

Literature Review of Information Technology Adoption Models at Firm Level

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Abstract: Today, information technology (IT) is universally regarded as an essential tool in enhancing the competitiveness of the economy of a country. There is consensus that IT has significant effects on the productivity of firms. These effects will only be realized if, and when, IT are widely spread and used. It is essential to understand the determinants of IT adoption. Consequently it is necessary to know the theoretical models. There are few reviews in the literature about the comparison of IT adoption models at the individual level, and to the best of our knowledge there are even fewer at the firm level. This review will fill this gap. In this study, we review theories for adoption models at the firm level used in information systems literature and discuss two prominent models: diffusion on innovation (DOI) theory, and the technology, organization, and environment (TOE) framework. The DOI found that individual characteristics, internal characteristics of organizational structure, and external characteristics of the organization are important antecedents to organizational innovativeness. The TOE framework identifies three aspects of an enterprise's context that influence the process by which it adopts and implements a technological innovation: technological context, organizational context, and environmental context. We made a thorough analysis of the TOE framework, analysing the studies that used only this theory and the studies that combine the TOE framework with other theories such as: DOI, institutional theory, and the Iacovou, Benbasat, and Dexter model. The institutional theory helps us to understand the factors that influence the adoption of interorganizational systems (IOSs); it postulates that mimetic, coercive, and normative institutional pressures existing in an institutionalized environment may influence the organization's predisposition toward an IT-based interorganizational system. The Iacovou, Benbasat, and Dexter model, analyses IOSs characteristics that influence firms to adopt IT innovations. It is based on three contexts: perceived benefits, organizational readiness, and external pressure. The analysis of these models takes into account the empirical literature, and the difference between independent and dependent variables. The paper also makes recommendations for future research.

Keywords: information technology, diffusion of innovations (DOI) theory, technology-organization-environment (TOE) framework, interorganizational systems (IOSs), institutional theory

1. Introduction

These days, information technology (IT) is universally regarded as an essential tool in enhancing the competitiveness of the economy of a country. It is commonly accepted today that IT has significant effects on the productivity of firms. These effects will only be fully realized if, and when, IT are widely spread and used. It is crucial, therefore, to understand the determinants of IT adoption and the theoretical models that have arisen addressing IT adoption. There are not many reviews of literature about the comparison of IT adoption models at the individual level, and to the best of our knowledge there are a smaller number at the firm level. This review will fill this gap.

In this study, we review theories for adoption models at the firm level used in information systems (IS) literature and discuss two prominent models, presented in Section 2. The two models reviewed are: diffusion on innovation (DOI) (Rogers 1995); and the technology, organization, and environment (TOE) framework (Tornatzky and Fleischer 1990), since most studies on IT adoption at the firm level are derived from theories such as these two (Chong *et al.* 2009). Section 3 presents an extensive analysis of the TOE framework, analysing the studies that used only this theory and the studies that combine the TOE framework with other theories such as: DOI, institutional theory, and the Iacovou *et al.* (1995) model. In the last section, we present the conclusions.

2. Models of IT adoption

There are many theories used in IS research (Wade 2009). We are interested only in theories about technology adoption. The most used theories are the technology acceptance model (TAM) (Davis 1986, Davis 1989, Davis *et al.* 1989), theory of planned behaviour (TPB) (Ajzen 1985, Ajzen 1991), unified theory of acceptance and use of technology (UTAUT) (Venkatesh *et al.* 2003), DOI (Rogers 1995), and the TOE framework (Tornatzky and Fleischer 1990). We will develop only the DOI, and

especially the TOE framework, because they are the only ones that are at the firm level. The TAM, TPB and UTAUT are at the individual level.

2.1 DOI

DOI is a theory of how, why, and at what rate new ideas and technology spread through cultures, operating at the individual and firm level. DOI theory sees innovations as being communicated through certain channels over time and within a particular social system (Rogers 1995). Individuals are seen as possessing different degrees of willingness to adopt innovations, and thus it is generally observed that the portion of the population adopting an innovation is approximately normally distributed over time (Rogers 1995). Breaking this normal distribution into segments leads to the segregation of individuals into the following five categories of individual innovativeness (from earliest to latest adopters): innovators, early adopters, early majority, late majority, laggards (Rogers 1995). The innovation process in organizations is much more complex. It generally involves a number of individuals, perhaps including both supporters and opponents of the new idea, each of whom plays a role in the innovation-decision.

Based on DOI theory at firm level (Rogers 1995), innovativeness is related to such independent variables as individual (leader) characteristics, internal organizational structural characteristics, and external characteristics of the organization (Figure 1). (a) *Individual characteristics* describes the leader attitude toward change. (b) *Internal characteristics of organizational structure* includes observations according to Rogers (1995) whereby: “centralization is the degree to which power and control in a system are concentrated in the hands of a relatively few individuals”; “complexity is the degree to which an organization’s members possess a relatively high level of knowledge and expertise”; “formalization is the degree to which an organization emphasizes its members’ following rules and procedures”; “interconnectedness is the degree to which the units in a social system are linked by interpersonal networks”; “organizational slack is the degree to which uncommitted resources are available to an organization”; “size is the number of employees of the organization”. (c) *External characteristics of organizational* refers to system openness.

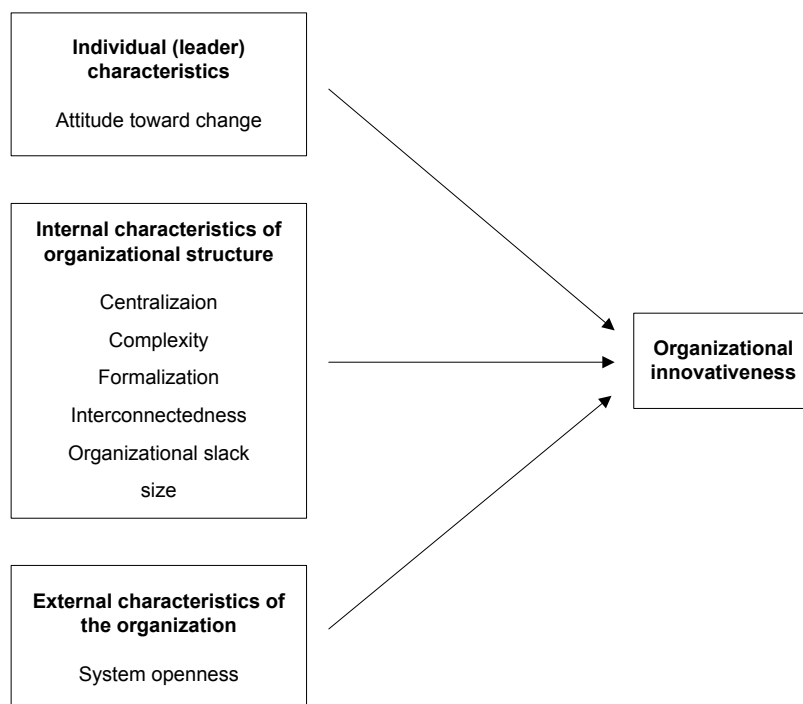


Figure 1: Diffusion of innovations (Rogers 1995)

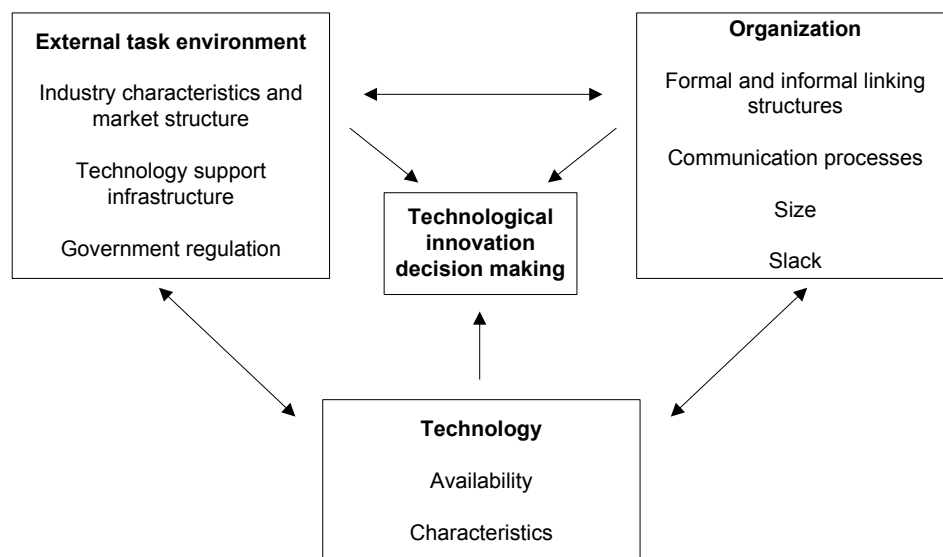
Since the early applications of DOI to IS research, the theory has been applied and adapted in various ways. Some examples are presented in Table 1.

Table 1: Some studies based on DOI theory (Rogers 1995)

IT Adoption	Author(s)
Material requirements planning (MRP)	(Cooper and Zmud 1990)
IS adoption (uses at least one major software application: accounting; inventory control; sales; purchasing; personnel and payroll; CAD/CAM; EDI; MRP), and extent of IS (number of personal computers and the number of software applications)	(Thong 1999)
Intranet	(Eder and Igbaria 2001)
Web site	(Beatty <i>et al.</i> 2001)
Enterprise resource planning (ERP)	(Bradford and Florin 2003)
E-procurement	(Li 2008)
E-business	(Zhu <i>et al.</i> 2006a)
E-business	(Hsu <i>et al.</i> 2006)

2.2 Technology, organization, and environment context

The TOE framework was developed in 1990 (Tornatzky and Fleischer 1990). It identifies three aspects of an enterprise's context that influence the process by which it adopts and implements a technological innovation: technological context, organizational context, and environmental context (Figure 2). (a) *Technological context* describes both the internal and external technologies relevant to the firm. This includes current practices and equipment internal to the firm (Starbuck 1976), as well as the set of available technologies external to the firm (Thompson 1967, Khandwalla 1970, Hage 1980). (b) *Organizational context* refers to descriptive measures about the organization such as scope, size, and managerial structure. (c) *Environmental context* is the arena in which a firm conducts its business—its industry, competitors, and dealings with the government (Tornatzky and Fleischer 1990).

**Figure 2:** Technology, organization, and environment framework (Tornatzky and Fleischer 1990)

The TOE framework as originally presented, and later adapted in IT adoption studies, provides a useful analytical framework that can be used for studying the adoption and assimilation of different types of IT innovation. The TOE framework has a solid theoretical basis, consistent empirical support (see Tables 2 and 3), and the potential of application to IS innovation domains, though specific factors identified within the three contexts may vary across different studies.

This framework is consistent with the DOI theory, in which Rogers (1995) emphasized individual characteristics, and both the internal and external characteristics of the organization, as drivers for organizational innovativeness. These are identical to the technology and organization context of the TOE framework, but the TOE framework also includes a new and important component, environment context. The environment context presents both constraints and opportunities for technological innovation. The TOE framework makes Rogers' innovation diffusion theory better able to explain intra-firm innovation diffusion (Hsu *et al.* 2006). Thus, the next Section analyses the studies that adopted TOE framework.

3. Empirical literature of the TOE framework

We thoroughly analyse the TOE framework and present an exhaustive description of studies that draw on this theory. Section 3.1 discusses the relevant papers that used only the TOE framework as a theoretical model (Table 2), while Section 3.2 includes some papers that combined the TOE framework with other theoretical models (Table 3).

3.1 Studies that used only the TOE framework

Several authors used only the TOE framework to understand different IT adoptions, such as: electronic data interchange (EDI) (Kuan and Chau 2001); open systems (Chau and Tam 1997); web site (Oliveira and Martins 2008); e-commerce (Liu 2008, Martins and Oliveira 2009, Oliveira and Martins 2009); enterprise resource planning (ERP) (Pan and Jang 2008); business to business (B2B) e-commerce (Teo *et al.* 2006); e-business (Zhu *et al.* 2003, Zhu and Kraemer 2005, Zhu *et al.* 2006b, Lin and Lin 2008, Oliveira and Martins 2010a); knowledge management systems (KMS) (Lee *et al.* 2009). The variables analysed, methods used, data, and context of empirical studies are presented in Table 2.

Table 2: Some studies based only on Tornatzky and Fleischer (1990)

IT Adoption	Analysed Variables	Methods	Data, and context	Author(s)
EDI	Technological context → perceived direct benefits; perceived indirect benefits. Organizational context → perceived financial cost; perceived technical competence. Environmental context → perceived industry pressure; perceived government pressure.	Factor analysis (FA), and Logistic regression	Letter with questionnaires was sent; 575 small firms Hong Kong	(Kuan and Chau 2001)
Open systems	Characteristics of the “Open Systems Technology” Innovation → perceived Benefits; perceived barriers; perceived Importance of compliance to standards, interoperability, and Interconnectivity. Organizational technology → complexity of IT infrastructure; satisfaction with existing systems; formalization of system development and management. External environment → market uncertainty	T-test, FA, logistic regression	Face-to-face interview, 89 firms Hong Kong	(Chau and Tam 1997)
Web site	Technological context → technology readiness; technology integration; security applications. Organizational context → perceived benefits of electronic correspondence; IT training programmes; access to the IT system of the firm; internet and e-mail norms. Environmental context → web site competitive pressure Controls → Services sector.	Multiple correspondence analysis (MCA), and probit model	3155 small and 637 large firms Portuguese	(Oliveira and Martins 2008)
Web site E-commerce	Technological context → technology readiness; technology integration; security applications. Organizational context → perceived	MCA, and probit model	2626 firms Portuguese	(Oliveira and Martins 2009)

IT Adoption	Analysed Variables	Methods	Data, and context	Author(s)
	benefits of electronic correspondence; IT training programmes; access to the IT system of the firm; internet and e-mail norms. Environmental context → web site competitive pressure; e-commerce competitive pressure. Controls → Services sector.			
Internet Web site E-commerce	Technological context → technology readiness; technology integration; security applications. Organizational context → perceived benefits of electronic correspondence; IT training programmes; access to the IT system of the firm; internet and e-mail norms. Environmental context → internet competitive pressure; web site competitive pressure; e-commerce competitive pressure. Controls → Services sector.	MCA, and logit model	3155 small firms Portuguese	(Martins and Oliveira 2009)
e-commerce development level (0-14)	Technological → support from technology; human capital; potential support from technology. Organizational → management level for information; firm size. Environmental → user satisfaction; e-commerce security. Controls → firm property.	FA and OLS	e-mail survey, online survey and telephone interview during 2006; 156 firms. Shaanxi, China	(Liu 2008)
ERP	Technological context → IT infrastructure; technology readiness. Organizational context → size; perceived barriers. Environmental context → production and operations improvement; enhancement of products and services; competitive pressure; regulatory policy.	FA, and Logistic regression	Face-to-face interview, 99 firms Taiwan	(Pan and Jang 2008)
Deployment of B2B e-commerce: B2B firms versus non-B2B firms	Technological inhibitors → unresolved technical issues; lack of IT expertise and infrastructure; lack of interoperability. Organizational inhibitors → difficulties in organizational change; problems in project management; lack of top management support; lack of e-commerce strategy; difficulties in cost-benefit assessment. Environmental inhibitors → unresolved legal issues; fear and uncertainty.	FA, t-tests and discrimination analysis	249 firms North America and Canada	(Teo <i>et al.</i> 2006)
E-business	Technology competence → IT infrastructure; e-business know-how. Organizational context → firm scope,	Confirmatory factor analysis (CFA), second-order factor	Telephone interview during 2000; 3552 firms	(Zhu <i>et al.</i> 2003)

IT Adoption	Analysed Variables	Methods	Data, and context	Author(s)
	firm size. Environmental context → consumer readiness; competitive pressure; lack of trading partner readiness. Controls (industry and country effect)	modelling, logistic regression, and cluster analysis (CA)	European (Germany, UK, Denmark, Ireland, France, Spain, Italy, and Finland)	
E-Business usage	Technological context → technology competence. Organizational context → size; international scope; financial commitment. Environmental context → competitive pressure; regulatory support. e-Business functionalities → front-end functionality; back-end integration.	CFA, second-order factor modelling, and SEM	Telephone interview during 2002, 624 firms across 10 countries Developed (Denmark, France, Germany, Japan, Singapore, U.S.) and developing (Brazil, China, Mexico and Taiwan) countries	(Zhu and Kraemer 2005)
E-Business initiation E-Business adoption E-Business routinization	Technological context → technology readiness; technology integration. Organizational context → firm size; global scopes; trading globalization; managerial obstacles. Environmental context → competition intensity; regulatory environment.	CFA, and structural equation modelling (SEM)	Telephone interview during 2002, 1857 firms across 10 countries Developed (Denmark, France, Germany, Japan, Singapore, U.S.) and developing (Brazil, China, Mexico and Taiwan) countries	(Zhu <i>et al.</i> 2006b)
E-business	Technological context → technology readiness; technology integration; security applications. Organizational context → perceived benefits of electronic correspondence; IT training programmes; access to the IT system of the firm; internet and e-mail norms. Environmental context → web site competitive pressure Controls → Services sector.	T-test, FA, and CA	Telephone interview during 2006, 6964 firms across 27 countries UE27 countries	(Oliveira and Martins 2010a)
Internal integration of e-business External diffusion of use of e-business	Technological context → IS infrastructure; IS expertise. Organizational context → organizational compatibility; expected benefits of e-business. Environmental context → competitive pressure; trading partner readiness.	CFA, and SEM	e-mail survey during 2006; 163 large firms Taiwan	(Lin and Lin 2008)
KMS	Technology aspect → Organizational IT	Not empirical work	Not empirical	(Lee <i>et al.</i>

IT Adoption	Analysed Variables	Methods	Data, and context	Author(s)
	competence; KMS characteristics (compatibility, relative advantage and complexity). Organizational aspect → top management commitment; hierarchical organizational structure. Environmental aspect → With external vendors; among internal employees.		work. Chinese	2009)

3.2 Studies that used the TOE framework combined with other theories

Some authors used the TOE framework with other theories to understand IT adoption (Thong 1999, Gibbs and Kraemer 2004, Hsu *et al.* 2006, Zhu *et al.* 2006a, Li 2008, Soares-Aguiar and Palma-Dos-Reis 2008, Chong *et al.* 2009, Oliveira and Martins 2010b). In Table 3 we can see that DOI, institutional theory, and the Iacovou *et al.* (1995) model were used in combination with the TOE framework to better understand IT adoption decisions.

Studies combining the TOE framework and DOI theories include the following. Thong (1999) joins CEO characteristics from DOI to the TOE framework. Chong *et al.* (2009) add innovation attributes (relative advantage, compatibility, and complexity) from DOI and an additional new factor in the adoption study called information sharing culture characteristics to the TOE framework. Zhu *et al.* (2006a) combined relative advantage, compatibility, cost, and security concern from DOI with the TOE framework. Wang *et al.* (2010) add relative advantage, complexity, and compatibility from DOI to the TOE framework. Additional theories include those listed below.

3.2.1 Institutional theory

Institutional theory emphasizes that institutional environments are crucial in shaping organizational structure and actions (Scott and Christensen 1995, Scott 2001). According to the institutional theory, organizational decisions are not driven purely by rational goals of efficiency, but also by social and cultural factors and concerns for legitimacy. Institutions are transported by cultures, structures, and routines and operate at multiple levels. The theory claims that firms become more similar due to isomorphic pressures and pressures for legitimacy (DiMaggio and Powell 1983). This means that firms in the same field tend to become homologous over time, as competitive and customer pressures motivate them to copy industry leaders. For example, rather than making a purely internally driven decision to adopt e-commerce, firms are likely to be induced to adopt and use e-commerce by external isomorphic pressures from competitors, trading partners, customers, and government.

Several recent studies have taken an institutional approach to e-commerce or EDI diffusion and assimilation (Purvis *et al.* 2001, Chatterjee *et al.* 2002, Teo *et al.* 2003). It is well known that mimetic, coercive, and normative institutional pressures existing in an institutionalized environment may influence organizations' predisposition toward an IT-based interorganizational system (Teo *et al.* 2003). Mimetic pressures are observed when firms adopt a practice or innovation imitating competitors (Soares-Aguiar and Palma-Dos-Reis 2008). Coercive pressures are a set of formal or informal forces exerted on organizations by other organizations upon which the former organizations depend (DiMaggio and Powell 1983). Normative pressures come from dyadic relationships where companies share some information, rules, and norms. Sharing these norms through relational channels amongst members of a network facilitates consensus, which, in turn, increases the strength of these norms and their potential influence on organizational behaviour (Powell and DiMaggio 1991).

Some studies combine the TOE framework with the institutional theory (Gibbs and Kraemer 2004, Li 2008, Soares-Aguiar and Palma-Dos-Reis 2008). The institutional theory adds to the environmental context of the TOE framework external pressures, which include pressure from competitors and pressure exerted by trading partners.

3.2.2 Iacovou et al. (1995) model

Iacovou et al. (1995) analysed interorganizational systems (IOSs) characteristics that influence firms to adopt IT innovations in the context of EDI adoption. Their framework is well suited to explain the adoption of an IOS. It is based on three factors: perceived benefits, organizational readiness, and external pressure (see Figure 3). Perceived benefits is a different factor from the TOE framework, whereas organizational readiness is a combination of the technology and organization context of the TOE framework. Hence, IT resources is similar to technology context and financial resources is similar to organizational context. The external pressure in the Iacovou et al. (1995) model adds the trading partners to the external task environmental context of the TOE framework as a critical role of IOSs adoptions.

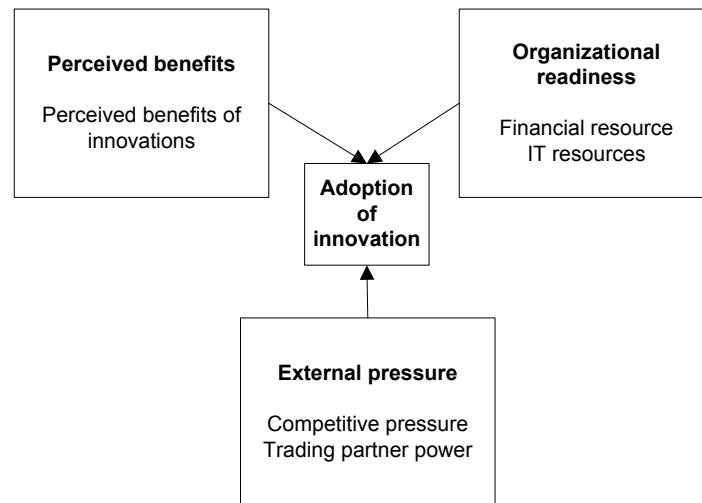


Figure 3: Iacovou et al. (1995) model

Hsu et al. (2006) used the DOI theory, the TOE framework, and the Iacovou et al. (1995) model to explain e-business use. Their model proposed four constructs (perceived benefits, organizational readiness, external pressure, and environment). Organization readiness, is consistently used in all three frameworks in the literature. Environment is from the TOE framework. Perceived benefits and external pressure are from the Iacovou et al. (1995) model.

Oliveira and Martins (2010b) used the TOE framework, and the Iacovou et al. (1995) model to explain adoption of e-business by firms belonging to European Union (EU) countries, by comparing the effect across two different industries: telecommunications and tourism. Their model proposed comprises three dimensions (perceived benefits, technology and organizational readiness, and environmental and external pressure). The perceived benefits dimension comes from the Iacovou et al. (1995) model. The technology and organizational readiness is a combination of TOE from the Tornatzky and Fleischer (1990) framework and organizational readiness from the Iacovou et al. (1995) model. The environmental and external pressure is also a combination from both earlier studies.

Table 3: Some studies that combine Tornatzky and Fleischer (1990) with other theoretical models

Theoretical Model	IT Adoption	Analysed variables	Methods	Data, and Context	Author(s)
TOE and DOI	Uses at least one major software application: accounting; inventory control; sales; purchasing; personnel and payroll; CAD/CAM; EDI; MRP.	CEO characteristics → CEO's innovativeness; CEO's IS knowledge. IS characteristics → relative advantage of IS; compatibility of IS; complexity of IS. Organizational characteristics → business size; Employees' IS knowledge; information intensity.	T-tests, FA, discriminatory analysis, and partial least squares (PLS)	Letter with questionnaires sent during 2005, 166 small firms; Singapore	(Thong 1999)

Theoretical Model	IT Adoption	Analysed variables	Methods	Data, and Context	Author(s)
	Number of personal computers and software applications	Environmental characteristic → competition.			
TOE and DOI	Collaborative commerce (c-commerce)	Innovation attributes → relative advantage; compatibility; complexity. Environmental → expectations of market trends; competitive pressure. Information sharing culture → trust; information distribution; information interpretation. Organizational readiness → top management support; feasibility; project champion characteristics	FA, and OLS	e-mail survey; 109 firms Malaysian	(Chong <i>et al.</i> 2009)
TOE and DOI	E-Business usage E-business impact	Relative advantage Compatibility Costs Security concern Technological context → technology competence. Organizational context → organization size. Environmental context → competitive pressure; partner readiness.	CFA, second-order factor modelling, and SEM	Telephone interview during 2002; 1415 firms across 6 EU countries European (Finland, France, Germany, Italy, Spain, and U.K.)	(Zhu <i>et al.</i> 2006a)
TOE and DOI	RFID	Technology → relative advantage; complexity; compatibility. Organization → top management support; firm size; technology competence. Environment → competitive pressure; trading partner pressure; information intensity.	FA, and logistic regression	e-mail survey; 133 firms Taiwan; manufacturing firms	(Wang <i>et al.</i> , 2010)
TOE, DOI and institutional theory	E-procurement	Technological context → relative advantage; complexity; compatibility. Organizational context → financial slacks; top management support. Environmental context → external pressure; external support; government promotion.	FA, and logistic regression	Telephone interview during 2006; 120 firms; 50-2000 employees China; manufacturing firms	(Li 2008)
TOE and Institutional theory	Scope of e-commerce use	Technology context → Technology resources Organizational context → perceived benefits; lack of organizational compatibility; financial resources; firm size.	FA, and OLS	Telephone interview during 2002; 2139 firms 3 sectors (manufacturing	(Gibbs and Kraemer 2004)

Theoretical Model	IT Adoption	Analysed variables	Methods	Data, and Context	Author(s)
		Environmental context → External pressure; government promotion; legislation barriers. Controls → countries (Brail, China, Denmark, France, Germany, Japan, Mexico, Singapore, Taiwan, and U.S.A.); industries (distribution, finance, and manufacture).		, distribution, and finance); 10 countries (Brazil, China, Denmark, France, Germany, Japan, Mexico, Singapore, Taiwan, and U.S.A.)	
TOE and Institutional theory	Electronic procurement systems (EPSs)	Technological context → Technology competence; IT expertise; B2B know how. Organizational context → firm size; firm scope. Environmental context → trading partner readiness; extent of adoption amongst competitors; perceived success of competitor adopters. Controls → Industry effects.	T-test, and logistic regression	e-mail survey; 240 large firms Portugal	(Soares-Aguiar and Palma-Dos-Reis 2008)
DOI, TOE and Iacovou <i>et al.</i> (1995) model	E-business use: diversity, and volume.	Perceived benefits → perceived of innovations. Organizational readiness → firm size; technology resources; globalization level. External pressure → trading partners' pressure; government pressure. Environment → regulatory concern; competition intensity. Controls → Industry effects.	CFA, and SEM	Telephone survey during 2002; 294 firms U.S. market (manufacturing, wholesale/retail distribution, banking and insurance.	(Hsu <i>et al.</i> 2006)
TOE and Iacovou <i>et al.</i> (1995) model	E-business adoption	Perceived benefits → perceived benefits and obstacles of e-business. Technology and organization readiness → technology readiness; technology integration; firm size. Environment and external pressure → competitive pressure; trading partner colaberation. Controls → country and industry effects.	FA, and logistic regression	Telephone interview during 2006; 2459 firms 2 sectors (Tourism, and Telecommunications); 27 EU countries.	(Oliveira and Matins 2010b)

4. Conclusions

This paper made a review of literature of IT adoption models at the firm level. Most empirical studies are derived from the DOI theory and the TOE framework. As the TOE framework includes the environment context (not included in the DOI theory), it becomes better able to explain intra-firm innovation adoption; therefore, we consider this model to be more complete. The TOE framework also has a solid theoretical basis, consistent empirical support, and the potential of application to IS adoption. For this reason an extensive analysis of the TOE framework was undertaken, analysing

empirical studies that use only the TOE model, and empirical studies that combine this model with the DOI theory, the institutional theory, and the Iacovou *et al.* (1995) model, and concluding that the same context in a specific theoretical model can have different factors.

In terms of further research, we think that for more complex new technology adoption it is important to combine more than one theoretical model to achieve a better understanding of the IT adoption phenomenon.

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