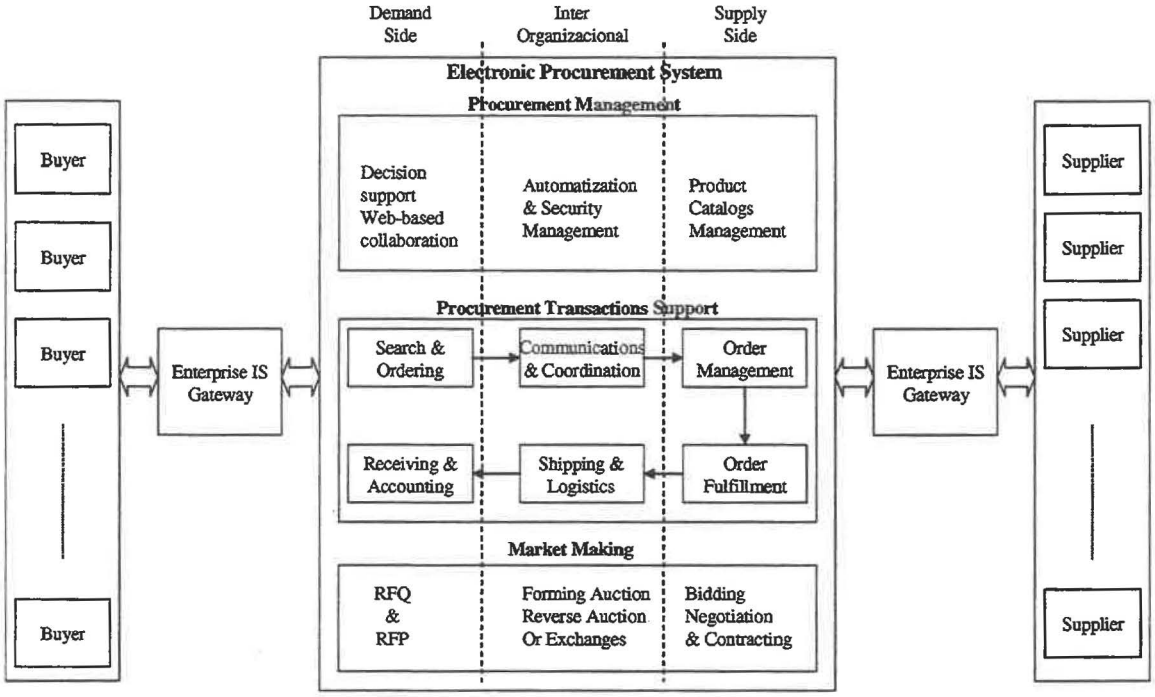

Fig. 1. Main functionalities of an e-procurement system. Adapted from Subramaniam (2004)

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 Inter-Organizational 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.

Out of these features, the transaction support ends up being 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 assures the quality of the messages transmitted between the agents involved on transactions.

Once the firms have adopted the functionalities above, they can also use a more advanced market-making functionality to do 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 e-procurement system to electronically conduct auctions or to run a B2B exchange where 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 supply chain integration are likely to yield higher levels of performance [16]. Obviously, the EPSs make a contribution towards 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 on 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 bring up as a result of an EPS implementation. For instance, people on 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. Adding to this, 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 to go 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 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 electronic procurement system, whether such change represents a benefit for the organization or not is an issue that is not the subject 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]. Focusing on the financial impact of EPS on organizations, [18] developed a Delphi study with three rounds of interviews to executives holding high management positions on the financial, information systems and purchasing departments as well as account managers. On that study, consensus was achieved regarding the data on Table I.

TABLE I - ADMINISTRATIVE COST ANALYSIS

Process Stage	**Manual Process**	**EPS - Using the manual system costs as the base index (=100) (Adjusted Costs)**
Requisition Generation	66	29.2

Requisition Distribution	6	0.0
Order Generation	10	1.5
Order Distribution	1	0.0
Expedition	1	0.3
Goods Receipt	4	1.5
Invoice Processing	9	0.7
Material	3	0.0
Total	100	33.2

Analyzing the data on Table I, we realize that organizations using EPSs have a significant advantage over organizations that use manual processes to acquire goods and services. 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 considered to support the importance of electronic procurement systems, all acknowledging that most information technology 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 of the firm, which explains firm performance based on organizational resources and capabilities. The Resource-Based View (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 resource-based view 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, data-bases, technical platforms, and communication networks form the core of a firm's overall IT infrastructure resources. On the same way, EPSs may provide value to a firm, by combining the firms' resources and capabilities, such as manpower, knowledge regarding suppliers and the specificities of their products, as well as the firms' organizational procedures, towards 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 towards achieving 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 subsection shows that the RBV and DCP theories provide support to

justify a research towards ascertaining what are the determinant factors of EPSs adoption and to evaluate the differences between EPS adopters and non adopters.

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: organizational context, technological context, and environmental context. 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. 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. Environmental context is the arena in which a firm conducts its business - its industry, competitors, access to resources supplied by others, and dealings with government.

Meanwhile, using institutional theory as a lens to understand Financial Electronic Data Interchange (FEDI) adoption, [1] posits that mimetic, coercive and normative pressures existing in an institutionalized environment may influence organizations' predisposition towards an information technology based inter-organizational 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, facing problems of uncertainty in what concerns to an innovation, decision makers choose to minimize search costs [29], save experimental costs [30] and avoid management risks [31]. The existence of mimetic pressures towards 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 on [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 above, other studies on inter-organizational information systems adoption provided examples that were considered relevant while building the research model and designing the research methodology. Such studies focused on EDI, [37] - [44], Marketplaces [45] and e-business adoption, [46] - [49].

III. CONCEPTUAL MODEL AND HYPOTHESES

Even though inter organizational systems may contribute to firm's performance, little attention has been provided to inter-organizational innovation [50]. That 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, deserve an independent research to study their adoption. They are different because they overcome firm borders, use a recent technology (compared to EDI technology), its implementation depends on trading partners readiness and, in most cases, are used to improve operational efficiency of the firm as well as the supply chain where the firm is in. So, based on the institutional theory, and on the technology-organization-environment framework, we propose a conceptual model for electronic procurement

adoption, which is shown in Fig. 2.

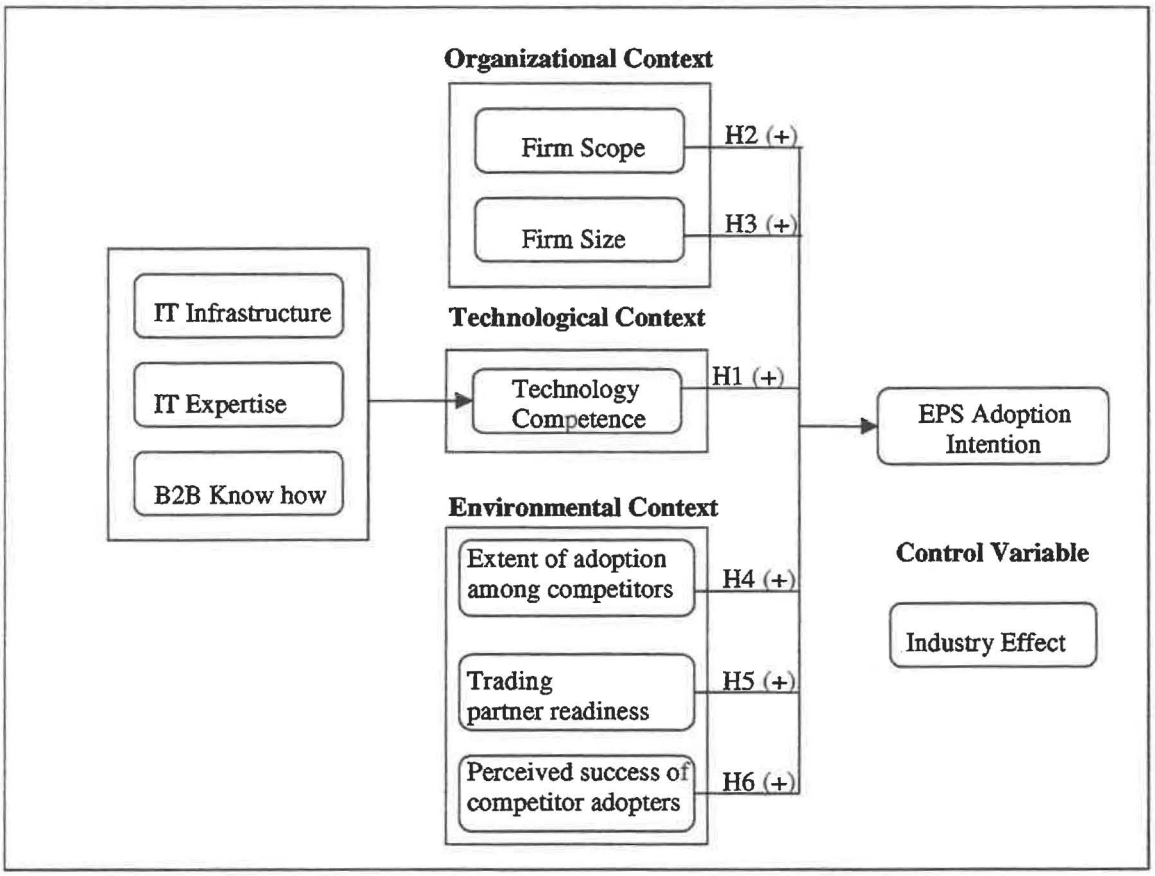

Fig. 2. *Conceptual Model for EPS Adoption*

This conceptual model posits six main predictors for EPS adoption within a three-context framework (technological, organizational and environmental) and is controlled for industry effects. The description of the model's components follows.

A. EPS Adoption

The dependent variable in the conceptual model in Fig. 2 is the EPS adoption (EA). It is a discrete binary variable which 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 IS adoption [39], [51], [52]. Hence, this study posits

technology competence as an adoption driver, which encapsulates three sub-constructs: (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. Based on 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 on three sub-hypotheses:

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 [54], [27]. 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], what 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 more slack 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 that:

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 that:

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 are its trading partners along the value chain 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 that:

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 that:

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, 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 research type, the unit of analysis, the time horizon, and the research environment. Beyond that, the research methodology section describes the universe of the study, the data collection methods, the survey pre-test 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 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 on 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 the present research the unit of analysis is the firm.

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

The *research environment* refers to the extent of interference of the researcher in the place where the phenomena occurs [66]. Therefore, we can have a field study, a field experiment or a laboratory experiment. Field experiments and laboratory experiments should be carried on when the research purpose is establishing 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 on Section III.

In what concerns to *data collection methods* we used two categories of data sources: (1) a secondary source, [69], 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 on Appendix A. Beyond the web site, we also developed a data base 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 pre-tested* through interviews with managers, academics and EPS suppliers that assessed the overall quality of the questionnaire. Based on the results of the pre-test, the questionnaire was slightly adjusted towards 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 II and III present the different concepts, dimensions and indicators as well as the existing validated scales and the sources where we got their definitions.

TABLE II - 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]

TABLE III - 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	Interval Likert (1 to 5)	

		externally; Browse internet sites; Browse intranet; Communicate via video-conferencing	
	B2B Know How (BKH)	(perception variable)	Interval Likert (1 to 7)

V. RESULTS

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

TABLE IV - 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 %			

Non-response is a potential source of bias in survey studies that needs to be properly addressed [71]. The potential bias in this study was evaluated by comparing responses between early and late respondents. Early respondents were defined as those 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 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 non adopters; and (2) it combines the various independent variables' contribution for explaining 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 bellow 0.05, we consider that there is a statistically significant relationship between the hypothesized variable or construct and the EPSs adoption. The results of the t-test for homogeneity of means are shown in Table V, together with the Levene's test for equality of variances. Note that the mean differences that are shown on Table V refer to the difference between the average value of the group of EPS adopters and the average value of the group of non adopters, so the differences presented are positive when the statistic is higher for EPS adopters.

TABLE V - 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

In order to decide in which hypotheses should we apply the heteroscedastic t-test versus

the homocedastic t-test, we computed the 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' means 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. Once 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 sub-hypotheses leads to the confirmation of (H1) Firms with higher levels of technology competence are more likely to adopt EPS. Additionally, we have support to (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 towards explaining EPS adoption. According to [72], 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 [72]. 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:

$$\text{logit}(p)=\ln\left(\frac{p}{1-p}\right)=\beta_0+\beta_1*FSZ+\beta_2*AOC+\beta_3*SOC+\beta_4*TPR+\beta_5*ITI$$
$$+\beta_6*ITE+\beta_7*BKH+\sum_{i=1}^{3}(a_i*IE_i) \qquad (1)$$

where ln is the natural logarithm, p = Pr (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", [72], EA stands for EPS Adiotion, FSZ stands for Firm Size, AOC stands for Extent of Adoption Among Competitors, SOC stands for Success of Competitor Adopters, TPR stands for Trading Partner Readiness, ITI stands for IT Infrastructure, ITE stands for IT Expertise, BKH stands for B2B Know How and IE stands for 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.

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

TABLE VI - 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

However, one of the coefficients, SOC, the impact of the perceived success of competitors that have adopted EPS on the likelihood to adopt 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, Table VII (A), the variance inflation factors (VIF) and the condition indexes that are presented on Table VII (B).

TABLE VII (A): 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 (B): COLLINEARITY DIAGNOSTICS: VARIANCE INFLATION FACTORS 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

Since all VIFs are shorter than 10 [73], and all condition indexes are bellow 30 [74], it seems that these indicators are not reporting multicollinearity problems. However, as we can see from Table IX (A), 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 give up SOC in order to get reliable results since SOC would display a signal change on the regression model due to seveer multicolinearity. Therefore, the model tested in the logistic regression is that IT Infrastructure, IT Expertise, B2B Know How, firm size, perception of supplier readiness to adopt EPS, and the perceived extent of adoption among competitors, may explain why some firms adopt EPSs, while others do not. The following Section examines the refined model.

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

Second, the Hosmer – Lemeshow test [75] 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 is the departure of the data from the model, 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 on 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 on the classification

table showed on Table VIII and the relative entropy, according to [76] *op.cit.*[77].

TABLE VIII - CLASSIFICATION TABLE – COMPARING THE PREDICTED AND OBSERVED OUTCOMES

Observed	Predicted		
	0	1	Percentage Correct
0	185	7	96.4
1	16	32	66.7
Overall Percentage			90.4

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%. As we can see from Table VIII, the observed percentage of correct estimates is 90.4% while the random guess ratio is 80%. Indeed, if we assume the naive hypothesis of having all predictions as non adopters since that is the most common case in the population, then we would have a correct prediction rate of (192/240=80%) which compares to 90.4%. So, the classification accuracy by random guess (80%) is poorer than the value obtained from the classification table of the logit model (90.4%) 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 which holds the value of 0.0046. Since the relative entropy is close to zero and, according to [77], 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 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 non-significance of the beta for the 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.

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

These results provide further evidence to support the hypotheses that: 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 have support to (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 above, classified correctly 90.4% of the sample cases and provided a Pseudo R-square 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 one. For example, if $a_1 = -0,735$ and $\exp(a_1) = 0,479$, then a company whose main activity is manufacturing has less chances to adopt 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 V). The significant t-test statistics provide strong support for hypotheses H1a, H1b, H1c, which confirms H1. Additionally we got evidence to confirm H3, H4, H5 and 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 colected, firm scope does not differentiate electronic procurement systems adopters from non adopters, since the scope difference between EPS adopters and non adopters is not significant (Table V). This result is not consistent with the theory developed on Sub-section III.C that hypothesizes scope as an EPS adoption facilitator.

Finding 3: The factors facilitating adoption, which are mentioned above, are not equal in importance towards explaining the firms' adoption of EPSs. Indeed, the results presented on 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 which main activity is commerce have more propensity to adopt EPSs than 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 on Table IX.

B. Limitations

Our results are constrained by missing answers to some questions. When asking people about their perception regarding EPSs penetration on competitors, a great number 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 executing 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 on Sub-section VI.A constitute important results, not only for academics, who may be interested on the conceptual model to explain EPS adoption, but also for other economic agents. Indeed, once the factors that foster electronic procurement systems 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 towards the firms' technological development. The implementation of better programs may have a positive effect on the

percentage of firms using electronic procurement systems, resulting on 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 which propensity to adopt EPS is large enough to deserve a sales effort.

VII. CONCLUSIONS AND FUTURE RESEARCH

Any technology adoption process is influenced by some factors thtat 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 electronic procurement systems (EPSs). The literature review provided a set of factors that are likely to influence the EPS adoption, factors that were gathered in the research model from which the hypotheses were derived. The research hypotheses raised are: (H1) Firms with higher levels of technology competence are more likely to adopt EPS, which is split on 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 the hipotheses above, H1a, H1b, H1c, H3, H4, H5 and H6 are confirmed. However, hypothesis two, "Firms with greater scope are more likely to adopt EPS" was not confirmed because of its low significance level (0.199).

Additionally, a logistic regression provided further evidence that 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 to adopt EPS.

Beyond the test of hypotheses, this research also identifies the differences between EPS adopters and non adopters. EPS adopters present more technology competence than non adopters, bigger firm size, higher perception of extent of EPS adoption among competitors and superior levels of expectations regarding their trading partners' ability to do business electronically.

Finally, based on Table IX, there is only one significant control variable, $a_2 = 2{,}391$ with p-value < 0.001, suggesting that firms operating in the commerce area are more likely to adopt EPSs than organizations from manufacturing or services industries.

In what concerns to future research, this study is only a first step towards understanding factors influencing the EPS adoption intention. 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 non adopters, it is also recommended that additional research be developed towards 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: _____

Charge

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

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