Environment determinants in business adoption of Cloud Computing

Abstract

Purpose: This paper analyzes the influence of Technology Providers, Public Administrations and R&D Institutions on Cloud Computing adoption. This research also considers Killer Applications and Success Cases as other environmental factors.

Design/Methodology/Approach: Factorial analyses and structural equation models were used on a sample of High-Technology firms located in technological parks in Southern Europe, with more than 10 employees and sustained investments in R&D.

Findings: Results show that Technology Providers and Success Cases are determinant in Cloud Computing adoption. Moreover, Killer Applications are a forerunner for Success Cases.

Originality/value: This study contributes to Cloud Computing adoption literature because it includes Technology Providers, Public Administrations and R&D Institutions simultaneously as well as other variables as Killer Applications and Success Cases. The importance of the external agents on IT adoption, especially when the technologies to be adopted are new and in an emergent stage, together with the lack of prior investigations focusing on specific environmental factors affecting the adoption of these new, emerging IT, justify the value of this research.

Practical implications: An appropriate fit between the tools and resources provided by suppliers and the internal resources of the company is needed to create competitive advantages. Firms should evaluate Technology Providers, identify Success Cases to Cloud Computing adoption and implement technological benchmarking.

Keywords: Adoption models, Cloud Computing, Environment, Technology Providers, Success Cases.

Paper type: Research paper.

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Introduction

In turbulent environments Information Technology (IT) combined with tangible and/or intangible resources, can be a powerful tool to attain competitive advantage (Powell and Dent-Micallef, 1997). A technological trend, named Cloud Computing, emerged to modify the use of information technology in a competitive way. In Cloud Computing (Buyya *et al*., 2009; Buyya *et al.*, 2011), resources are located in virtualized and distributed environments geographically disperse. They can be accessed on an on-demand basis through web-based technologies, combining Internet connectivity and pay per use systems (Winans and Brown, 2009) in a new business model for IT provisioning (Son, *et al*., 2014).

The National Institute of Standards and Technology, US department of commerce defines Cloud Computing as (Mell and Grance, 2011): a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Public Administrations, R&D Institutions and Technology Providers can arise as important environment factors in Cloud Computing adoption (Arinze and Anandarajan, 2010; Marston *et al*., 2011; Kenji *et al.*, 2011), specially in the initial stages of their life-cycle (Dos Santos and Pfeffers, 1998). Other environmental factors that are acquiring particular relevance on IT adoption are Killer Applications and external Success Cases. The former allows firms to visualize the great potential of a given technology. Success Cases can stimulate IT adoption because the firms can observe and understand the real benefits of its adoption (Xu and Gutiérrez, 2006).

Knowing the role of key environmental players on Cloud Computing adoption is a relevant issue. Throughout the company evolution of the IT towards the “cloud”, firms should be able to manage their organization to adapt to a future dominated by the standardization of IT infrastructures and services (Buyya *et al.,* 2009). Within this transition, companies will act depending on the role exerted by external agents such as technology providers, R&D institutions and public administrations. The future behavior of each of these agents will also be affected by their role on adoption itself (Leydesdorff and Etzkowitz, 1996). However, in spite of the relevance of this question for the business management of IT, we have not identified prior research with a focus on IT adoption using these three environmental forces simultaneously.

The aforementioned reasons (importance of external agents on IT adoption, when technologies are in emergent stage and the lack of prior investigations focusing on specific environmental factors) justify the value of this research. Thus, in this study the research problem will be focused on the role of environmental agents: Public Administrations, Technology Providers and R&D Institutions in Cloud Computing adoption. This study also seeks to analyze the effect of other variables of the environment that might prove to be relevant to explain Cloud Computing adoption such as the existence and awareness of Killer Applications and Success Cases (Low *et al*., 2011; Lin and Chen, 2012; Cegielski *et al*,. 2012). Interestingly, these latter variables have received very little attention on literature dealing with IT and particularly with Cloud Computing adoption (Alshamalia *et al*., 2013).

The rest of the paper is organized as follows: first, the theoretical background about IT adoption is presented. Next, research design, theoretical model and hypotheses are described, followed by the method and data analysis. Subsequently the results, their discussion and implications are presented. The research ends with main conclusions, limitations and suggestions for future research.

Theoretical Background

IT adoption models in firms

Difussion of Innovation Theory (Rogers and Shoemaker, 1971; Rogers, 1962) –a pioneering work about IT adoption-, explained innovation adoption at the individual level in terms of the characteristics of the innovation. Various models have been used to study IT adoption in the field of the organization. An approach focusing on innovation diffusion at the organizational level (Hovav *et al.* 2004; Dos Santos and Peffers, 1998; Rogers, 1995) considers, in addition, the external influence arising in the environment. Likewise, Contingent Models (Premkumar *et al.,* 1997; Tornatzky and Fleischer, 1990) explain adoption by referring to three groups of factors: (1) environmental; (2) organizational; and (3) innovation characteristics. There are also partial contingent models that focuses only on a group of factors.

Additional models have been used which stressed the modular nature of adoption, which might be split in different levels. Thus, Nambisan and Wang (1999) propose different adoption levels for Web technologies: (1) Information access; (2) collaborative work and (3) business transaction kernell. Teo and Pian (2003, 2004) provide five adoption levels of Web technologies: (1) level 0: e-mail; (2) level 1: Internet presence; (3) level 2: Prospecting; (4) level 3: Business integration and (5) level 4: Business transformation. In this paper we will use a modular model based on adoption levels to measure the evolution and use of Cloud Computing in the company.

IT adoption and environmental factors

Two mechanisms influence the adoption of a technology within a community (Dos Santos and Peffers, 1998): (1) external agents: e.g. public administrations, technology suppliers or research institutions; and (2) internal influence: when there is a sufficient critical mass (Liao *et al.*, 1999) of adopters, the positive network externalities (Hovav *et al.*, 2004) favor mechanisms of communication, learning and imitation between the members of the community, evident for example in the support of trading partners or customers who have already adopted the technology (Premkumar *et al.*, 1997; Soliman and Janz, 2004) or in the positive influence of the competition (Thong, 1999).

The influence of Public Administrations, Technology Providers and R&D institutions on IT adoption have been considered in prior research (Kuan and Chau, 2001; Quaddus and Hofmeyer, 2007; Salwani *et al.*, 2009) but in a separated way. We have not found any prior piece of adoption research simultaneously analyzing the three environmental forces.

Other environmental factors have been considered in prior literature about IT adoption: competitors pressure; trading partners pressure and confidence in the business relationship (Premkumar *et al*., 1997; Soliman and Janz, 2004); business partners/clients support that already had implemented the technology and power-dependence relationship (Premkumar *et al*., 1997); positive network externalities (Hovav *et al*., 2004; Wang *et al*., 2005, Hsu and Fang, 2005); critical mass (Liao *et al.*, 1999; Dos Santos and Peffers, 1998) or turbulent environments (Chau and Tam, 1997). They have been found related to IT adoption: competitors pressure, trading partners pressure, confidence in commercial relationship, commercial partners/clients support, positive network externalities and critical mass. However, Killer Applications and Success Cases, although are factors that can play a crucial role on adoption as a way to boost IT knowledge and use, have received little attention in research (Xu and Gutiérrez, 2006). A better, comprehensive knowledge on the factors that encourage or inhibit IT adoption would allow companies to get access to a successful adoption. Revisiting environmental adoption factors for new technologies, such as cloud computing, is therefore a relevant question that should be addressed.

Cloud Computing Adoption

Cloud Computing technologies can be classified in (Mell and Grance, 2011): (1) Private Cloud -internal cloud infrastructure in one single organization-; (2) Community Cloud -distributed infrastructure made up by a group or business partners to share business resources-; (3) Public Cloud -provisioned by the general public for open use-, and (4) Hybrid Cloud -two or more distinct cloud infrastructures (private, community, or public)-. Cloud Computing implementation can be carried out together with the next service models: (1) Software as a Service (SaaS), uses provider's applications running on a cloud infrastructure where the applications are accessible from a thin client interface, such as a web browser (e.g., web-based email), or a program interface; (2) Platforms as a Service (PaaS), that deploys onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider, and (3) Infrastructure as a Service (IaaS), that provides processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run software.

Investigations on Cloud Computing adoption has diverse. Cloud computing is affected by geographical and industrial factors. Finance and business areas in educational institutions use more Cloud Computing than other industries (Tuncay, 2010). Arinze and Anandarajan (2010) examine the potential of Cloud Computing in developing countries. Low *et al.* (2011), use a contingent model to analyze the factors (relative advantage, complexity, compatibility, top management support, firm size, technology readiness, competitive pressure, and trading partner pressure) that affect Cloud Computing adoption by firms belonging to the high-tech industry in Taiwan. Gupta *et al.* (2013) highlight the easy of use, security and privacy in their study about Cloud Computing use and adoption on small and medium enterprises (SMEs). Based on diffusion of innovation theory and technology-organization-environmental framework, Oliveira *et al.* (2014) focus on innovation characteristics. Hsu *et al.* (2014) found that the perceived benefits, business concerns and IT capability are determinants of Cloud

Computing adoption, but external pressure are not (competitors pressure, government policy, partners pressure, regulations). Finally, Lian *et al.* (2014) state that the most critical factors in Cloud Computing adoption are data security, perceived technical competence, cost, top manager support, and complexity.

Regarding environmental factors, some studies reported a no significant relationship between Public Administration and Cloud Computing adoption (Oliveira *et al.*, 2014; Hsu *et al*., 2014). Some other authors considered R&D institutes as an important factor for dealing with enterprises' concerns about IT standardization, security and the interoperability of cloud solutions (Low y Chen, 2012). And few studies more explore the important role of the Technology Providers in facilitating Cloud Computing adoption (Alshamalia *et al*., 2013; Nuseibeh, 2011).

Research model and hypotheses

R&D Institutions

Close collaboration between universities, firms and R&D institutions can be usually related to the adoption of a particular business model or technological innovation (Leydesdorff and Etzkowitz, 1996). The link between R&D institutions and business applications is usually supported by the creation of startups and spin-outs as a way to transfer scientific knowledge into ground-level, applied business realities. Nowadays many firms closely cooperate with universities or R&D centers and these institutions became R&D departments of the firms. In the ground of GRID IT (the forerunner for Cloud Computing), CERN and its Large Hadron Collider (LHC) are acknowledged as one of the major landmarks for GRID utilization for scientific purposes. Likewise, many companies involved in the LHC Project have adopted GRID IT due to the influence of CERN. R&D institutes are also cited as an important factor for dealing with firms' concerns about IT standardization, security and the interoperability of cloud solutions and to develop security standards, which jointly facilitates the Cloud Computing adoption (Low y Chen, 2012). Considering the above arguments:

H1: The higher the influence of R&D Institutions over an organization, the higher the level of Cloud Computing adoption.

Technology Providers

Many small, innovative software developers and large computer manufacturers are active in GRID IT (Maqueira *et al.*, 2009) and Cloud Computing (Velten and Janata, 2011), and in its application in the business world (Abdulaziz 2012; Marston *et al.*, 2012). This effect was already evident in the adoption of the Internet. Thus, firms like Cisco Systems raised awareness in many organizations about the strategic and competitive need to adapt Web technologies to their business strategies and value chain activities (Chatterjee *et al.*, 2002). Private Technology Providers support could: (1) increase the number of organizations carrying out adoption through consortia; (2) provoke an artificial crisis by withdrawing support for technologies based on previous standards; (3) offer financial incentives to early adopters; and (4) develop transition technologies (Hovav *et al.,* 2004).

Many large technology companies, led by Amazon, are building huge server farms to offer Cloud Computing with virtual applications and business software with self-service interfaces so that customers can use resources when they want (Chris, 2011). Furthermore, an increasing number of Cloud Computing technological providers are ready to attract companies to Cloud business models (Marston *et al.,* 2011). Thus, key Technology Providers (like Apache, EMC or Cisco) adapt their technologies to facilitate firms access to the Cloud. Established key players (as Google, IBM or Microsoft) and also innovators (as Amazom or Salesforce) exert and influence adoption through marketing action among potential customers and enablers (like CapGemini or RightScale). Furthermore, these companies closely cooperate with clients to offer products and services that use or are intimately related to Cloud computing adoption (Marston *et al.,* 2011).

Furthermore, private support can become even more influential if the relationship between the customer firm and its technology provider is highly dependent (Hsu *et al.,* 2014). Cloud Computing adoption will depend on the balance of bargaining power in the commercial relationship, and will be stronger when the supplier or customer with this adopted technology is key for the business of the other party that has not adopted the technology yet (Premkumar *et al.,* 1997). The support for implementing and using cloud services made available by cloud services providers is likely to motivate enterprises to adopt Cloud Computing (Alshamalia, *et al.*, 2013). Thus, the following hypothesis is proposed:

H2: The higher the influence of Technology Providers the higher the level of Cloud Computing adoption.

Public Administrations

Public Administrations might have played a key role as drivers for many cloud based research and development projects (Marston *et al.,* 2011), for example, in one of the most powerful GRID IT facilities in the world: the development of the EGEE infrastructure in Europe (Maqueira and Bruque, 2007). Recently, the governments of several countries are considering Cloud Computing potential as a way to upgrade the services offered to their citizens, specially within the tax administration service (Navonil, 2010). Some examples led by public administrations that also involved many private companies are the British G-Cloud, a part of the Digital Britain Plan; the United States' Apps. Gov, Japan's Kasumigaseki, the European Union's EuroCloud, and South Korea's governmental Cloud Computing plan (Yang and Hsu, 2011).

Public Administrations' role on technology adoption might be twofold. On the one hand, Public Administrations can be companies' clients or suppliers (Janssen and Joha, 2011). On the other hand, they can influence on companies with public subsides, technology promotion initiatives or by introducing legal changes favorable to IT adoption (Hovav *et al.*, 2004). Public Administrations might establish, for instance, a common regulatory framework able to ensure an appropriate policy for data protection and security as well as to favor fair contractual relations between the parties (suppliers and clients of cloud services which commonly act in a globalized environment) (Marston *et al.,* 2011). A wide emphasis on the importance of government regulations at the national and international levels and the lack of government regulations can hinder enterprises from adopting the cloud (Lian *et al.* 2014). These arguments lead to the following hypothesis:

H3: The higher the influence of Public Administration on a given organization the higher the level of Cloud Computing adoption.

Killer Applications

Killer Application is a service or application able to create value and that is quickly recognized and used by an increasing number of users (Xu and Gutiérrez, 2006) and that is also an enabler or promoter of the use of related technologies. Thus, the e-mail was a Killer Application for web technologies and SMS was a Killer Application for the use of mobile telephones (Xu and Gutiérrez, 2006). Other examples for web technologies were the Internet search engine Google, Voice over IP such as Skype or, more recently, video screening systems through the Internet (Shin, 2006) such as YouTube or social electronic networks like Foursquare. Firms like Foursquare hold all their infrastructure hosted in the Amazon EC2 servers. Emerging cloud models the ones more appropriate to satisfy traffic and concurrency needs (Buyya *et al.*, 2009). Therefore, a positive relationship between the existence of Killer Applications in the Internet age and Cloud Computing adoption could arise. Products like Google's Gmail, -a Cloud killer application-, encourage many firms to use Cloud services provided by Google App.

In Cloud Computing literature, the Amazon EC2 models are considered as Killer Applications related to Cloud Computing (Abdulaziz, 2012). They might be succeeding in attracting many users through imitation or contagion (Dos Santos and Peffers, 1998; Middleton, 2007). In fact, many successful companies working in Internet-related services such as Reddit, Quora and Foursquare, use their IT services. Based on Institutional Theory (DiMaggio and Powell, 1983), Killer Applications might favor mimesis or imitative behavior, which is a powerful explicative factor of IT adoption in companies. Therefore, we propose the following hypothesis:

H4: The higher managers' awareness of Killer Applications based on Cloud Computing, the higher the level of Cloud Computing adoption.

Killer Applications might be closely related to the R&D Institutions and Technology Providers. Killer Applications may act as triggers so that these two agents would be more motivated to attain quicker and deeper access to the technical foundations and knowledge underlying Cloud Computing as well as to Cloud-related know-how. The accumulated knowledge of R&D Institutions may materialize in a higher likelihood of tight cooperation with companies which in turn may evolve towards higher levels of Cloud adoption. These arguments lead to the following hypotheses:

H5: The higher managers' awareness of Killer Applications based on Cloud Computing, the higher the influence of R&D institutions on Cloud Computing adoption.

H6: The higher managers' awareness of Killer Applications based on Cloud Computing, the higher the influence of Technology Providers on Cloud Computing adoption.

Success Cases

Success Cases are specific and well defined applications able to solve a business problem in an efficient way. Unlike Killer Aplications, Success Cases are not very popular, and have not many users and, therefore, have a more limited application scope. So, generally its use is restricted in a particular industry. Success Cases are intensively used by technology providers, who include them into their websites as a promotion instrument (Alshamaila and Papagiannidis, 2013). Thus, their potential clients can visualize the effects of the new technology. So, Technology Providers try to attract interest on their products/services, increasing their sales opportunities.

This can explain why adoption models have included Success Stories/Cases among the potential enablers of technology adoption (Moore, 1995). Furthermore, Success Cases in key industries can act on IT adoption in a bowling effect way: a given Success Case, through an increased, extended confidence, is able to create momentum, thus influencing many companies towards technology adoption so that adopters can cross the chasm which separates the area of early adoption, also called early market from the area of massive adoption in the first majority or principal market (Rogers, 1995; Moore, 1991, 1995). This thrust effect is usually assisted by a strong imitative effect (DiMaggio and Powell, 1983).

The European project BEINGRID (25 Cloud Computing/GRID IT success cases in different industries) tries to promote success cases in each industry, thus nurturing an imitative effect so that Cloud Computing/GRID IT could be massively adopted (Dimitrakos *et al*., 2010). IT cloud providers' demonstration of successful business cases and models are likely to increase Cloud Computing adoption rates (Alshamaila and Papagiannidis, 2013). Observing perceived benefits from using Cloud Computing can be an important motivation towards its adoption (Low *et al*., 2012; Lin and Chen, 2012, Cegielski *et al*. 2012). Therefore, the following hypothesis is proposed:

H7: The higher managers' awareness of Success Cases in Cloud Computing, the higher the level of adoption of Cloud Computing.

Killer Aplications and Success Cases might be related. A Killer Application can be visualized and widely recognized in multiple sectors, which may favor technology awareness by other agents working in different industries. Thus, awareness about Killer Applications might cause a sense of urgency among potential technology adopters to rise. Early adopters in some industries might be visualized by other potential early adopters as Success Cases. This enables to state the following hypothesis:

H8: The higher the number of Killer Applications related to Cloud Computing, the higher the number of Cloud Computing Success Cases.

Success Cases might be fostered by R&D Institutions, Technology Providers and Public Administrations. Likewise, the higher the number of Success Cases, closely related to Cloud developers, the higher business partners are able to increase their internal technological know-how. Indirectly, through increasing the internal technological expertise, R&D Institutions can increase their influence over potentially adopting organizations (Montealegre, 1999). The same rationale can be applied to Technology Providers that might be also seen by clients as the most appropriate collaborators in technology adoption. Success Cases may also act as technology transfer promoters for Public Administrations, aiming and fostering initiatives related to the diffusion of public programs among potential adopters (Dimitrakos *et al*., 2010). These arguments lead to the following hypotheses:

H9: The higher managers' awareness of Success Cases in Cloud Computing, the higher the influence of R&D Institutions on Cloud Computing adoption.

H10: The higher managers' awareness of Success Cases in Cloud Computing, the higher the influence of Technology Providers on Cloud Computing adoption.

H11: *The higher managers' awareness of Success Cases in Cloud Computing, the higher the influence of Public Administrations on Cloud Computing adoption.*

Figure 1 depicts the research model.

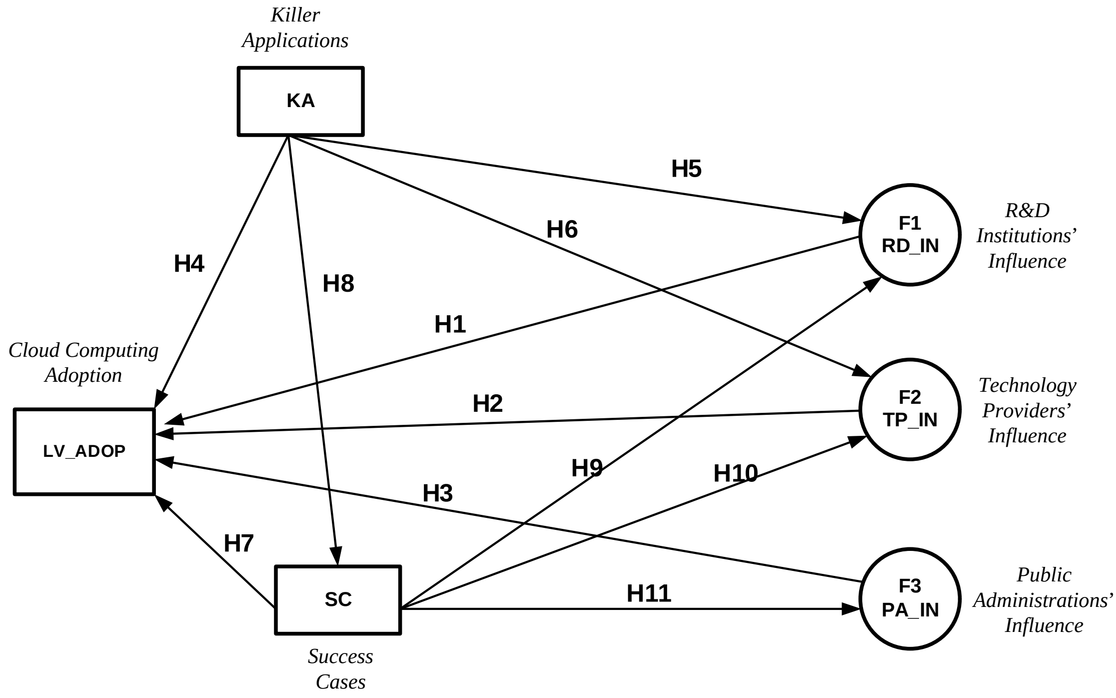

Figure 1. Research Model.

Research Methodology

Sample and data collection

In 2013, 79 technological parks in Spain hosted 5,115 companies with an accumulated turnover of 21,256 million euro. These companies employed 136,218 workers, 23,138 of them were directly related to R&D (APTE, 2013). The population in this study comprises 1,330 high-technology firms located in technological parks in Spain with more than 10 employees and sustained investment in R&D (APTE, 2013).

A questionnaire was used to collect data. Final data gathering was carried out through a phone interview using a Computer Aided Telephone Interviewing (CATI) which ensured data had been collected randomly and that contributes to the sample representativeness (Synodinos and Brennan, 1988).

Informants were Chief Information Officer (CIO) or Chief Executive Officer (CEO). 281 valid questionnaires were gathered (21.13% response rate), which can be considered as an on-average or even higher response rate compared to works dealing with similar populations and research topics (Chatterjee *et al*., 2002). Table 1 gathers sample distribution regarding sizes and informants. Table 2 exhibits sectorial sampling distribution.

Table 1. Sample Distribution	**Sample**	
Size (number of employees)	**n**	**%**
Between 11 and 100	182	64.77
Between 100 and 200	43	15.30
Between 200 and 500	27	9.61
More than 500	29	10.32
Total	281	100
Informants		
CEO	52	18.50
CIO	229	81.50
Total	281	100

Table 2. Sectorial sample distribution	**Sample**		**Total firms in Technological Parks**	
Sector	**n**	**%**	**n**	**%**
Automotive and Aeronautics	12	4.3	102	2
Training and Human Resources	13	4.6	153	3
Information, Informatics and Telecommunications	83	29.5	1381	27
Health and Medicine	17	6.0	358	7
Agrifood and Biotechnology	22	7.8	205	4
Electronics	14	5.0	153	3
Manufacturing	26	9.3	307	6
Engineering & Consulting	46	16.4	716	14
Energy and Environment	12	4.3	307	6
Technological Centres and R&D	36	12.8	307	6
Others	0	0	1126	22
Total	281	100	5115	100

Measures

R&D Institutions influence, Public Administrations influence and Technology Providers influence have been measured using instruments proposed and validated in prior research. Killer Applications and Success Cases variables have been operationalized through direct questions (Xu and Gutiérrez, 2006). Cloud Computing adoption has been built up using the same methodology employed to measure Web adoption levels (Nambisan and Wang, 1999; Teo and Pian, 2003, 2004) and including the taxonomy of Cloud Computing (Mell and Grance, 2011). Therefore, our scale of Cloud Computing adoption includes four basic adoption levels: (1) MicroCloud, small internal Cloud with experimental purposes; (2) Private Cloud, internal Cloud infrastructure which covers just one single organization; (3) Community Cloud, distributed infrastructure made up by a group of business partners closely linked in order to share business resources and (4) Public Cloud, infrastructure managed and provided by professional technology providers which offer services to business clients. Furthermore, a pre-adoption stage made up by three sublevels: (0_1) utilization of clusters just for experimental purposes; (0_2) utilization of departmental clusters, and (0_3) utilization of interdepartmental clusters.

Table 3 shows measure variables. Table 4 shows the Cloud Computing adoption scale, indicating if it is a pre-adoption or adoption level.

Table 3. Scales, measure variables and sources

Measures	Authors
With regards to the institutions that carry out R&D in your environment, your opinion is that:	
1. (RD_IN1) They would be willing to cooperate with my organization 2. (RD_IN2) They would be willing to lightly severe cooperative relations with my organization 3. (RD_IN3) They will not seek to take advantage of our cooperation relationship	Wu (2006)
You think that, among the Cloud Computing providers, there are some companies that are willing to:	
1.(TP_IN1) Cooperate with my organization 2.(TP_IN2) Hold a severe cooperative relations with my organization 3.(TP_IN3) They will not seek to take advantage of our cooperation relationship	Wu (2006)
With regards to Public Administrations and Cloud Computing:	
1. (PA_IN1) Public Administrations are leaders with regards to these technologies 2. (PA_IN2) Public Administrations already use Cloud Computing 3. (PA_IN3) Public Administrations provide direct financial support and efficient infrastructures to promote the use of Cloud Computing	Quaddus and Hofmeyer (2007); Teo et al. (1997); Premkumar and Roberts (1999)
Killer Applications	
1. (KA) I know one or several applications (Killer Applications) which confirm the great potential of Cloud Computing	Xu and Gutiérrez (2006)
Success Cases	
1. (SC) I know one or several Success Cases which encourage to use Cloud Computing in my Organization	Xu and Gutiérrez (2006)

Table 4. Cloud computing adoption scale

LEVEL	DESCRIPTION	ITEM	CLOUD
Level 0_1	Experimental cluster	We use a cluster made up by a limited number of computers just for experimental purposes.	NO
Level 0_2	Departmental cluster	We use a cluster made up by a limited number of computers connected through a local area network in a particular department for operational purposes.	NO
Level 0_3	Interdepartmental cluster	We use clusters made up by computers connected through a local area network, connecting several departments mostly for operational purposes.	NO
Level 1	MicroCloud	We use clusters made up by computers connected through a wide area network, connecting several departments mostly for operational purposes.	YES
Level 2	Private Cloud	In our organization, Cloud Computing is used grouping a big number of resources, mostly for operational purposes within the organization.	YES
Level 3	Community Cloud (Private Cloud with partners)	In our organization, Cloud Computing is used grouping a big number of resources, mostly for operational purposes, allowing interaction with other organizations which also provide resources and with which we are connected through strong links.	YES
Level 4	Public Cloud	In our organization, Cloud Computing is used to gather a big number of resources coming from heterogeneous external organizations freely associated through a wide global network.	YES

Content validity was ensured through a questionnaire analysis carried out by 5 academics and 2 managers directly related to Cloud Computing. Scale unidimensionality was assessed through an Exploratory Factor Analysis, providing eigenvalues higher than 1, standardized factorial loads of observed variables higher than 0.5, a significant explained variance for each extracted factor and high values for Chi-Squared/degrees of freedom in Barlett's sphericity test ($p<.05$). Therefore, one single factor was extracted in each of the proposed scales: Influence of R&D Institutions, Influence of Technology Providers and Influence of Public Administrations. Table 5 shows results for the Exploratory Factor Analysis. Based on IT adoption research (Premkumar, 2003), the Composite Reliability Index (CRI) was used to test measures' reliability, with scores higher than 0.6 (Bagozzi and Yi, 1988).

Table 5. Exploratory Factor Analysis

Factor	Variable	CRI	Standardized Factor Loading	Barlett Test	% Explained Variance
R&D Institutions' Influence	RD_IN1		.903	X^2=283.276	
	RD_IN2	.71	.911	g=3	65.135
	RD_IN3		.557	sig=.00	
Technology Providers' Influence	TP_IN1		.882	X^2=258.669	
	TP_IN2	.75	.894	g=3	66.481
	TP_IN3		.647	sig=.00	
Public Administrations' Influence	PA_IN1		.817	X^2=108.316	
	PA_IN2	.65	.754	g=3	57.872
	PA_IN3		.708	sig=.00	
-------	KA		---	---	---
-------	SC		---	---	---

A Confirmatory Factor Analysis (CFA) was performed, using EQS 6.1, to analyze scales' dimensionality and test convergent validity. First, a data exploration was carried out through normalized estimation of Mardia's test (Bentler and Wu, 2002), which confirmed multivariate non-normality of data, so we could apply the Robust Maximum Likelihood method. Thus, a factor model was designed including the 9 observed variables, three for each construct. Once the measurement model was tested, yet all indicators were significant and the overall model presented a satisfactory goodness of fit, it was necessary to rule out all the factors whose standardized loads were lower than 0.5 or which had a R^2 score lower than 0.3 (Kline, 1998). The final fit of the Confirmatory Factor Analysis was highly satisfactory (Kline, 1998) (Scaled, Satorra-Bentler's X^2 = 6.245; degrees of freedom g = 6; X^2/g=1.04; RMSEA=.012; MFI=1; NFI=.985; NNFI=.998; CFI=.999; IFI=.999). Standardized factorial loads and R^2 are shown in Table 6.

Table 6. Confirmatory Factor Analysis

Factor	Variable	Standardized Factor Loading	R^2
R&D Institutions' Influence	RD_IN1	0.774	0.600
	RD_IN2	1.000	1.000
Technology Providers' Influence	TP_IN1	1.000	1.000
	TP_IN2	0.731	0.534
Public Administration' Influence	PA_IN1	0.615	0.379
	PA_IN2	0.713	0.509
-------	KA	---	---
-------	CE	---	---

Discriminant construct validity was confirmed as per comparison of correlation coefficients (Table 7) between constructs/variables, which in all cases are relatively low (no >.8) but not too low (>.10) (Kline, 1998). A structural equation model was developed (Figure 2). We used EQS and the Robust, Maximum Likelihood Method because it is the most appropriate for non-normal settings (Satorra, 2002).

Table 7. Descriptive statistics and correlation matrix

Factor/Variable	Mean	Standard deviation	1	2	3	4	5
1. R&D Institutions influence	5.514	1.224					
2. Technology Providers Influence	5.324	1.234	.198**				
3. Public Administrations Influence	3.710	1.328	.135*	.060			
4. Killer Applications	4.655	1.890	.105	.285**	.012		
5. Success Cases	4.885	1.785	.023	.291**	.020	.674**	

N = 281; * $p < 0.05$; ** $p < 0.01$

Results, discussion and implications

Results

The model yielded an overall good fit (Satorra-Bentler's scaled X^2 = 33.6067; g=19; X^2/g =1.769, RMSEA=.052; NFI=.952; NNFI=.958; CFI=.978; IFI=.978; MFI=0.974) (Figure 2). Significant relationships (p<.05) are those included in H2, H5, H6, H7, H8 and H10 whereas that hypotheses H1, H3, H4, H9 and H11 do not receive enough support.

Results show that the environmental factors that explain Cloud Computing better adoption are Technology Providers (H2) and Success Cases (H7). Conversely, neither Public Administrations nor R&D Institutions exert a significant effect on adoption. Furthermore, Technology Providers' influence is mediated by the managers' awareness of Killer Applications (H6) and Success Cases (H10) and R&D Institutions' influence is mediated by the managers' awareness of Killer Applications (H5). Moreover, Success Cases do not modify the effect of Public Administrations (H11) whereas of Killer Applications is a direct cause for Succes Cases (H8).

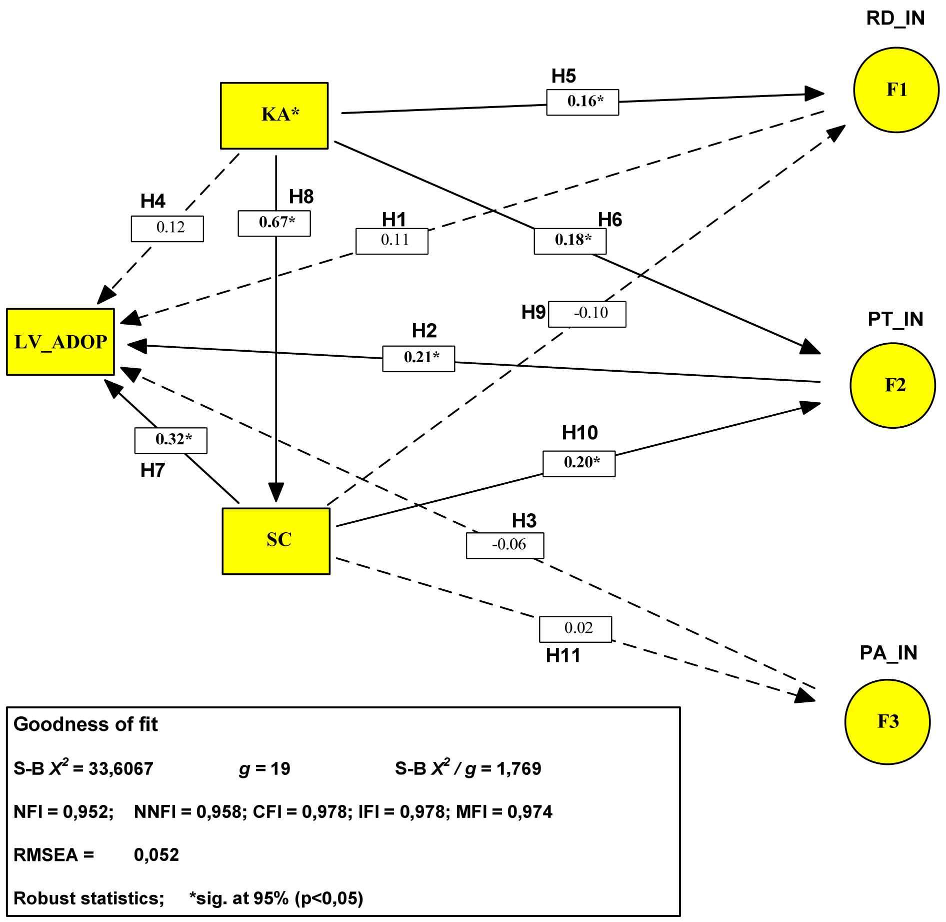

Figure 2. Structural Equations Results

Discussion

Technology Providers are a key factor of Cloud Computing adoption. This result is also supported by research on other IT with a strong organizational nature such as e-commerce between companies (B2B) (Quaddus and Hofmeyer, 2007) or innovative IT-related services (Frambach *et al.*, 1998).

Cloud Computing is creating a breakthrough in the market since it is shaping a new paradigm in the form of IT services that are commoditized and delivered in a similar way such as in traditional utilities like water, electricity, gas and telephony. This is the reason why Cloud Computing has been called the 5th utility (Buyya *et al.*, 2009). Some reports (Velten and Janata, 2011) highlight the role played by Technology Providers in the market of Cloud Computing and how companies like Google, Amazon, IBM, BT, HP, Fujitsu, Dell, T-Systems, Oracle or Vodafone are carrying out big investments and deploying huge infrastructures to compete and reach small and big companies through systems such as IaaS, PaaS and SaaS. Cloud Computing is being adopted quickly in the business arena (Arinze and Anandarajan, 2010; Low *et al.*, 2011) for small, medium and large enterprises, in industries such as the Automotive, Aerospace, Financial Services, Logistics, Textile or Health (Dimitrakos *et al*., 2010).

With revolutionary effects on business (Marston *et al*., 2011), Cloud Computing is able to strengthen firm capabilities (Iyer and Henderson, 2010) and increase business value (Abdulaziz, 2012). Some Cloud Computing's benefits can be instant global platforms, elimination of hardware infrastructures and software licenses, reduced costs (Benlian and Hess, 2011), simplified scalability and the elimination or reduction of disaster recovery risks and its high costs (Tuncay, 2010).

Some reasons might explain the key role played by Technology Providers. Small companies can benefit from services provided by a cloud provider because they do not have the necessary budget and knowledge to build and maintain their own infrastructure. Large providers own scalable resources and a professionally operated infrastructure which small companies cannot afford (Repschlaeger *et al*., 2013). Cloud adoption by SMEs depends on how the cloud providers build trust through their cloud services, fostering sharing and collaboration via cloud tools (Gupta *et al.*, 2013).

Medium and large firms are looking for not just technological suppliers but for actual technological partners able to provide support and valuable know-how. Thus, many firms rely on strong ties with trading partners for their IT design, implementation and operations tasks (Pan and Jang, 2008). IT providers have been able to accumulate and nurture knowledge on the factors that allows us to understand complexity related to Cloud Computing. This accumulated knowledge on the elements that disentangle Cloud complexity would be boosting adoption of hybrid clouds. Hybrid clouds have been created by IT providers to transform the company's infrastructure into private clouds that coexist and are eventually integrated within public clouds. These public clouds are also offered by a reduced number of IT providers. Likewise, clients would be able to take advantage of an appropriate fit between IT itself and the remaining bundle of complementary resources within the organization. Our results show that Technology Providers have succeeded in performing this twofold role (partner and supplier). However, Public Administration and R&D Institutions have failed in this role in light of our results. This conclusion is also supported by literature; trading partners was just the factor with a stronger influence in Cloud Computing adoption (Low *et al.*, 2011). Furthermore, Quaddus and Hofmeyer (2007) also found that Public Administrations are not determinant on B2B adoption while Zhang and Si (2008) found that R&D

Institutions have not a direct effect on technology adoption by companies (although there might be an indirect, mediating effect).

R&D Institutions would be performing a remarkable role on the development of the technology itself but not on actual technology adoption by companies. R&D Institutions and Public Administrations would not be that closely linked to the daily activity of firms (Bakouros *et al.*, 2002) since they usually work under a target and timeline framework which is not the same as the one valid for companies. For instance, CERN played an important role in the development of the World Wide Web, but its influence on actual Internet adoption by companies was really limited.

Probably, Public Administrations are not still aware of the actual relevance of Cloud Computing and, although efforts are being put into place to promote adoption by companies, Public Administrations have still a long way ahead to promote adoption effectively.

It is particularly remarkable the effect exerted on adoption by the existence of Success Cases and its awareness among managers. Success cases can be a storefront where companies visualize the effects on Cloud Computing adoption. These success cases, boosted by IT providers, increase, through a positive feedback effect, the influence of IT providers on adoption. This loop will generate new and powerful success cases that will keep fostering adoption. Whilst Killer Applications do not exert a significant influence. This fact can be explained because of the difficulty in reproducing the success attained by a particular Killer Application in different environments. For instance, electronic social networks such as Facebook or Twitter (included within the so-called Web 2.0) are Killer Applications to Web Technologies. However, massive use of social networks for private purposes has not led firms to use them to internally interconnect their employees. Conversely, Success Cases are more directly connected to the daily reality of firms, allow to visualize how a given technology solve usual, concrete problems efficiently, can be better understood in the business setting and can be easily generalize. In turn, all these facts facilitate technology adoption and diffusion by other peer companies.

Furthermore, results show how Technology Providers are aware of and use Killer Applications and Success Cases indeed to promote ulterior adoption of Cloud Computing (Alshamaila and Papagiannidis, 2013). Technology Providers usually develop a continuous work of technological surveillance to not fall behind in the competition race against other players in the market. This technology surveillance carried out by Technology Providers is probably more intense than the one carried out by Public Administrations. Finally, Killer Applications are a forerunner for Success Cases because facilitate that a given technology (for example, Cloud Computing) can be easily applied to business problems which, under certain conditions, can build up a Success Case if the application is successful, innovative and takes place in the early stages of adoption.

Implications

Managers who wish to adopt Cloud Computing in their organizations should pay special attention on the actions implemented by Cloud Computing providers which, according to our results, are one of the most relevant predictors of eventual Cloud adoption. A deep knowledge of the suppliers acting in the market, their products and their capabilities (reputation, credibility, knowledge management, know-how, etc.) is needed (Koehler *et al*. 2010). Nowadays, companies may acquire experience and expertise by a technology provider as a partner in technologies developing (Doolin *et al.*, 2003). Sustained observation of incumbent providers will help managers to choose and select the ones who are more capable of providing this technology in an efficient way. Likewise, managers would be able to build up an appropriate fit between the tools and resources provided by suppliers and their internal resources to create sustained competitive advantages. Technology providers with respect to their key role on adoption as well as the increasing complexity in the IT market, should be therefore chosen according to their willingness to cooperate and their ability to provide complementary capabilities to the firm. Furthermore, managers should create the adequate environment so that firms can carry out a sustained exercise of technological surveillance that, aside from classifying and evaluating technology providers, can identify Success Cases relevant to Cloud Computing adoption. Thus, firms could implement “technological benchmarking” to seize and apply the lessons learned outside the tasks that make up the business value chain. These implications are tightly related to the adoption scale we used (see Table 4). Success cases would be encouraging companies to venture in the world of Cloud Computing through experimental, departmental or inter-departmental clusters. This approach to technology providers would allow the development of Micro-clouds which in turn would nurture know-how among adopters. Technology providers and their capabilities would subsequently develop Private and Community Clouds. To develop a sound Community Cloud, the close cooperation among commercial partners will be key (Bruque *et al*., 2015), and technology providers will complement the capabilities of incumbent companies acting as real technological partners. Finally, companies hosting Public Clouds will strengthen the relationship between the technological provider and the business partner that will give rise to a greater success likelihood.

These results also have some public policy implications. Some directions for future adoption policies might entail infrastructure development, support to early adopters and creation of the necessary conditions so that R&D Institutions might be actually interested and connected in/to potential adopters. Public Administrations must foster cloud applications and Success Cases could be explained and shown through Pilot Centers in which Technology Providers, R&D Institutions and Public Administrations might cooperate. Business associations related to IT also might deepen the diffusion activities of Cloud Computing among their partners and, particularly, he diffusion of Success Cases. In addition, public administrations should enable a stronger interconnection among the three agents, such as through new joint ventures that could be set up to lead the development of Cloud Computing applications. Furthermore, the creation of Spin-out companies from research results in universities and research centers can be another interesting future work direction for policy-makers, particularly if Technology suppliers are somehow involved in the initiative.

Drawing upon our analyses, it is possible to envision what is in the pipeline regarding business adoption of Cloud Computing. Overall, IT is moving towards an “industrialization process”, by which IT is becoming a commodity. In the meantime, companies, influenced by IT providers will massively adopt Cloud Computing, leaving aside own IT infrastructures and services and moving onto pay-per-use models. These pay-per-use models will be provided by a bundle of highly specialized public cloud providers that will dominate the market. As an intermediate step, IT providers are currently boosting the use of hybrid clouds where public and private clouds coexist. Success cases, thanks to a positive feedback effect, will increase the influence of IT providers on adoption, which in turn will create new success cases.

Conclusions, limitations and future research

This work is the first research attempt aiming to identify the influence exerted over Cloud Computing adoption by R&D Institutions, Technology Providers and Public Administrations, considering also other environmental variables such as Killer Applications and Success Cases. The results are relevant and have important implications to business practice: the only environmental agents with a significant role on adoption are Technology Providers. Neither R&D Institutions nor Public Administrations have a recognizable effect on adoption. The existence and awareness of Success Cases have an important role on adoption while Killer Applications do not influence significantly.

This research has several limitations. First, data were only collected from High-Technology firms located in Technology Parks in Spain. These relationships may not be the same for all industries or regions. Second, this research uses a cross-sectional design. Furthermore, the proposed theoretical model could be considered as a sub-model of contingent theoretical frameworks which in turn entails offering a partial view of adoption.

Future research might study other industries less prone to risk themselves in high technology adoption initiatives or different countries and geographical settings so that they can make cross-national adoption comparisons, implications and recommendations. Finally, further research is needed about other internal drivers that may determine Cloud Adoption in companies, particularly in more advanced stages of adoption.

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