Evaluating the impact of virtualization characteristics on SaaS adoption

Sara Tomás[2], Manoj Thomas[2], Tiago Oliveira[3]

[1,3]NOVA Information Management School (NOVA IMS), Universidade Nova de Lisboa, 1070-312 Lisbon, Portugal
[2]School of Business, Virginia Commonwealth University, 301 W. Main Street, Richmond, VA 23284-4000, USA

[1]sara.c.tomas@gmail.com, [2]mthomas@vcu.edu, [3]toliveira@isegi.unl.pt

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[1,3]NOVA Information Management School (NOVA IMS), Universidade Nova de Lisboa, 1070-312 Lisbon, Portugal

[2]School of Business, Virginia Commonwealth University, 301 W. Main Street, Richmond, VA 23284-4000, USA

[1]sara.c.tomas@gmail.com, [2]mthomas@vcu.edu, [3]toliveira@isegi.unl.pt,

Correspondent Author: Manoj Thomas

Address: School of Business, Virginia Commonwealth University
301 W. Main Street, Richmond, VA 23284-4000, USA

Email: mthomas@vcu.edu

Telephone: +1.804.828.4044

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Abstract

Software as a service (SaaS) is a service model in which the applications are accessible from various client devices through internet. Several studies report possible factors driving the adoption of SaaS but none have considered the perception of the SaaS features and the organization's context. We propose an integrated research model that combines the process virtualization theory (PVT), the technology-organization-environment (TOE) framework and the institutional theory (INT). PVT seeks to explain whether processes are suitable for migration into virtual environments via an information technology-based mechanism as SaaS. The TOE framework seeks to explain the effects of the intra-organizational factors, while INT seeks to explain the effects of the inter-organizational factors on the technology adoption. This research addresses a gap in the SaaS adoption literature by studying the internal perception of the technical features of SaaS and technology, organization, and environment perspectives. Additionally, the integration of PVT, the TOE framework, and INT contributes to the information system (IS) discipline, deepening the applicability and strengths of these theories.

Keywords: *Process virtualization theory (PVT), technology-organization-environment (TOE) framework, institutional theory (INT), software as a service (SaaS), IT adoption*

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1. Introduction

Software as a service (SaaS) represents a service model in which software applications are hosted centrally and made accessible via internet through various client devices. They exemplify software solutions that can be reused and shared across various functional applications of an enterprise informaiton system (EIS) (Cancian, Rabelo, and von Wangenheim 2015; Rico et al. 2016). By enabling single-instance multi-tenancy architecture (i.e., offering the same instance of an application to multiple users), SaaS allow the design, development, and deployment of customizable process-aware applications (Mietzner, Leymann, and Unger 2011). At the enterprise level, SaaS not only helps to lower investments in IT infrastructure, but also reduces operational costs associated with the acquisition or development of EIS (Rico et al. 2016). However, the operational flexibility, cost saving, and software reuse capabilities of SaaS are often accompanied by tradeoffs, specifically as it relates to challenges of seamless integration within the EIS landscape (Scheibler, Mietzner, and Leymann 2009). Nevertheless, adoption of SaaS continues to grow, and the spending on "as a service" offerings is forecasted to grow to $258 billion in 2020 (Goode et al. 2015). According to the study conducted by the International Data Corporation (Benjamin McGrath 2015), SaaS delivery is projected to grow five times faster than traditional software market, and predicted to become a significant growth driver to all functional software. The SaaS phenomenon has thus attracted the attention of information systems (IS) researchers, IT professionals, and practitioners (Benlian and Hess 2011).

Within the last decade, some empirical studies have sought to determine what influences firms to adopt SaaS. However, the studies have not integrated the internal perception of the SaaS' features and the external pressures felt by the organization. We propose an integrated model that combines the process virtualization theory (PVT), the technology-organization-environment (TOE) framework, and the institutional theory (INT) to fill this gap. The PVT helps to understand how SaaS could increase the ability for organizations to collaborate virtually, i.e., processes that were delivered face-to-face could be conducted virtually via Internet (Overby 2008). The TOE framework helps to distinguish the characteriscs of the enterprise's context that influence the adoption of SaaS (Tornatzky and Fleischer 1990). The INT helps to analyze the impact of institutional forces on organizational actions related to the use of SaaS (Scott 2001; Teo, Wei, and Benbasat 2003).

The purpose of this research is to understand how the characteristics of the virtualization mechanism (SaaS) and organization's context could influence organizational predisposition toward SaaS adoption. This yields three main contributions. First, the integrated model that we propose fills a gap in SaaS adoption literature with respect to the influence of features of the technology itself, and the internal and external factors of the organization. Second, the empirical evaluation of the integrated model analyzes many propositions of PVT, the TOE framework and INT in the SaaS context. The research thus helps to develop measures of the constructs, empirically validate the hypotheses, and examine how the theories operate in practice. Third, the integration of PVT, the TOE framework, and INT contributes to the information system (IS) discipline by enhancing its underlying theory base. Although the theories individually represent theoretical breadth to the discipline, the integration of the three theories enhances the theoretical depth by combining the strengths of the theories to improve our knowledge of the role of IS in the execution of processes.

The paper is organized as follows. First, we provide an overview of SaaS, earlier studies on SaaS adoption, PVT, the TOE framework, and INT. Then, we present the research model and develop the hypotheses. We then describe the researh methodology, followed by data analysis. Study results are then presented, followed by a discussion of the major findings. Finally, we conclude by highlighting the implications of the findings, summarizing limitations of the study, and suggesting directions for future research.

2. Theoretical Background

2.1 Software as a service

Software as a service (SaaS) is one of the three service models of cloud computing (Marston et al. 2011), as a type of on-demand outsourcing (Chou and Chiang 2013), characterized as a type of software delivery in which the software is hosted off-premises (Susarla, Barua, and Whinston 2010), developed by service providers, accessed by customers over the Internet, and follows a subscription model (Espadas et al. 2013). From an economic viewpoint, SaaS essentially bundles software delivery with service (Fan, Kumar, and Whinston 2009). There is a wide range of SaaS applications, from productivity applications (e.g., word processing) to programs such as customer relationship management (CRM) and enterprise-resource management (ERM) (Sultan 2011). SaaS is an evolution of the application service provider (ASP) model. ASP is based on a single-tenant architecture, in which software vendors are limited in their ability to share infrastructure and application code efficiently across their customers. Unlike ASP, SaaS is based on a multi-tenant architecture in which there is only a single instance of the common code and data definitions (Benlian and Hess 2011; Kim et al. 2012). The interest in SaaS has been driven by several benefits, but the acknowledged risks still leave firms and researchers doubtful about whether to adopt it or not (Benlian and Hess 2011;

Wu, Mahajan, and Balasubramanian 2003; Wu 2011a). The main benefits and obstacles regarding SaaS adoption are summarized in Table 1.

Table 1 – Benefits and barriers of SaaS adoption.

Benefits		
Theme	***Description***	***Source***
Good user adaptation	It is easy to access, easy to use, and feature rich. It is not necessary to install and run the applications on the computer of the user and to carry out the maintenance and support tasks.	(Zorrilla and García-Saiz 2013)
Flexibility	End user can access data and services via smartphones, laptops, and netbooks from anywhere.	(Lin and Chen 2012)
Scalability	Allows easily upscaling or downscaling as required.	(Lin and Chen 2012; Marston et al. 2011)
Cost savings	Reducing or eliminating cost associated with "in-house" provision (e.g., hardware, software, and licensing fee) and the company pays for only the actual usage.	(Marston et al. 2011; Benlian and Hess 2011; Rohitratana and Altmann 2012)
Business opportunities	Low cost of entry represents an opportunity for small firms and third-world countries benefiting from information technology.	(Marston et al. 2011)
Sustainability	Improved resource utilization, more efficient systems, and carbon neutrality.	(Li et al. 2012; Sultan 2010)
Obstacles		
Theme	***Description***	***Source***
Latency	Lack of constant and high-speed internet connections.	(Sultan 2010)
Lock-in	Lack of standardization of application program interfaces and platform technologies means that interoperability among platforms is poor and firms will not be able to transfer easily from one cloud provider to another.	(Armbrust et al. 2010)
Lack of reliability	Unstable access to services.	(Benlian and Hess 2011; Sultan 2010);
Lack of control	IT performance is controlled not by firm staff but off-premises cloud providers and may not be able to make necessary changes in application features easily.	(Sultan 2010)
Security	Possible security breaches and improper protection of firm data.	(Benlian and Hess 2011; Armbrust et al. 2010)

Earlier studies related to cloud services adoption have improved our understanding of their current state and trends (Wu 2011b). However, few studies have shed light on SaaS adoption. Table 2 summarizes the few studies with SaaS adoption as dependent variable. Benlian and Hess (2011) found that cost advantage is the strongest opportunity factor for SaaS adoption, while security issues is the major risk factor. However, their study was focused on a specific set of risks and opportunities already used in earlier research. Another study concluding that the economic benefits are the strongest drivers of SaaS adoption was developed by Lee, Chae, and Cho (2013). However, their study did not develop a research model. Different conclusions were reached by other researchers but based on theories (technology acceptance model (TAM), unified theory of acceptance and use of technology (UTAUT), and theory of planned behavior (TPB)) that pertain to an individual level analysis and not to the firm level. Wu (2011a, 2011b) suggests that (1) expert opinions about SaaS, (2) the need to improve their effectiveness and performance, and (3) security and data backups, are the most important determinants of SaaS use. Du et al. (2013) found that improvements in ease of use, reliability and responsiveness have more impact on user acceptance than improvements in security. Benlian, Hess, and Buxmann (2009) found that patterns of decisions on SaaS adoption vary between application types, and that IT user firms are influenced by expert opinions and peer pressure. In our research we develop a new integrative research model that combines variables from other theories used at the firm level and test the model with a representative sample.

Table 2 –SaaS adoption studies published in peer reviewed journals.

Model theory	*Constructs (independent variables)*	*Methods*	*Data, and context*	*Source*
Transaction cost theory (TCT), resource-Based View (RBV), and theory of planned behavior (TPB)	Attitude toward SaaS-adoption, subjective norm, application specificity, perceived uncertainty, strategic value, application inimitability	Partial least squares (PLS)	297 IT executives in German firms	(Benlian, Hess, and Buxmann 2009)
Opportunity-risk framework; Theory of reasoned action	Perceived risk of SaaS adoption, Perceived opportunities of SaaS adoption, performance risks, economic risks, strategic risks, security risks, managerial risks, cost advantage, strategic flexibility, focus on core competencies, access to specialized resources, quality improvements	PLS	349 IT executives in German firms	(Benlian and Hess 2011)
Technology acceptance model (TAM) and diffusion Theory Model (DTM)	Marketing efforts, social influence, perceived benefits, attitude toward technology innovations, security and trust, perceived usefulness, perceived ease of use, behavioral intention	PLS	Survey of 120 CEO´s and Managers in Taiwan firms	(Wu 2011a)
TAM and DTM	Social influence, perceived benefits, attitude toward technology innovations security and trust, perceived usefulness, perceived ease of use, behavioral intention	Rough set theory (RST)	246 IT/MIS managers in Taiwan firms	(Wu 2011b)
Decision making trial and evaluation laboratory (DEMATEL)	Case study	Case study	One company in Taiwan	(Wu 2011c)
TAM and unified theory of acceptance and use of technology (UTAUT)	Ease of use, security, reliability, responsiveness, social influence, perceived usefulness, behavioral intention to use	covariance-based structural equation modeling (CBSEM)	2931 respondents from a single SaaS provider	(Du et al. 2013)
Analytic hierarchy process (AHP) – matrix analysis	16 drivers and 16 inhibitors	PEST analysis	24 IT consultants in Korean firms	(Lee, Chae, and Cho 2013)

2.2 Process Virtualization Theory

The PVT was designed with the aim to identity if the process can be virtualized, i.e., whether a process is suitable to be executed in a virtual environment. Overby (2008) defined a process as “a set of activities to achieve an objective”, a physical process as “a process that involves physical interaction between people or between people and objects,” and a virtual process as “a process in which physical interaction between people and/or objects has been removed.” The definition of “virtual” can be confused with the term virtualization used in system architecture such as server virtualization or operation systems virtualization, but its interpretation is excluded of the theory scope. So, in this context, process virtualization means that the activities that were carried out face to face, are now held an information system (Overby 2012).

PVT proposes three information tecnhology (IT) characteristics related to the virtualization mechanism: representation, reach, and monitoring capability. The key premise of this theory is that IT can be used to make a process more amenable to virtualization by helping to satisfy the requirements, i.e., IT may moderate the relationship between the variables that characterize a process and the dependent variable. *Representation* refers to IT capacity to present information to simulate objects, environments and people as in the physical world, with which process participants can interact. *Reach* is the IT capacity to allow the simultaneous interaction of process participants, physically distant and to promote the relationship between them. *Monitoring* specifies the IT capacity to authenticate the process participations, each with a unique identity, and track their actions (Overby 2008, 2012). In addition to these variables, the theory proposes four variables about process characteristics (sensory requirements, relationship requirements, synchronism requirements, and identification and control requirements). These were not considered in this study as the research question we address is the evaluation of factors that guide the adoption of SaaS. We therefore focus on technological characteristics in order to evaluate whether SaaS is a good virtualizable mechanism independent of the effect of process characteristics.

2.3 Technology-organization-environment (TOE) framework

The TOE framework describes the organizational drivers that affect the firm's adoption decisions. Tornatzky and Fleischer (1990) propose three principle contexts – technology, organization, and environment, that influence the adoption of technological innovations. The technology context represents the technologies in use and the technical skills available in the organization. The organization context refers to the resources available to support the acceptance of the innovation, and is assessed based on firm size, degree of centralization, or managerial structure. The environment context refers to the external environment in which an organization operates covering its industry, competitors, and government relations.

2.4 Institutional Theory

The INT theory addresses the central question of why all organizations in a given area are similar. INT suggests that organizational decision to adopt structures, procedures, or ideas is not only based on increasing efficiency, but also by social and cultural influences and legitimacy issues (Dimaggio and Powell 1983). For instance, organizations instead of taking the decision to adopt SaaS only by internal influence, these are likely to be influenced by isomorphic pressures exerted by other organizations (Oliveira and Martins 2011).

Dimagio and Powell (1983) identify three types of pressures: coercive, normative, and mimetic. Coercive pressures are those for an organization to adopt a practice imposed by an organization that depends and by cultural expectations imposing uniformity in organizational performance. Normative pressures derive from professionalization and come from the sharing of standards and knowledge among organizations, and creating standardized forms of action in relation to comparable situations. This facilitates consensus, influenced organizations to adopt these standard pratices. Mimetic pressures emanate from responses to uncertainty, which encourages imitation. It is observed when organizations imitate a successful practice or innovation following by competitors.

3. Research model and hypotheses

The integrative research model that we propose brings together three theoretical perspectives - the PVT, the TOE framework, and the INT. The constructs of PVT theory are incorporated to assess SaaS as a virtualization mechanism to explain its adoption. PVT theory suggests that IT plays a key role in making the SaaS process more suitable for virtualization, and may influence the intention for adoption. In earlier studies, similar variables were used to explain behavioral intention to adopt new technology (Dua et al. 2013; Wu 2011b, 2011a). The TOE framework is used to evaluate how technology competence on technology context, top management support on organization context, and pressures on organization's environment impact the different stages of adoption. Some earlier studies (Yoon and George 2013; Oliveira and Martins 2011; Martins, Oliveira, and Thomas 2016; Ciganek, Haseman, and Ramamurthy 2014) added INT in the environmental context of the TOE framework to enrich the evaluation of this context.

The research model is shown in Figure 1.

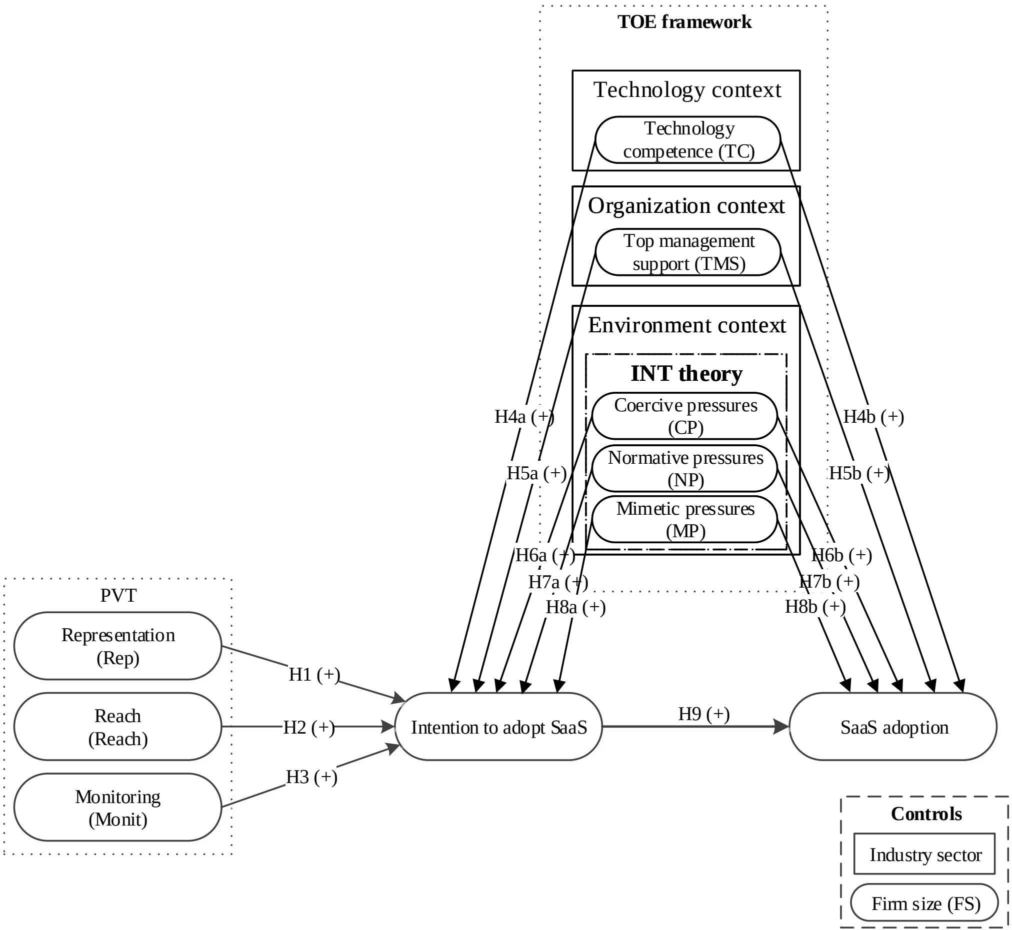


Figure 1 – The research model

3.1 PVT Constructs

Representation refers to the IT capacity for providing information with which process participants can interact (Overby 2008). SaaS can represent object characteristics that process participants would otherwise learn through physical process inspection. Representation capability of SaaS simulates sensory elements of the physical world, especially the senses of sight and sound. This suggests that when firms perceive a high fit between their requirements and representation capability of SaaS, their intention to adopt SaaS will increase. Thus,

H1: *Representation capability of SaaS positively influences the intention to adopt SaaS.*

Reach refers to IT capacity to allow process participation across time and space (Overby 2008). SaaS enables participation of many individuals anywhere in the world to collaborate virtually at the same time, and provides additional opportunities for relationship development that otherwise would not exist. Therefore, firms have the possibility to manage their process more efficiently, even if their SaaS service provider is physically distant. This suggests that if firms perceive a high fit between their requirements and reach capability of SaaS, their intention to adopt SaaS will increase. Hence,

H2: *Reach capability of SaaS positively influences the intention to adopt SaaS.*

Monitoring refers to the IT capacity to allow authentication and activity tracking (Overby 2008). SaaS contains features related to (1) authentication that facilitates the identification of credentials on the system; (2) access rights management that controls which tasks participants are authorized to conduct, and (3) recording of participant activity, which facilitates audit trails. Thus, SaaS provides tools to firms to effectively control their users' access and activity. This suggests that if firms perceive a high fit between their requirements and monitoring capability of SaaS, their intention to adopt SaaS will increase. Therefore,

H3: *Monitoring capability of SaaS positively influences the intention to adopt SaaS.*

3.2 TOE Constructs

Technology competence refers to the technologies available in the organization, including tangible assets such as IT infrastructure and intangible resources such as IT expertise. IT infrastructure refers to the installed platforms that can complement or be replaced by a new technology solution (Oliveira, Thomas, and Espadanal 2014). IT expertise refers to IT teams with knowledge and skill to implement new technological solutions (Zhu and Kraemer 2005). Thus, technological resources together with human resources available to the organization can provide a higher degree of technology readiness to adopt a new IT solution. This suggests that if firms have a higher level of technology competence, their intention to adopt SaaS and the adoption of SaaS will increase. Thus,

H4a**:** Technology competence *positively influences the intention to adopt SaaS.*

H4b**:** Technology competence *positively influences the adoption of SaaS.*

Top management support refers to the commitment of top management to the change, and is often recognized as one of the most important factors in the organization context for assessing the adoption of innovation (Low, Chen, and Wu 2011). Top Management can influence the organization's employees to adopt the change by allocating necessary resources and promoting the business value of this adoption. This suggests that if top management does not recognize the value of SaaS to the business, and/or if top management support is weak, the firm may be opposed to its adoption and resist the change. Hence,

H5a**:** Top management support *positively influences the intention to adopt SaaS.*

H5b**:** Top management support *positively influences the adoption of SaaS.*

3.3 INT Constructs

Coercive pressures are the pressures for an organization to adopt the same practice in a dependency context of other organizations (Dimaggio and Powell 1983). They can derive from regulatory environment exerted by government or industry association even as multinational companies or business groups on their subsidiaries and representative office (Harcourt, Lam, and Harcourt 2005). When firms face pressures to adopt SaaS from government and professional regulatory agencies, or when key organizations that they depend on already use it or stimulate its use, they are more likely to adopt SaaS. This suggests that if firms face a high level of coercive pressures, their intention to adopt SaaS and the adoption of SaaS will increase. Thus,

H6a: *Coercive pressures positively influence the intention to adopt SaaS.*

H6b: *Coercive pressures positively influence the adoption of SaaS.*

Normative pressures are derived from dyadic relationships in which organizations share information, creating patterns of actions for similar situations (Dimaggio and Powell 1983). Through the knowledge disseminated by education, and professional and trace associations (Dimaggio and Powell 1983) arise equivalent forms to interpret and solve problems, legitimizing them as the most correct or even as the only solution (Harcourt, Lam, and Harcourt 2005; Johnson, Dowd, and Ridgeway 2006). This suggests that if firms face a high level of normative pressures, their intention to adopt SaaS and the adoption of SaaS will increase.

Therefore,

H7a: *Normative pressures positively influence the intention to adopt SaaS.*

H7b: *Normative pressures positively influence the adoption of SaaS.*

Mimetic pressures occur when an uncertain context, organizations is pressed to adopt successful practices implemented in other organizations (Dimaggio and Powell 1983), in the belief that their result will be positive too. In addition, through imitating, organizations minimize search costs and experimentation costs (Teo, Wei, and Benbasat 2003), and reduce risks inherent to being the first-movers (Lieberman and Montgomery 1988). If firms perceive better results from organizations that have already adopted SaaS, they are more likely to adopt SaaS. This suggests that if firms face a high level of mimetic pressures, their intention to adopt SaaS and the adoption of SaaS will increase. Hence,

H8a: *Mimetic pressures positively influence the intention to adopt SaaS.*

H8b: *Mimetic pressures positively influence the adoption of SaaS.*

3.3 Adoption Stages

Intention to adopt SaaS is the first stage of the diffusion model. In this stage a firm evaluates the potential benefits of the new technology and signals the intention of using it prior to actual adoption (Chan and Chong 2013). According to diffusion of innovation (DOI) theory, the diffusion of technology occurs in stages (Rogers 1995). It represents the decision making process that may lead to the routine use of the technology within the firm. The intention to adopt stage is followed by the actual adoption, when a firm decides to use the new technology and allocate resources to acquire it. This stage of adoption is influenced by the pre-stage of intention to adopt. Thus,

H9: *Intention to adopt SaaS positively influences the adoption of SaaS.*

3.4 Control Variables

In addition to these theoretical constructs, our research model incorporates control variables to account for the cross-sectional variations in SaaS adoption. Specifically, we control the effect of industry sector and firm size. Following the literature (Bresnahan, Brynjolfsson, and Hitt 2002; Soares-Aguiar and Palma-Dos-Reis 2008; Zhu, Kraemer, and Xu 2003; Zhu et al. 2006), we include variables for industries and firm size to control for data variation that would not be captured by the explanatory variables mentioned above.

4. Research methodology

4.1. Measurement

To test the theoretical constructs, we conducted a survey in Portugal. Survey items and scales were adapted from Chong and Chan (2012), Chan and Chong (2013), Overby (2008), and Liang, Saraf, Hu, and Xue (2007). The constructs were measured using a seven-point Likert scale on an interval level ranging from "disagree" to "agree" for PVT constructs, and "strongly disagree or very low" to "strongly agree or very high" for TOE and INT constructs. The items of constructs are presented in Appendix A. Since the survey was administered in Portugal, the

English version of the instrument was translated to Portuguese and then back to English to ensure the translation equivalence. To ensure the content validity of the instrument, it was reviewed by a group of five established academic IS researchers and two language experts (Brislin 1970). To test the instrument, a pilot study was conducted among 30 firms that were not included in the main survey. The results of the pilot study provided evidence of the reliability and validity of the scales, and helped to determine whether the respondents had difficulty in answering the survey.

4.2. Data

The survey was emailed in early 2016 to 2000 firms in Portugal from Dun & Bradstreet database. The range of firms selected covered varying types of business and company size category. After two weeks, a follow up email was sent to non-respondents. A total of 317 usable responses (203 early respondents and 114 late respondents) were obtained at the end of ten weeks, yielding a response rate of 15.9%. The largest sub-section of respondents were from medium-size companies of the services sector with an annual revenue from 2 - 10 million €. The sample characteristics are shown in Table 3.

Table 3 – Sample characteristics (*N*=317).

Industry	***Obs.***	***%***	***Annual revenue (Euro million)***	***Obs.***	***%***
Construction	25	7.89%	≤ 2	74	23.34%
Manufacturing	100	31.55%	2 to 10	109	34.38%
Services	136	42.90%	>10 to 50	84	26.50%
Health	14	4.42%	>50	50	15.77%
Wholesale and Retail Trade	33	10.41%	**Respondent's position**	***Obs.***	***%***
Information and Communication	9	2.84%	CEO, President, Director	23	7.26%
Firm size (*)	***Obs.***	***%***	CIO, CTO	84	26.50%
> 10 (micro)	20	6.31%	IS Manager	75	23.66%
10-49 (small)	61	19.24%	Administration/Finance Manager, CFO	31	9.78%
50-249 (medium-size)	161	50.79%	Human Resources Manager	23	7.26%
> 250 (large)	75	23.66%	Other Managers (Business Operations, Quality, Other)	81	25.55%

Note: **(***) Based on the classification by number of employees of the European Commission (2003)

As the group of respondents were from two different moments, we tested non-response bias using the Kolmogorov–Smirnov (K–S) test (Ryans 1974). The sample distribution of the early and late respondent groups demonstrated an absence of non-response bias since the results did not differ statistically (Ryans 1974). Furthermore, we examined the common method bias in two ways. First, Harman's one-factor test (Podsakoff et al., 2003) showed that the first factor explained 37.7% of the variance. This implies that none of the factors added variance more than the threshold value of 50%. Second, using marker-variable technique (Lindell and Whitney

2001), we added a theoretically irrelevant marker variable in the research model. This obtained 0.067 (6.7%) as the maximum shared variance with other variables, a value that can be considered as low (Johnson, Rosen, and Djurdjevic 2011). This indicates that common method bias is not a concern in the data set.

5. Results

We assess the research model by using partial least squares (PLS), a variance-based technique of structural equation modeling (SEM) (Henseler, Ringle, and Sinkovics 2009). This is the most adequate method since all measurement items are not distributed normally ($p<0.001$) based on the Kolmogorov–Smirnov's test, and the proposed research model has not been tested in the literature (Hair, Ringle, and Sarstedt 2011; Hair et al. 2012). For PLS estimation the minimum sample size needs to be "ten times the largest number of formative indicators used to measure one construct; or ten times the largest number of structural paths directed at a particular latent construct in the structural model" (Hair, Ringle, and Sarstedt 2011; Wu 2011b). The sample in our study involved 317 firms, thus fulfilling this condition for using PLS. SmartPLS 2.0.M3 software (Ringle, Wende, and Will 2005) is used to evaluate first the reliability and validity of the measurement model, and then analyze the structural model (Anderson and Gerbing 1988).

5.1. Measurement Model

For the assessment of the measurement model, we evaluated construct reliability, indicator reliability, convergent validity, and discriminant validity (tables 4 and 5). The construct reliability was assessed using composite reliability (CR) coefficient. As shown in Table 4, the results are above 0.7, suggesting that the constructs are reliable (Straub 1989). The indicator reliability was tested based on the criteria that loadings should be greater than 0.7 and loadings less than 0.4 eliminated (Henseler, Ringle, and Sinkovics 2009; Churchill Jr 1979). As shown in Table 5, all loadings are above 0.7, meaning that the instrument presents good indicator reliability. The convergent validity was evaluated using the average variance extracted (AVE) that should be higher than 0.50. As seen in Table 4, all constructs have the AVE higher than 0.5, meeting this criterion. The discriminant validity of the constructs was measured by Fornell-Larcker criterion, cross-loadings, and Hetrotrait-Monotrait Ratio (HTMT) (Henseler, Ringle, and Sarstedt 2015). The first measure requires that the square root of AVE is greater than the correlations between the constructs (Fornell and Larcker 1981). As seen in Table 4, the square root of AVE (diagonal of Table 4 in bold) is greater than the correlation between each of the pair factors, satisfying this criterion. The second measure requires that the loading of each indicator should be greater than all cross-loadings. As can be seen in Table 5, this criterion is also satisfied. Finally, the last criterion requires that the HTMT ratio should be lower than 0.9. Based on Table 6, HTMT ratios are below the threshold of 0.9. Thus, all measures are satisfied for all constructs and indicators.

Table 4 – Correlation matrix, means, standard deviations, square root of AVE (shown in bold at diagonal), and composite reliability (CR).

	Mean	**SD**	**AVE**	**CR**	**Rep**	**Reach**	**Monit**	**TC**	**TMS**	**CP**	**NP**	**MP**	**SaaSi**	**SaaSa**
Rep	4.375	1.438	0.791	0.938	**0.889**									
Reach	4.655	1.379	0.833	0.937	0.604	**0.913**								
Monit	4.804	1.395	0.857	0.960	0.717	0.675	**0.925**							
TC	3.995	1.292	0.664	0.855	0.362	0.395	0.389	**0.815**						
TMS	3.803	1.603	0.872	0.953	0.373	0.415	0.373	0.670	**0.934**					
CP	2.568	1.467	0.797	0.922	0.262	0.314	0.206	0.293	0.309	**0.893**				
NP	3.019	1.281	0.741	0.895	0.355	0.401	0.296	0.506	0.483	0.572	**0.861**			
MP	3.026	1.429	0.938	0.978	0.280	0.377	0.286	0.421	0.468	0.652	0.565	**0.968**		
SaaSi	3.606	1.585	0.794	0.920	0.425	0.523	0.483	0,581	0.621	0.344	0.556	0.431	**0.891**	
SaaSa	2.989	1.686	0.870	0.953	0.415	0.459	0.378	0.572	0.600	0.564	0.635	0.575	0.705	**0.933**

Table 5 – Loadings and cross-loadings for the measurement model.

	Rep	Reach	Monit	TC	TMS	CP	NP	MP	SaaSi	SaaSa
Rep1	**0.914**	0.556	0.688	0.348	0.376	0.211	0.280	0.253	0.370	0.345
Rep2	**0.929**	0.580	0.701	0.322	0.338	0.212	0.310	0.231	0.377	0.351
Rep3	**0.811**	0.462	0.535	0.333	0.321	0.288	0.338	0.249	0.392	0.404
Rep4	**0.899**	0.548	0.626	0.281	0.289	0.216	0.333	0.261	0.367	0.369
Reach1	0.525	**0.928**	0.532	0.356	0.374	0.310	0.391	0.373	0.489	0.429
Reach2	0.574	**0.940**	0.634	0.383	0.406	0.302	0.398	0.353	0.511	0.444
Reach3	0.558	**0.869**	0.696	0.341	0.354	0.242	0.301	0.303	0.426	0.380
Monit1	0.655	0.637	**0.936**	0.329	0.298	0.172	0.240	0.237	0.443	0.320
Monit2	0.604	0.575	**0.896**	0.356	0.334	0.185	0.253	0.258	0.452	0.345
Monit3	0.712	0.657	**0.950**	0.377	0.358	0.222	0.314	0.297	0.439	0.368
Monit4	0.682	0.629	**0.919**	0.376	0.389	0.185	0.287	0.266	0.454	0.366
TC1	0.268	0.341	0.360	**0.764**	0.486	0.142	0.330	0.280	0.478	0.346
TC2	0.320	0.316	0.241	**0.855**	0.614	0.348	0.513	0.431	0.484	0.567
TC3	0.294	0.314	0.368	**0.822**	0.527	0.204	0.377	0.304	0.462	0.465
TMS1	0.372	0.397	0.375	0.604	**0.906**	0.194	0.391	0.400	0.590	0.489
TMS2	0.336	0.372	0.323	0.617	**0.949**	0.314	0.485	0.437	0.563	0.573
TMS3	0.340	0.394	0.349	0.653	**0.946**	0.351	0.473	0.471	0.587	0.614
CP1	0.201	0.253	0.143	0.205	0.215	**0.903**	0.493	0.496	0.252	0.442
CP2	0.200	0.214	0.136	0.218	0.202	**0.898**	0.458	0.493	0.233	0.426
CP3	0.279	0.343	0.245	0.330	0.369	**0.877**	0.556	0.701	0.396	0.596
NP1	0.376	0.384	0.305	0.475	0.474	0.525	**0.927**	0.518	0.553	0.632
NP2	0.289	0.311	0.260	0.467	0.428	0.417	**0.875**	0.504	0.473	0.531
NP3	0.236	0.339	0.184	0.356	0.328	0.546	**0.772**	0.431	0.393	0.460
MP1	0.292	0.360	0.276	0.413	0.469	0.645	0.566	**0.958**	0.422	0.587
MP2	0.257	0.367	0.278	0.416	0.453	0.607	0.526	**0.978**	0.416	0.541
MP3	0.261	0.368	0.276	0.395	0.436	0.642	0.546	**0.970**	0.414	0.539
SaaSi1	0.417	0.513	0.463	0.544	0.604	0.319	0.531	0.452	**0.922**	0.677
SaaSi2	0.432	0.523	0.503	0.529	0.589	0.326	0.500	0.382	**0.930**	0.620
SaaSi3	0.274	0.347	0.310	0.477	0.455	0.273	0.451	0.307	**0.816**	0.585
SaaSa1	0.381	0.471	0.399	0.582	0.630	0.441	0.582	0.497	0.767	**0.910**
SaaSa2	0.401	0.404	0.339	0.515	0.506	0.554	0.604	0.551	0.603	**0.947**

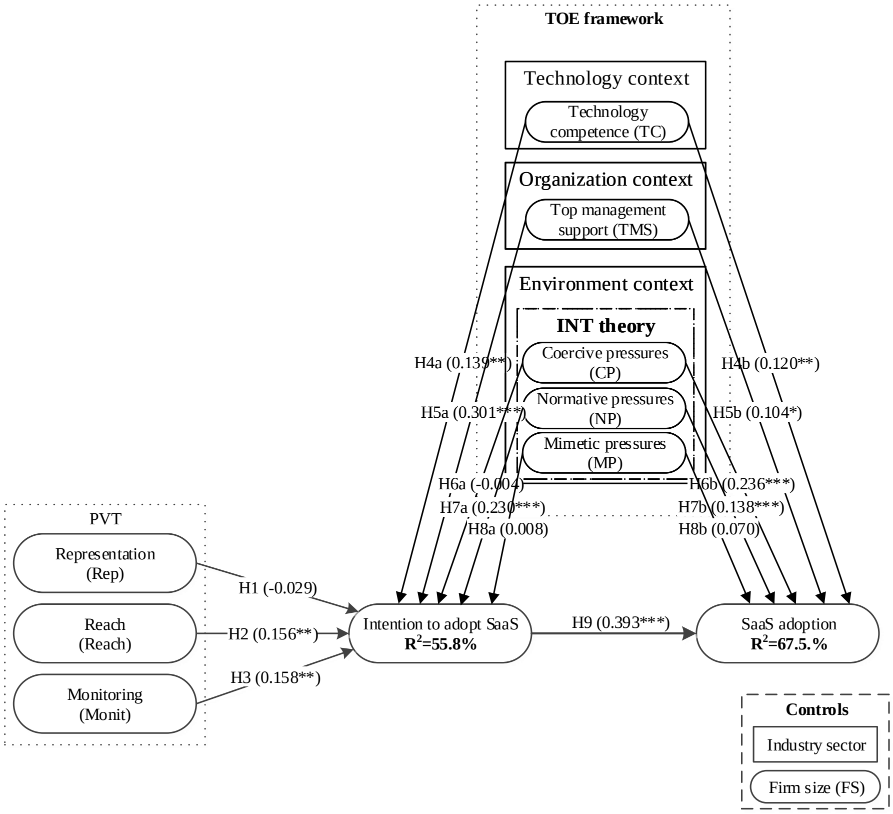
SaaSa3	0.377	0.406	0.316	0.500	0.537	0.587	0.591	0.561	0.594	**0.940**

Table 6 – Hetrotrait-Monotrait Ratio.

	Rep	Reach	Monit	TC	TMS	CP	NP	MP	SaaSi	SaaSa
Rep										
Reach	0.669									
Monit	0.774	0.738								
TC	0.436	0.484	0.471							
TMS	0.407	0.454	0.399	0.799						
CP	0.282	0.337	0.215	0.335	0.321					
NP	0.403	0.463	0.330	0.632	0.546	0.667				
MP	0.297	0.403	0.299	0.488	0.493	0.683	0.631			
SaaSi	0.472	0.583	0.528	0.722	0.688	0.375	0.650	0.466		
SaaSa	0.450	0.500	0.403	0.676	0.644	0.607	0.721	0.607	0.783	

5.2. Structural Model

The structural model was evaluated using R^2 measures and the level of significance of the path coefficients. The results of the analysis are shown in Figure 2. The path significance level was assessed by the bootstrapping method (Hair, Ringle, and Sarstedt 2011; Henseler, Ringle, and Sinkovics 2009) with 5000 re-samples (Chin 1998). To detect multicollinearity among independent variables, we calculated the variance inflation factor (VIF). The VIF ranges from 1.08 (lowest) to 2.97 (highest), which is less than the threshold of 5. These values suggest an absence of multicollinearity (Hair Jr et al. 2013).



Note: * Significance at p<0.10; ** Significance at p<0.05; *** Significance at p<0.01;

Figure 2 – Results of research model

The research model explains 55.8% of variation in the intention to adopt SaaS. Hypotheses for reach (H2) ($p<0.05$), monitoring (H3) ($p<0.05$), technology competence (H4a) ($p<0.05$), top management support (H5a) ($p<0.01$), and normative pressures (H7a) ($p<0.01$), are confirmed to explain the intention to adopt SaaS. Representation (H1), coercive pressures (H6a), and mimetic pressures (H8a) hypotheses are not confirmed.

The research model explains 67.5% of variation in SaaS adoption. Hypotheses for technology competence (H4b) ($p<0.05$), top management support (H5b) ($p<0.10$), coercive pressures (H6b) ($p<0.01$), normative pressures (H7b) ($p<0.01$), and intention to adopt SaaS (H9) ($p<0.01$) are statistically significant in explaining SaaS adoption. Overall, of the 14 hypotheses formulated, ten are confirmed by the data. We therefore conclude that the research model has good explanatory power.

6. *Discussion*

The goal of this study is to assess the determinants of SaaS adoption by using an integrative research model that combines the characteristics of the virtualization mechanism of SaaS and the organization's context. The results indicate that the intention to adopt SaaS is influenced by five factors: reach and monitoring capability of SaaS, technology competence and top management support of the organization, and normative pressures felt by the organization.

The results also show that five factors influence the adoption of SaaS: intention to adopt SaaS, technology competence, top management support, coercive pressures, and normative pressures (see Figure 2). Table 7 shows the outcomes of hypotheses tested.

Table 7 – Hypotheses conclusions.

Hypothesis	**Findings**	**Conclusion**
H1: *The representation capability of SaaS positively influences the intention to adopt SaaS.*	No statistically significant effect	*Not supported*
H2: *The reach capability of SaaS positively influences the intention to adopt SaaS.*	Positive and statistically significant ($\hat{\beta} = 0.156$; $p<0.05$)	*Supported*
H3: *The monitoring capability of SaaS positively influences the intention to adopt SaaS.*	Positive and statistically significant ($\hat{\beta} = 0.158$; $p<0.05$)	*Supported*
H4a*: The technology competence positively influences the intention to adopt SaaS.*	Positive and statistically significant ($\hat{\beta} = 0.139$; $p<0.05$)	*Supported*
H4b*: The technology competence positively influences the adoption of SaaS.*	Positive and statistically significant ($\hat{\beta} = 0.120$; $p<0.05$)	*Supported*
H5a*: The top management support positively influences the intention to adopt SaaS.*	Positive and statistically significant ($\hat{\beta} = 0.301$; $p<0.01$)	*Supported*
H5b*: The top management support positively influences the adoption of SaaS.*	Positive and statistically significant ($\hat{\beta} = 0.104$; $p<0.10$)	*Supported*
H6a: *Coercive pressures positively influence the intention to adopt SaaS.*	No statistically significant effect	*Not supported*
H6b: *Coercive pressures positively influence the adoption of SaaS.*	Positive and statistically significant ($\hat{\beta} = 0.236$; $p<0.01$)	*Supported*
H7a: *Normative pressures positively influence the intention to adopt SaaS.*	Positive and statistically significant ($\hat{\beta} = 0.230$; $p<0.01$)	*Supported*
H7b: *Normative pressures positively influence the adoption of SaaS.*	Positive and statistically significant ($\hat{\beta} = 0.138$; $p<0.01$)	*Supported*
H8a: *Mimetic pressures positively influence the intention to adopt SaaS.*	No statistically significant effect	*Not supported*
H8b: *Mimetic pressures positively influence the adoption of SaaS.*	No statistically significant effect	*Not supported*
H9: *Intention to adopt SaaS positively influences the adoption of SaaS.*	Positive and statistically significant ($\hat{\beta} = 0.393$; $p<0.01$)	*Supported*

The study found that representation is not significant in the intention to adopt SaaS, i.e., the capability of SaaS to provide a greater user experience does not necessarily impact the intention to adopt it. An explanation for diminished significance of representation characteristics of SaaS may be that these features are now basic to most information systems and do not constitute a differentiating factor for SaaS decision makers.

The analysis of results indicates that reach has a positive influence on the intention to adopt SaaS, suggesting that the capability of SaaS to allow the interaction between people, and facilitate collaboration and partnerships, positively influence the intention to adopt SaaS. Although no other studies have evaluated the reach capability of SaaS, earlier studies on cloud computing have found comparable results (Li et al. 2011; Stevenson and Hedberg 2013; Brown 2013). Gupta et al. (2013) found that small and medium enterprises prefer conventional methods for sharing and collaboration (e.g. face to face meetings, phone calls) instead of cloud based solutions. However, compared to other observations on technologies with virtualizable characteristics, we can conclude that reach is a facilitator for the intention to adopt SaaS.

Monitoring is also found to be a facilitator for the intention to adopt SaaS. The results of the study indicate that the ability to manage security issues related to authentication and activity tracking has a positive influence on the intention to adopt SaaS. The finding reported in literature regarding monitoring capability is mixed with regard to studies on other technologies with virtualizable characteristics. For instance, Oliveira et al. (2014) found that security does not inhibit the adoption of cloud computing. Dua et al. (2013) found that security has only an indirect positive impact on the behavioral intention to use SaaS due to perceived usefulness, (i.e., perception of SaaS as a secure service does not change user acceptance until they perceive its usefulness). Goode et al. (2015) found similar conclusion namely security is important to SaaS clients satisfaction when it seen as a valuable addition to the service. A possible explanation for the concern regarding authentication and authorization is the recent advances in identity management (IdM) and sign-on processes, which are supported via independent IdM stack, credential synchronization, or federated IdM (Subashini and Kavitha 2011). Additional research is needed to determine the impact of monitoring capability on the adoption of virtualizable technologies.

Technology competence is found to have a positive influence on the intention to adopt SaaS and SaaS adoption. This may suggest that IT assets and specialized human resources available within an organization may help to facilitate the implementation of SaaS and increase the intention for its adoption. This finding is similar to earlier research that suggests technology competence to be an important driver for adoption of new technologies (Chan and Chong 2013; Xu, Zhu, and Gibbs 2004).

Top management support is also found to have a positive influence on the intention to adopt SaaS and SaaS adoption. Similar findings were identified in other IT adoption studies, such as those related to cloud computing (Oliveira, Thomas, and Espadanal 2014) and mobile supply chain management (Chan and Chong 2013). Our results thus further confirm the role of top management in influencing the behavior of employees, reducing user resistance by communicating the value of the SaaS in achieving strategic business goals, and demonstrating support in the form of committing financial and organizational resources.

Coercive pressures have a positive influence on the adoption of SaaS. This type of pressure does not have an impact on the intention to adopt SaaS. This observation is similar to the findings reported in studies on the importance of coercive pressures on technological innovation adoption behavior (Jan, Lu, and Chou 2012). An explanation for the impact of coercive pressure on SaaS adoption may be that this type of pressure is mandatory, forcing firms to act, and not just disclosing the intention to do so.

Normative pressures have a positive influence on the intention to adopt SaaS, and on SaaS adoption. Despite the importance of normative pressures on IT adoption, few empirical studies have considered this construct. Our findings are consistent with studies that have reported them in the literature. For example, normative pressures were found to influence the e-business adoption (Wu, Mahajan, and Balasubramanian 2003), as well as the intention to adopt FEDI (financial electronic data interchange) (Teo, Wei, and Benbasat 2003). Furthermore, Schneider & Sunyaev (2014) suggest that increased efforts on standardization and the emergence of community cloud platforms for specific industries can influence organizations to adopt cloud computing solutions. Our study thus highlights the importance of considering the role of normative pressures in future adoption studies.

Mimetic pressures were not found to have a positive influence on the intention to adopt SaaS or adoption of SaaS. This finding is consistent with earlier studies in which mimetic pressures were mentioned as being important when a high degree of complexity in the adoption of the technology was perceived (Teo, Wei, and Benbasat 2003; Liang et al. 2007). With SaaS, the technology complexity (e.g., development, support, maintenance, and upgrades of customer software on demand) is managed by the SaaS provider. Thus uncertainty associated with technology complexity is reduced, which may lead to a lower need for imitating actions of other organizations. The intention to adopt SaaS has a positive influence on the SaaS adoption. The findings confirm the link between the adoption stages of SaaS, i.e. the formal stage of adoption is influenced by their pre-stage of adoption, which is similar to other studies on technology adoption (Bose and Luo 2011; Zhu, Kraemer, and Xu 2006).

The implications of the study to practice and theory are summarized below.

6.1. Practical implications

In evaluating SaaS, a relatively recent service model, our study highlights the importance of assessing the SaaS characteristics as a virtualized mechanism, the organization characteristics, and the various environment pressures on SaaS adoption. This highlights several features of SaaS, and their internal and external context that managers should consider prior to making informed SaaS decisions.

The findings indicate that SaaS features such as enabling interactions between processes, participants, global reach, and monitoring capabilities make firms more amenable to support SaaS solutions and increase the intention to adopt SaaS. For SaaS providers, developing enhancements focused on these types of functionalities will make SaaS solutions more attractive as a good virtualizable mechanism, and therefore increase their potential market. Recent technological advances in the security domain (Mohammed 2011; Zissis and Lekkas 2012; Ryan 2013) are promising developments that may be beneficial to both SaaS providers, as well as to firms considering SaaS solutions (Rico et al. 2016).

The study underscores the importance of technology competence and top management support on the adoption stages of SaaS. Implementation of new technological solutions can disrupt service operation and create challenges in an organization (Oliveira, Thomas, and Espadanal 2014). Top management needs to ensure that the infrastructure technology and the skills of the IT team are adequate for the adoption of SaaS solutions in the business operations. In addition, to gain user acceptance, top managers should explain the firm's strategic use of SaaS and guide the allocation of resources on SaaS implementation projects. Coercive pressures and normative pressures also play key roles in the firm's adoption of SaaS initiatives. For the successful adoption of SaaS, managers need to analyze and understand the effect of institutional pressures on the firm's environment. With a better understanding of how these pressures may influence the behaviors or performances of competitors, firms can predict or understand their future market competition better and identify more market opportunities. Forces of the local government, industry association, and competitive conditions (coercive pressures) are important determinants of SaaS adoption. Thus, policy makers can play a vital role in developing adequate regulations and a legal base to assist organizations in the adoption of SaaS. Such regulations can instill the sense of confidence necessary for firms to consider the perceived benefits of SaaS over the risks, and to convert SaaS into global business opportunities. The extent of SaaS adoption by firm's suppliers, firm's customers, and government's promotion of IT (normative pressure) are important considerations in the intention stage, adoption stage, and during the transition from intention to adoption. Thus, managers should pay careful attention to understanding how these kinds of pressures impact their organization and formulate appropriate strategies to stimulate SaaS adoption.

6.2. Theoretical implications

The study presents important contributions to the IS community, and adds new knowledge to this emerging area of IS research. In this research we follow the recommendations of earlier researchers to consider other theories for better understanding SaaS adoption, and include constructs beyond those already studied in earlier research (Chan and Chong 2013; Lee, Chae, and Cho 2013; Benlian, Hess, and Buxmann 2009; Benlian and Hess 2011). We integrate three theoretical perspectives (PVT, the TOE framework, and INT) to develop the research model. The model combines the virtualization features of SaaS, the technology competence, the top management support, and the coercive, normative, and mimetic pressures in the organization's environment that underlie the adoption of SaaS. To the best of our knowledge, no earlier study has empirically validated the propositions of PVT, the TOE framework, and INT in the SaaS context, and tested the integrative model with these three theories.

The instrument developed in this study was verified for reliability and validity. The research model and the instrument provide a solid basis for understanding the determinants of

SaaS adoption. The model and the instrument can be replicated across industries in other countries or adopted for use in other innovation studies.

6.3. Limitations and future research

Despite the achieved results, more research can be done to address the limitations of our study. One limitation is that we did not consider the process characteristics variable of PVT in our research model and without focus on a specific process. Thus, we encourage additional research focused on the role of the PVT variables that were not considered in this study, and assess the adoption of SaaS as a virtualized mechanism for specific business processes. Other limitation is the data collected was restricted to Portugal, which reflects only the situation in that country. As would be interesting to determine whether the findings differ in other countries we recommend to apply the model and the instrument in others countries. Additionally, our study was not focused on any particular sector or made comparisons between sectors. As the results could be different (Oliveira and Martins 2010; Oliveira, Thomas, and Espadanal 2014) since some industries (e.g., the service sector) are more technologically advanced than others (e.g., the construction sector), we encourage additional research to test the model in a specific target industry or identify potential differences between industries.

7. Conclusion

SaaS is an important trend in the IS sector. It boasts attractive properties such as good user adaptation, flexibility, scalability, and cost savings. This study empirically evaluated the determinants of SaaS adoption based on the SaaS characteristics as a virtualized mechanism, the technology and organizational context, and the pressures existing in the organization’s environment. A research model was developed that integrates PVT, the TOE framework, and INT. The model was evaluated based on a sample of 317 firms from Portugal.

The results indicate that intention to adopt SaaS is influenced by reach and monitoring capabilities of SaaS, technology competence, top management support, and normative pressures. SaaS adoption is influenced by intention to adopt SaaS, technology competence, top management support, coercive pressures, and normative pressures. Among the three types of institutional pressures, normative pressures positively influence all the stages of SaaS adoption. Our study also confirms the link between the adoption stages of SaaS, i.e. the stage of adoption is influenced by the pre-stage of adoption.

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Appendix A: Measurements items

Constructs	Authors
Technology competence TC1. The technology infrastructure of my company is available to support SaaS. TC2. My company is dedicated to ensuring that employees are familiar with SaaS. TC3. My company has good knowledge of SaaS.	(Chan and Chong 2013)
Top management support TMS1. Top management is likely to take risk involving the implementation of SaaS. TMS2. Top management actively participates in establishing a vision and formulating strategies for utilizing SaaS. TMS3. Top management communicates its support for the use of SaaS.	(Chong and Chan 2012)
Representation **Rep1:** SaaS can provide online reports on everything I need to know about the process. **Rep2:** I can get all the information needed about the process when I use SaaS. **Rep3:** I don´t need face-to-face interaction with others to manage the process because I can access enough information using SaaS. **Rep4:** SaaS can provide all information needed to know about my business process.	(Overby 2008)
Reach **Reach1:** SaaS can facilitate partnerships that otherwise would not exist. **Reach2:** SaaS can enable new opportunities through collaboration with the supplier of this service. **Reach3:** SaaS can help process participants from around the world to interact.	(Overby 2008)
Monitoring capability **Monit1:** Authentication requirements in SaaS will enable the identification of the participants if necessary. **Monit2:** SaaS allows that all participants are registered with a unique identification. **Monit3:** Activities in SaaS can be tracked systematically and analyzed in detail. **Monit4:** SaaS allows strict control over their privileges.	(Overby 2008)
Coercive pressures **Cp1:** The local government requires our firm to use SaaS **Cp2:** The industry association requires our firm to use SaaS **Cp3:** The competitive conditions require our firm to use SaaS	(Liang et al. 2007)
Normative pressures **NP1:** The extent of SaaS adoption by your firm's suppliers **NP2:** The extent of SaaS adoption by your firm's customers **NP3:** The extent to which the Government's promotion of Information Technology influences your firm to use SaaS	(Liang et al. 2007)
Mimetic pressures *Our main competitors who have adopted SaaS:* **MP1:** Have greatly benefitted **MP2:** Are favorably perceived by others in the same industry **MP3:** Are favorably perceived by their suppliers and customers	(Liang et al. 2007)
Intention to adopt SaaS **SaaSi1:** My company intends to use SaaS if possible. **SaaSi2:** My company collects information about SaaS with the possible intention of using it. **SaaSi3:** My company has conducted a pilot test to evaluate SaaS.	(Chan and Chong 2013)
SaaS adoption **SaaSa1:** My company invests resources to adopt SaaS. **SaaSa2:** Business activities in our company require the use of SaaS. **SaaSa3:** Functional areas in my company require the use of SaaS.	(Chan and Chong 2013)