

Cloud computing in industrial SMEs: identification of the barriers to its adoption and effects of its application

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Abstract Cloud computing is a new technological paradigm that may revolutionize how organizations use IT by facilitating delivery of all technology as a service. In the literature, the Cloud is treated mainly through a technological approach focused on the concept definition, service models, infrastructures for its development and security problems. However, there is an important lack of works which analyze this paradigm adoption in SMEs and its results, with a gap between the technological development and its adoption by organizations. This paper uses a qualitative technique methodology -group meetings with managers- and a quantitative one—survey- and identifies which factors act as barriers to Cloud adoption and which positive effects its application generates in 94 industrial SMEs. The conclusion is that the main barriers are of a cultural type and that the positive effects go well beyond reducing costs.

Keywords Cloud computing · Industrial SMEs · Barriers to adoption · Effects

JEL classification M15 · L86

Introduction

Nowadays, competitiveness and enterprise survival depend on the firm's ability to react and adapt innovations that allow them to take advantage of opportunities and improve the

efficiency, quality and costs of business processes (Ramayah et al. 2011; Soto-Acosta et al. 2010).

It is in this context that the development of information technologies can become an essential tool for those companies which know how to take advantage of them. In particular, the spectacular progress made in recent years by information technologies related to the Internet such as Web 2.0, Semantic Web and Cloud Computing have given rise to new forms of working, interacting, sharing knowledge and business that involve significant advances over previous periods. (Sher and Lee 2004; Melville et al. 2004; Russ et al. 2008; Colomo-Palacios et al. 2010; Dewan and Ren 2011).

A concrete example is Cloud Computing (hereafter CC), a new technological paradigm (Youseff et al. 2008; Armbrust et al. 2009; Böhm et al. 2010; Etro 2010; Marston et al. 2011), that in a first approximation can be understood as the convergence of old and new technology developments like Service-Oriented Architectures (SOA), distributed and grid computing, as well as virtualization (Youseff et al. 2008; Kim 2009; Böhm et al. 2010; Tsaravas and Themistocleous 2011). This convergence allows on-demand and via Internet a configurable set of Information Technology (hereafter IT) resources and capabilities, so providing all information technology-as-a-service (IT-as-a-Service) and, therefore, important advantages for organizations are expected, e.g. reduced IT costs, scalability, flexibility and better access to IT resources (Armbrust et al. 2009; Leavitt 2009; Bhardwaj et al. 2010; Dillon et al. 2010; Marston et al. 2011). This has made CC a key issue for academics, large corporations and Governments (Lasica 2009; Dillon et al. 2010; Etro 2010; OECD 2010).

Several reports and studies coincide that CC is one of the technologies that will have most growth in coming years (IDC 2008; Lasica 2009; OECD 2010), occupying more than 12 % of the IT market by 2015 (IDC 2009; OECD 2010; Bayrak, et al. 2011). In Europe, it is expected that the increase of CC adoption by organizations will make a positive contribution to

economic growth, helping to create a million jobs and thousands of new companies (Etro 2009, 2010; European Commission 2010).

However, despite the recognition of the importance of CC implementation for organizations and economies, the literature focuses on investigating the topic from a technological perspective, analyzing security problems and inter-connection limitations between clouds, with an important absence of works which analyze the actual implementation of CC in organizations, the adoption barriers and the benefits to be obtained (Rittinghouse and Ransome 2010; Bayrak et al. 2011; Clemons and Chen 2011; Marston et al. 2011).

This is causing a gap between technological advancement of CC and its implementation by the organizations, which do not take advantage of new developments and therefore lose opportunities. Especially important is the absence of works that analyze these issues in SMEs, organizations of great importance, as they represent more than 95 % of the business sector of the developed economies (OECD 2010) and which, due to reduced resources and difficult access to IT, are ideal candidates for adopting CC. It is thus necessary to take a closer look at the elements that act as barriers and at motivations for its use, as well as identifying the results derived from its utilization (European Commission 2010). Our work focuses on studying CC in industrial SMEs, with two objectives: 1st to analyze the degree of knowledge of CC and identify barriers to its implementation, and 2nd to identify the results derived from the use of CC in these organizations. All of this with the aim that this work serves the researchers and IT professionals in order to they know the barriers that SMEs identify and, for these last ones, to give them an example of the benefits that can bring the Cloud Computing in the development of their activities.

The rest of the paper is structured as follows: the second section reviews the relevant literature of the concept of CC and its barriers and effects for the business user. The third section explains in detail the methodology used in the research. The fourth section shows and discusses the results obtained in two parts: the first, more descriptive, about the knowledge of CC that the SMEs have and their brakes, and the second, of statistical inference with ANOVA models, to examine CC benefits in companies. The paper ends with the conclusions, limitations and future lines of research.

Background

Cloud Computing is a modern and complex research topic, many authors indicate that this model is today in its infancy (Dillon et al. 2010; Tsaravas and Themistocleous 2011; Ma 2012), with as many definitions as authors that have dealt with the subject (Geelan 2009; Vaquero et al. 2009; Marston et al. 2011).

These definitions have evolved from a very technical perspective which identifies CC as a kind of parallel and distributed system, consisting of a collection of virtualized computers (Buyya et al. 2008) to complex definitions which seek consensus from the collection of other definitions, like that of Vaquero et al. (2009 p.50) which establishes that “*Clouds are a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms and/or services). These resources can be dynamically reconfigured to adjust to a variable load (scale), allowing also for an optimum resource utilization. This pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the Infrastructure Provider by means of customized SLAs*”.

Nevertheless, the most accepted and repeated definition by the academic community is that of the National Institute of Standards and Technology (Cloud security alliance 2009; Betcher 2010; Dillon et al. 2010) which in its final version in September, 2011 (Mell and Grance 2011 p.6) indicates that “*Cloud computing is 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*”.

This CC definition includes (Mell and Grance 2011):

- Five essential characteristics: 1) On-demand self-service, 2) Broad network access, 3) Resource pooling 4) Rapid elasticity and 5) Measured service.
- Three service models: 1) Infrastructure as a Service (IaaS), 2) Software as a Service (SaaS) and 3) Platform as a Service (PaaS).
- Four possible deployment models: 1) Private cloud, 2) Community cloud, 3) Public cloud and 4) Hybrid cloud.

The most discussed topics in the literature regarding CC have focused on:

- 1st. Features, levels of service and models of development (public, private and hybrid) (Buyya et al. 2008; Youseff et al. 2008; Armbrust et al. 2009; Geelan 2009; Leavitt 2009; Kim 2009; Vaquero et al. 2009; Böhm et al. 2010; Bhardwaj et al. 2010; Mell and Grance, 2011).
- 2nd. Challenges and technical limitations - cloud interconnection, standards—for implementation in organizations (Armbrust et al. 2009; Lasica 2009; Dillon et al. 2010; Clemons and Chen 2011; Marston et al. 2011; Ma 2012) and
- 3rd. Security and risk management questions (Cloud Security Alliance 2009; ENISA 2009; Kaufman 2009; Ahmad 2010; Betcher 2010; Chen et al.

2010; Rittinghouse and Ransome 2010; Takabi et al. 2010; Zissis and Lekkas 2012).

Other CC subjects discussed to a lesser extent that can be highlighted are research on CC implementation in public administrations (Cellary and Strykowski 2009; Rastogi 2010; Tsaravas and Themistocleous 2011; Das et al. 2011) and reports that analyze the possible impact of CC in economies (Etro 2009, 2010; European Commission 2010; OECD 2010; Bayrak et al. 2011).

In any case, in contrast to numerous works of a technological approach, one must highlight the lack of works dealing with CC from a user enterprise perspective. In particular, there are authors who indicate, at the theoretical level, the importance of CC may have for user enterprises for a new way of using IT that enables the CC user organizations take technological outsourcing to the highest level, by taking the IT concept nearer to a utility (Youseff et al. 2008; Etro 2010; Marston et al. 2011; Tsaravas and Themistocleous 2011, Ma 2012; Clemons and Chen 2011). But there is no work that analyzes in depth the real use of CC in the business practice.

Focusing on the objectives of the work, identify the barriers to the adoption of the CC by SMEs and the benefits they get from its application, we have not found any work in the literature that centers on analyzing these issues from the SMEs perspective as business users.

However, according to the literature review of features, service levels, delivery models and the reflections made by various authors on the future challenges of the CC, we have been identified which issues can act as barriers to the adoption of CC by the SMEs and what benefits might be expected from it. The potential barriers are:

- Security: this barrier included data loss, phishing, ciber attack, and new issues deriving from multi-tenancy like shared infrastructure between good and malicious resource and problems for reputation sharing (Armbrust et al. 2009; Etro 2009; Dillon et al. 2010; Clemons and Chen 2011; Marston et al. 2011; Tsaravas and Themistocleous 2011)
- Availability and quality of service: like all consumers, customer cloud organizations demand guarantees that the services are always available with sufficient quality (Armbrust et al. 2009; Erdogmus 2009; Betcher 2010; Marston et al. 2011).
- Data lock-in: the lack of interoperability between different clouds and the fact that each cloud provider has its own way of connecting with its customers, makes it very difficult for clients to change to another provider (Clemons and Chen 2011; Dillon et al. 2010).
- The control loss of the data: for a company to transfer its data and not control the infrastructures that manage them is always a difficult decision (Etro 2009; Clemons and Chen 2011).

- Data privacy, confidentiality and law requirements: customer cloud enterprises are obliged to comply with the current law with regard to privacy, access, protection and data location and, therefore, they must demand the Cloud provider complies with them. (Armbrust et al. 2009; Marston et al. 2011; Tsaravas and Themistocleous 2011; Clemons and Chen 2011).

As for the benefits that a company can theoretically obtain from CC use, the following are the most noteworthy:

- Costs reduction: in CC the provider manages all the computing resources (servers, software, storage, and networking). The user organizations do not need to make a large upfront investment in computing resources and the maintenance cost of administering the system, network, and database. They only pay for the computing resources and services they use, so the IT cost becomes not a fixed but a variable cost (Etro 2009; Erdogmus 2009; Leavitt 2009; Bhardwaj et al. 2010; Marston et al. 2011).
- Access to IT better resources: this includes access to software, storage and calculation capacity which a traditional model on-premise could not access, as well as a lower technological obsolescence risk (Vaquero et al. 2009; Velte et al. 2010, Marston et al. 2011; Ma 2012).
- Scalability, accessibility and flexibility: the CC allows a resource to be set up in a very short time, so organizations are flexible to scale their IT infrastructure up or down according to their needs. In addition, they can manage their entire IT resources through a simple web-based interface that allows ubiquitous access with any kind of equipment (Böhm et al. 2010; Betcher 2010; Bhardwaj et al. 2010, Rastogi 2010; Marston et al. 2011; Ma 2012).
- Focus on the core business: the CC, like an IT outsourcing, allows the user enterprise to use the IT as an utility thus freeing technical and human resources that can be allocated to what is its real business core (Etro 2009; Lasica 2009; OECD 2010).

It must be qualified that, there are no previous studies on these issues and therefore, the CC researchs evolution must try to answer them to bring the technological development nearer to its application in organizations (Dillon et al. 2010; Marston et al. 2011).

Methodology

The work focuses on identifying barriers to the adoption of the CC and the benefits that this generates in industrial SMEs.

Table 1 Research technical summary

Qualitative study	Two group meetings with 17 IT managers from industrial SMEs 1st of March 2011 2nd of May 2011
Quantitative study (survey)	
Universe	1,073 SMEs from the industrial sector with uninterrupted activity between 2008 and 2011.
Geographical scope	Cantabria, north of Spain
Procedure of sampling	Random sampling
Collection of information	Survey performed with IT managers, alternatively with managing director or owner by telephone.
Size of the sample	94
Sampling error	9.66 %
Level of trust	95.5 % (K=1.96) for the most unfavourable case $p=q=0.5$
Date of field work	October-December 2011

The industrial sector was chosen because despite its importance and wide recognition in modern economics, international organizations point out on their reports that it is a sector that is behind in the implementation of new IT developments in its processes and therefore, it needs to improve these levels (OECD 2010).

As a type of organizations, the SME has been considered suitable to focus on here because, despite the relevance that they have in economics, representing more than the 95 % of companies of modern economies (OECD 2009), there is a lack of works that analyze the factors that restrain IT adoption in these organizations (European Commission 2010; OECD 2010).

With regard to the methodological development of the work, in view of the absence of previous research that has analyzed the barriers and results of the CC in a set of SMEs that would serve as a guide, it was decided to use in this work an empirical research methodology with qualitative and quantitative techniques.

The aim of the qualitative one was to improve our knowledge about the application of CC by industrial SMEs and so better address the subsequent quantitative phase. For the development of the qualitative phase, in February 2011 IT managers from all Cantabria industrial SMEs were invited by email to participate. There were 17

responses from industrial SMEs interested in participating in the group meeting and two meetings were organized to facilitate its proper development. The first group meeting was held in March 2011 and involved 9 IT managers, and the second took place in May 2011 and involved 8 IT managers.

The two meetings were conducted by the authors of the research and followed the same outline: first to present the research objectives to the companies and second to talk openly about the concept of CC and its application in industrial SMEs. The meetings were recorded and later transcribed to analyze the most relevant issues. The results of the group meetings were very positive and helped improve our knowledge about the problems of the application of CC in Industrial SMEs and identify the main concerns of these companies: 1) how to measure the results of t CC and 2) the questions relating to information security, issues that were incorporated into the study and allowed us to improve the further development of the quantitative phase.

The quantitative phase aims to collect a sufficient number of data to analyze and statistically test the application of CC by the industrial SMEs and determine which issues act as barriers and what benefits are obtained. Thus in the absence of previous questionnaires

Table 2 Sample characteristics

Employees				Sales				Years old			
Intervals	%	N	Average value	Intervals sales	%	N	Average value	Intervals	%	N	Average value
0-9	18.1 %	17	34	0-500000 eur	11.7 %	11	1,8 mll	0-9	14.9 %	14	23
10-49	62.8 %	59		500001-1mll eur	50 %	47		10-20	51.1 %	48	
50-249	19.1 %	18		more of 1Mll eur	38.3 %	36		more of 20	34 %	32	
Total	100 %	94		Total	100 %	94		Total	100 %	94	

Table 3 Scale formed as indicator of IT cost reduction

Attributes	Please value the statements below from 1 to 7 (1=total disagreement and 7 total agreement):							
cIT1	Hardware costs have decreased in the last 2 years	1	2	3	4	5	6	7
cIT 2	Software costs have decreased in the last 2 years	1	2	3	4	5	6	7
cIT 3	IT personnel costs have decreased in the last 2 years	1	2	3	4	5	6	7
Crombach Aplha: 0.828								

and scales to analyze this issue, from the literature review and the information obtained in the qualitative phase a questionnaire consisting of 15 questions grouped into three sections was designed:

- 1st, Questions relating to general data of the company: number of employees, sales, years of operation of the business.
- 2nd, Specific dichotomous questions about the knowledge of CC the SMEs have and their wish to implement it.
- 3rd, Questions (using Likert scales) relating to the barriers to the application of CC and the benefits obtained.

Later, the surveys were applied by random sampling among all industrial SMEs of Cantabria through telephone interviews with decision-makers in enterprises conducted between October and December, 2011. The decision-maker targeted by the survey was normally the person responsible for IT within the company, typically the IT manager. Alternatively, particularly in small enterprises without a separate IT unit, the managing director or owner was interviewed.

With regard to respondents' positions, 83 % were IT managers, 9.6 % were managing directors, and 7.4 % were owners. The dataset was examined for potential bias in terms of the respondents' positions.

Since respondents included both IT managers and non-IT managers, one could argue that IT managers may overestimate CC benefits. To test this possible bias, the sample was divided into two groups: responses from IT managers versus responses from non-IT managers (owners or managing directors). One-way ANOVA was used to compare the means of factor scores between the two groups. No significant differences were

found, suggesting that the role of the respondents did not cause any survey biases.

At the end 94 questionnaire responses were obtained. Table 1 shows the main characteristic of both, the qualitative and quantitative phases.

The companies in the sample are industrial SMEs located in Cantabria (a northern region of Spain) that have an average of 34 employees, an average turnover of 1.8 million euro and have been operating for 23 years on average. Table 2 shows the sample characteristics.

Finally, collected data were coded and processed statistically with SPSS 19.0. Regarding statistical techniques for the first aim of the work—to analyze the degree of knowledge of CC and to identify the barriers to their implementation—these consist of the analysis of surveys with frequency analysis and descriptive statistics, and for the second aim—to indentify the results derived from the use of CC—we used statistical techniques of group differences. More specifically, the one-way ANOVA test was applied. To test the suitability of the analysis, we checked for the parametric assumptions as well as for homogeneity of group variances (Levene's test,significance > 0.05).

The ANOVA test allow the statistical comparison of differences between groups of the same sample, in our case industrial SMEs, with CC or without CC (independent variables), with respect to dependent variables. The independent variables were formed using as classification criterion those which have had CC since 2009, 2 years before the study results, because although there is no literature consensus on the exact period that has to pass to consider a technology as consolidated in an organization (and therefore one that generates effects), the theory of the experience and learning effect recommends using periods of between 2 and

Table 4 Scale formed as indicator of IT resources and organizational issues

Attributes	Please value the statements below from 1 to 7 (1=total disagreement and 7 total agreement):							
rIT1	Scalability, accessibility and flexibility in IT use have improved in the last 2 years	1	2	3	4	5	6	7
rIT 2	Access to previously unavailable IT resources has improved in the last 2 years	1	2	3	4	5	6	7
rIT 3	There are more resources and time for the core activities of the business	1	2	3	4	5	6	7
rIT 4	The number of information security problems has decreased in the last 2 years	1	2	3	4	5	6	7
Crombach Alpha: 0.715								

Table 5 Knowledge of the concept of CC and its application

CC concept	Knows		Has applied	
	Yes %	No %	Yes %	No %
	19.15	80.85	11.70	88.30

5 years lag (Powell and Dent-Micallef 1997; Brynjolfsson and Hitt 2003; Lee 2008).

For the measurement of the dependent variables—effects of CC on SMEs results—it should be noted that in the literature there are few works on this subject and they are case studies which qualitatively show the benefits of using CC for large companies or public administrations (Marston et al. 2011; Tsaravas and Themistocleous 2011; Ma 2012). However, there are no studies that quantitatively analyze the concrete results arising from the implementation of the CC in a larger sample focused on SMEs.

Besides, It should be noted that to measure the CC implementation results, an issue related to intangible assets such as information, it does not seem appropriate to consider economic and financial variables as result indicators (Lee 2008; Dumay 2009; Hubbard 2010), because these are affected by multiple issues which mayor not be related to CC. Therefore, it seems more appropriate to use as indicators those that can give measurements of the effects generated by CC on the benefits that are really attributable to it, which, as we have seen in the literature review, are:

- Cost reductions in hardware and software equipment and in personnel.
- Access to better IT resources and less technological obsolescence risk.
- Scalability, accessibility and flexibility in IT use.
- Focus on the business core.

In addition, given that the main barrier to CC adoption noted by companies in group meetings is security, this section includes an analysis of how CC has improved information security in these organizations.

In these sense, for measure these potential benefits two Likert scales have been made: the first collects the benefits relative to the decrease in costs, and the second includes the benefits related to IT resources—scalability, accessibility and flexibility, access to better IT

Table 6 Companies introduced to the CC concept and that wish to implant it

Explained the concept of CC.	Would you be interested in applying it	
	Yes %	No %
	55.26	44.74

resources- and organizational issues -focus on the business core and reduction of security problems-. Tables 3 and 4 show the scales which were subjected to a reliability analysis using the Crombach Alpha, with satisfactory results (Crombach Alpha > 0.7).

Results

The results shown are in two parts: the first, where the elements acting as barriers to CC adoption in industrial SMEs are identified; the second, where the effects arising from CC use in these companies are analysed.

Barriers to the CC adoption in industrial SMEs

Academics and large corporations are aware that CC offers significant advantages to user organizations (Marston et al. 2011; Ma 2012), but it is not clear that SMEs are aware of this, and knowing that something exists is indispensable for implementing it.

Hence, the first question of interest is to analyze the knowledge that companies have about the CC concept, as well as companies' attitudes towards its application. Secondly, it is interesting to know what elements restrain companies from applying CC.

Regarding the first question (Table 5), for the companies studied knowledge of the CC concept is not very elevated, since only 18 companies, 19.15 %, knew the concept and besides, of these, not all of them apply it, being only 11 (11.70 % of the sample) the companies that use CC.

Faced with this high ignorance, 80.85 % of the respondents did not know it, it is interesting to see in these companies s the respondents predisposition towards the CC implantation once they have been introduced to the concept and its implications. Table 6 shows how many companies, after introduction the CC concept, would be interested in its use (55.26 %),

The analysis of the rejection of companies that are not interested in applying CC is important as it reveals some factors which are barriers to CC development and, therefore, those that need to be addressed to change these behaviors.

Companies were therefore asked about those issues that the literature indicates as potential barriers to CC adoption. An element not identified in the literature but one that the IT managers of the companies in the group meetings distinguished as an important obstacle to the use of the CC was also incorporated, managers' difficulty in measuring the actual benefits that CC can generate in their business.

The Table 7 shows how all the possible barriers identified by literature obtain high average scores and consequently, for the companies analyzed, it is verified that these factors are seen as brakes to CC.

Table 7 Reasons companies neither apply nor intend to apply CC

Indicate, from 1 to 7, the importance of the following elements in the decision not to use the CC 1=not important and 7=very important	Average value
Security, including data loss, phishing and cyber attack.	6.48
The loss of control of the data, transfer of company data to third parties and no control over the infrastructures that manage them.	6.37
Not knowing how to measure the real benefits that CC generates and its cost benefit analysis.	6.13
Availability and quality of service	6.09
Data lock-in, difficult for clients to change to another provider.	5.88
Data privacy, confidentiality and law requirements about privacy, access, protection and location of the data.	5.45

This analysis allows the data to be presented in an orderly manner from highest to lowest scores, which means hierarchies can be established and the most important barriers to companies can be identified, highlighting safety, data transfer to third parties and not knowing how to measure benefits top the list, followed by less important issues of availability and quality of service, the difficulties clients could have in changing to other provider and, finally, the data privacy, confidentiality and law requirements.

Effects of the CC use in industrial SMEs

Tables 8 and 9 show the correlations and descriptive statistics of variables used in the contrasts. In the tables for each scale it is observed that the items that comprise it positively correlate with each other and at the highest possible level of significance (<0.01).

Second, as mentioned in the methodology section, the analysis of the variance models (ANOVA) were made to identify the existence of significant statistic between the use of CC (independent variable of the tests) and each of the attributes of the scales (dependent variables of tests).

Effect on the reduction of costs

Table 10 shows how companies that use CC obtain a better average behavior in each one of the attributes. This, added to the test significance (significance<0.01), confirms the

existence of a positive relation between the use of CC and the IT reduction of costs for the sample companies.

Effect on IT resources and on organizational issues

Table 11 shows that companies with CC obtain a better average behaviour in each of the attributes, but the relationship is statistically significant for three of them: scalability, accessibility and flexibility in the IT use, access to IT resources and decrease of information security problems.

Although for the “having more resources to focus on core business” item-rIT 3- the average indicates that the group formed by the companies with CC has higher values, statistical significance has not been reached, possibly because the reduced sample size means that average differences between the groups must be very high, which does not occur.

Conclusions

The CC is both a new technological paradigm as a new IT management model, which through the convergence of various technological developments can revolutionize the way organizations use IT, so favoring models in which all the IT resources and capabilities are made available for companies, such as services, thus taking IT towards conversion into utilities.

The literature analysis of CC shows us that study of this topic has mainly focused on analysing the CC concept, its

Table 8 Scale formed as an indicator of IT cost reduction

Attributes	Pearson correlation Sig. (bilateral)*			Descriptive statistics			
	cIT1	cIT 2	cIT 3	Average	Std	Max	Min
Hardware costs have decreased in the last 2 years cIT1	1			4.505	1.712	7	1
Software costs have decreased in the last 2 years cIT 2	0.836 0.000*	1 .*		4.375	1.521	7	1
IT personnel costs have decreased in the last 2 years cIT 3	0.738 0.000*	0.797 0.000*	1 .*	4.390	1.647	7	1

Table 9 Scale formed as indicator of IT resources and organizational issues

Attributes	Pearson correlation Sig. (bilateral) *				Descriptive statistics			
	rIT1	rIT2	rIT3	rIT4	Average	Std	Max	Min
Scalability, Accessibility and flexibility in the IT use, have improved in the last 2 years rIT1	1				4.460	1.300	7	1
Access to previously unavailable IT resources has improved in the last 2 years rIT2	0.670 0.001*	1 .			4.295	1.681	7	1
There are more resources and time for the core activities of the business rIT3	0.676 0.001*	0.791 0.000*	1 .		3,49	1.410	7	1
The number of information security problems has decreased in the last 2 years rIT4	0.554 0.009*	0.736 0.000*	0.597 0.004*	1	3,985	1.653	7	1

features, service levels, deployment models and security issues from a technological perspective.

However, there is a lack of research on CC use in organizations, the obstacles to its application and the identification of metrics which allow assessment of the effects of applying CC. This absence is particularly important in the case of SMEs, which are precisely the most important business organizations in advanced economies.

This paper focuses on the study of CC in 94 industrial SMEs. It uses an empirical research methodology of both nature, qualitative - group meetings - and quantitative, - questionnaire- with the double aim of identifying the barriers to CC adoption in SMEs and identifying the effects arising from the application of CC in these organizations.

With regard to the first, we can conclude that the knowledge degree of CC by SMEs is very low and it is stressed that once companies have knowledge of the concept, they have mostly shown interest in applying it. This reveals that the companies' ignorance about CC is the main barrier to its adoption. It is recommended to CC providers to develop spreading activities that bring SMEs closer to CC and its potentials and so facilitate their adoption. In addition, the work identifies the main elements acting as barriers to CC adoption and organize them hierarchically according to their importance for SMEs. In particular, companies indicate that the security issues and the distrust generated by transferring data to third parties as the two most important barriers to using the

CC. Thirdly the ignorance of managers on how to measure the results generated by the CC and to establish proper cost benefit analyses are highlighted as a further barrier.

Companies also indicate as barriers, although of less importance, the availability and quality of service, the possible difficulties of changing suppliers and compliance with legal data protection requirements.

Regarding the second objective, to identify the effects arising from the application of CC in organizations, we conclude for the sample companies, that CC favors: first, costs reduction for software, hardware and IT staff, second, scalability and flexibility in the IT use, third, access to IT resources not accessible for companies otherwise.

Also it is especially emphasized that for the sample companies CC using has decreased the number of information security problems. This is very important because companies indicate that information security is the main barrier to CC adoption, but in fact the data show that for many companies using CC means improving their levels of IT security.

These issues are of great interest to academics because provides them new literature with an approach to CC limitations and benefits from the point of view of user companies. It is also interesting for CC suppliers' companies and governments, because it allows them to learn what issues act to favor CC development, while user companies can benefit because it shows an example of the effects generated by CC implementation.

Table 10 ANOVA using CC and IT cost reduction

Using CC	(Average) cIT 1	cIT 2	cIT 3
YES	5.76	5.84	5.66
NO	3.25	2.91	3.12
<i>F</i> -value	9.15	13.37	9.27
Significance	0.007	0.001	0.007

Table 11 ANOVA CC and IT resources and organizational issues

Use of CC	(Average) rIT 1	rIT 2	rIT 3	rIT 4
YES	5.73	5.81	3.66	5,62
NO	3.19	2.78	3.32	2,35
<i>F</i> -value	9.25	11.17	5.47	15.37
Significance	0.007	0.001	0.119	0,001

To conclude, we would acknowledge that this study has some limitations, which could be addressed in future research. First, the sample used was from Spain. It may be that the findings could be extrapolated to other countries, since economic and technological development in Spain is similar to other OECD Member countries. However, in future research, a sampling frame that combines firms from different countries could be used in order to provide a more international perspective on the subject. Second, the sample consisted of small and medium sized enterprises (SMEs). As SMEs are characterized by having less technological resources than their higher-level counterparts (large firms), this may influence the extent of sophistication in IT systems use and cloud computing. Therefore, in future works, the segment of large companies is worth special analysis. Third, the key informant method was used for data collection. This method, while having its advantages, also suffers from the limitation that the data reflects the opinions of one person. Future studies could consider research designs that allow data collection from multiple respondents within an organization. Fourth, it takes a static, cross-sectional picture of cloud computing, which makes it difficult to address the issue of how cloud computing evolves over years. A longitudinal study could enrich the findings. Related to the foregoing, as future research lines, it would be interesting to replicate this work in other sectors, like service companies. Also it would be interesting to identify new business variables to measure CC effects on the value generation of companies.

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