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Inter-organizational innovation and cloud computing

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Abstract Firms are increasingly shifting from the 'closed' innovation paradigm, in which their innovation design and implementation activities were based on their own internal knowledge resources, skills and production facilities, towards the inter-organizational 'open' innovation paradigm, which is based to a significant degree on collaboration with other organizations, aiming at the exploitation of external knowledge resources, skills and production facilities as well. This paper investigates empirically the effects of firm's inter-organizational collaboration for the design and implementation of innovations, and also use of ICT for supporting this collaboration, on firm's propensity to adopt cloud computing (CC), and in this way it examines in an 'objective' manner to what extent firms regard CC as a cost-effective means of supporting inter-organizational collaboration for the design and implementation of innovation. Our study is based on a dataset collected in the e-Business Survey of the European Commission from 676 European firms from the glass, ceramics and cement manufacturing sectors. It has been concluded that firms of these sectors regard CC as a cost-effective means of supporting collaboration with other firms for the design of innovations in their products, services and

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processes, and also of reducing the costs and increasing the capabilities and flexibility of already existing electronic support of inter-organizational innovation design collaboration. Furthermore, our results indicate that firms find CC useful for the reduction of the costs and the increase of the capabilities and flexibility of their existing electronic support of the complex operations required for the inter-organizational implementation of innovations.

Keywords Cloud computing · Open innovation · Inter-organizational innovation · Business network

1 Introduction

A major trend in the modern economy is the shift of firms from the 'closed' innovation paradigm, in which their innovation design and implementation activities were based on their internal knowledge resources, skills and production capabilities, towards the inter-organizational 'open' innovation paradigm, which is based to a significant degree on collaboration with other organizations, aiming at the exploitation of external knowledge resources, skills and production facilities as well [10–12, 26, 71]. A widely cited definition of open innovation is provided by its pioneer Henry Chesbrough stating that 'Open Innovation means that valuable ideas can come from inside or outside the company, and can go to market from inside or outside the company as well. This approach places external ideas and external paths to market on the same level of importance as that reserved for internal ideas and paths' [10]. The same scholar later defined open innovation as 'the use of purposive inflows and outflows of knowledge to accelerate internal innovation and to expand the markets for external use of innovation, respectively' [12]. The globalization, the strong competition, the continuous emergence of new technologies, the fast changes that characterise the modern business environment, as well as the high expectations and demands of consumers for high value-added products and services, and also for continuous renewal and improvement of them, make it difficult for individual firms to design and implement the continuous stream of innovations required for their survival on their own, relying only on their internal resources, skills and production facilities. This drives firms to form various collaboration structures with other organizations, such as business networks, clusters, ecosystems, innovation hubs, keiretsu, and triple-helix [42, 43, 58, 73, 74], in which participate suppliers, customers, partners, and even universities and government agencies, and collaborate in order to design and implement product, service and process innovations.

At the same time another major trend of the modern economy in the area of information and communication technologies (ICT) is the emergence of cloud computing (CC), which changes radically the way firms access and use ICT for supporting their activities [2, 46, 50, 66, 75]. Marston et al. [46] define CC as "an information technology service model where computing services (both hardware and software) are delivered on-demand to customers over a network in a self-service fashion, independent of device and location'. The US National Institute of Standards and Technology (NIST) defined CC as 'a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of computing resources (e.g., networks, servers, storage, applications, services) that can be rapidly provisioned and released with minimal management effort or service provider interaction' [47]. There are three main categories of CC services (also termed as 'service models') currently offered: infrastructure as a service (IaaS) (=remote use of provider's storage and computing facilities), platform as a service (PaaS) (=remote use of provider's platform, including also operating system support and software development environment, for the development and deployment of applications) and software as a service (SaaS) (=remote use of software applications running on provider's systems and supported/maintained by them). CC can provide significant benefits to firms, such as reduction of their ICT ownership and operation costs, conversion of related capital investments to operating expenses, rapid deployment of ICT services, scalability (dynamic adjustment of these services in order to meet changing needs), and also quick and inexpensive development of the ICT support required for product/service and process innovations [8, 46, 50, 67]. At the same time, it is widely recognized that CC can pose some risks as well, such as service availability and performance related risks, data security risks (related to firm's data integrity, confidentiality and privacy), economic risks (associated with 'hidden costs' and also CC services provider 'lock-in'), process compatibility risks and strategic risks [1, 7, 66].

It has been argued that there is an association between these two major trends of the modern economy: a highly important condition for the efficiency and effectiveness of inter-organizational open innovation is appropriate ICT support, and CC can provide at a low-cost extensive capabilities for this, and especially for the electronic support of inter-organizational collaboration for the design and implementation of innovations (see Sect. 2.2 for more details on this). However, the above arguments and expectations have not been empirically investigated: it has not been empirically examined to what extent firms perceive CC as a useful and cost-effective means of supporting open inter-organizational innovation; or (equivalently) to what extent there is positive association between these two important trends of modern economy, the inter-organizational open innovation and the adoption (or propensity for adoption) of CC (for more details on this see Sect. 2.3 briefly reviewing previous research on CC adoption factors).

This paper contributes to filling this research gap. It investigates empirically the effects of firm's inter-organizational collaboration for the design and implementation of innovations, and also the use of ICT for supporting such collaborations, on firm's propensity to adopt CC; in this way it examines in an 'objective manner' (without resorting to subjective perceptions of firms' managers) to what extent firms regard CC as a cost-effective means of supporting inter-organizational collaborative design and implementation of innovation. So the main research question our study attempts to address is:

> 'Do firms perceive CC as a cost-effective means of supporting inter-organizational collaboration for the design and implementation of innovations?'

Furthermore, since some firms already use some ICT for the electronic support of such inter-organizational innovation collaborations, our second research question is:

> ‘Do firms perceive CC as a means of reducing the cost and increasing the capabilities and flexibility of already existing ICT support of inter-organizational collaboration for the design and implementation of innovations?’

This research aims to create useful knowledge on an important aspect of the potential of CC, which concerns the support and promotion of open innovation. We expect that its findings will be interesting and useful for researchers (making a contribution to the existing CC adoption research, and opening up new directions of CC adoption and business value research), CC services providers (in order to improve and enrich their offerings and value propositions towards the electronic support of inter-organizational collaboration for the design and implementation of innovations), consulting firms (interested in finding new ways of CC organizational exploitation), and also CC user (or potential user) firms’ management (providing guidance to them in order to make advanced and multi-dimensional exploitation of CC).

Our study has been based on a large dataset collected through the ‘e-Business Survey’ of the European Commission from 676 European firms from the glass, ceramics and cement manufacturing sectors. While previous research concerning the adoption and exploitation of various ICT focuses mainly on high-tech and in general highly innovative services or manufacturing sectors, our study on the contrary focuses on three important manufacturing sectors, which are rather conservative in terms of adoption of new ICT, and innovative business practices in general, and more representative of ‘traditional’ manufacturing [21].

This paper consists of six sections. This introduction is followed by Sect. 2 outlining the background of this study concerning open inter-organizational innovation and CC adoption factors. Then the research hypotheses are formulated in Sect. 3, and the data and method are described in Sect. 4. The results are presented in Sect. 5 and then discussed in Sect. 6, while the final Sect. 7 summarizes the conclusions.

2 Background

2.1 Open inter-organizational innovation

As mentioned in the introduction, firms are increasingly looking for knowledge, skills and production resources required for the development and implementation of innovations not only inside, but also outside their boundaries, and this has given rise to a gradual shift from the closed internal innovation paradigms to increasingly open inter-organizational ones [10–12, 26, 71]. For this purpose firms are creating various types of business collaboration structures, such as business networks, clusters, ecosystems, innovation hubs, keiretsu, and triple-helix [42, 43, 58, 73, 74], which comprise different and heterogeneous organizations, having various types of relationships among them, and also economic and social exchanges, aiming at the collaborative design and implementation of complex and demanding product, service and process innovations. This also results in an increase of firms' outsourcing of some parts' production or services provision to other specialised firms all over the world, in order to take advantage of their resources and economies of scale [3, 30, 51]. It should be emphasized that the above collaboration structures have become of critical importance in the modern economy, so competition in many industries tends to be more among such collaboration structures than among individual firms [9, 42, 57, 74].

The participation of a firm in such collaboration structures offers significant business benefits [5, 16, 27, 33, 45, 74]: access to complementary resources and capabilities, new technologies and markets, diverse knowledge, and also opportunities to achieve economies of scale, to share the costs and risks of firm's activities, and to cope with market and technological complexities. Also, they facilitate learning through the transfer of knowledge among participating firms, acting as 'conduits' for moving and processing knowledge, so they increasingly become the 'locus' of a combination of diverse knowledge and complementary resources, and collaborative creation of novel knowledge and innovation. However, the realization of these benefits is not straightforward and relies critically on the organization of such complex collaborations. For this reason, considerable research has been conducted for the identification and the development of open innovation methods and practices, usually based on the use of ICT, and also for their analysis and evaluation, and for discovering the contexts and types of problems for which each of them is more appropriate [6, 22, 37, 49, 54]. The use of ICT for supporting open innovation is discussed in the following Sect. 2.2.

2.2 Open innovation and ICT/CC

An important condition for the efficiency and effectiveness of the open inter-organizational innovation, and the realization of its abovementioned potential benefits, is the use of appropriate ICT for supporting it [5, 15, 16, 20, 25]. According to Hakansson and Snehota [25] and Baraldi and Nadin [5] among firms participating in such structures specific coordination actions are required at three layers: 'activity links' (i.e. mutual adaptations in their activities), 'resource ties' (i.e., technical connections and mutual orientations of their physical and organisational resources) and 'actor bonds' (i.e. social interactions between individuals and organisational units of collaborating firms). These coordination actions require extensive exchanges of information, both 'structured' and 'unstructured', which can be greatly supported through the use of appropriate ICT, and especially through the use of appropriate CC services, taking into account the strong potential of the latter to support and facilitate business collaboration at a low cost, as mentioned previously in the Introduction. ICT can provide digital spaces that allow the rapid, extensive and cost-effective exchange of knowledge required among the multiple organizations participating in an open innovation initiative (e.g. suppliers, customers, business partners, and even universities and government agencies) for the collaborative design of innovation; at the same time ICT can support and reduce the cost of the coordination required for the inter-organizational collaborative implementation of innovations [39, 42, 48, 60]. These have led to a big growth of the business collaboration software market. Numerous ICT platforms have been recently developed in order to support such inter-organizational collaboration for the design of innovations, which enable firms to access and use a rich collaboration support functionalities (e.g. centralized content storage and sharing, forums, instant messaging and other interaction and productivity applications, support of groups, social media type applications, project management, etc.), that can be made available to both firm's employees and also external entities, rapidly (requiring only minimal initial settings and customizations) and at a low cost [23, 56, 63]. Furthermore, various types of ICT platforms have been developed which can support substantially inter-organizational collaboration at the operational level for the implementation of innovations (e.g. for the production of innovative products, or the provision of innovative services), such as the supply chain management (SCM) systems [13, 36, 55, 72].

The emergence of CC creates significant opportunities for providing to firms the abovementioned ICT support of open innovation (both for the inter-organizational collaborative design and implementation of it) rapidly and at a low cost. According to Berman et al. [8] CC can facilitate external collaboration with partners and customers, which will result in significant improvements in productivity and increased innovation performance; CC-based platforms can bring together disparate groups of people, both from inside and outside the firm, who can collaborate and share resources, information, and processes. Sultan [62] argues that CC can revolutionize both internal and external knowledge management of firms, as it allows overcoming the main technological, organizational and financial obstacles it traditionally faced, and this can promote both closed and open innovation. Clohessy and Acton [14] argue that open innovation is a promising route to value generation from CC, and propose a framework for this, which aims to assist firms in order to create value from CC by combining appropriate characteristics of it (such as on-demand service, resource pooling, rapid elasticity, etc.), deployment models (public, private, hybrid and community) and service models (IaaS, PaaS, SaaS) with closed or open innovation (with main emphasis on the latter). A study conducted by the London School of Economics (LSE), based on interviews with ICT and management practitioners, revealed that CC has a strong potential to provide extensive electronic support of design and operation oriented collaboration among organizations at a low cost [68]. It concludes that the existing organizational computing paradigm is based on firms' internal information systems (IS), which are usually are not designed to be systematically accessible by external entities, e.g. customers, suppliers, business partners, etc. (with the exception of some specific types of IS, such as the SCM systems, or systems brokering hotel or airline reservations). On the contrary the new organizational computing paradigm emerging through CC aims by design to enable systematic controlled (under strict security and authorizations) access to appropriate parts of firm's data or functionality by external entities (e.g. customers, suppliers, business partners, etc.) as well, anytime and from anywhere, as it happens with firm's employees; this supports and promotes collaboration with the external world, easily and at a low cost. The above study concludes that this will gradually blur the boundaries of organizations, and in general lead to structural changes of them, giving rise to the 'cloud corporation', which has much more 'amorphous' and less strict boundaries with the external world, is much more collaborative with external stakeholders, flexible and 'fluid'. Jede and Teuteberg [32], based on an extensive review of relevant literature, conclude that many CC services have been developed, which can provide substantial support of the main SCM processes at a low cost, enabling real-time information sharing among all participating firms, quick decision making, and better coordination, and finally higher efficiency of the whole SC; such CC services can provide extensive support for rapid inter-organizational open innovation implementation at a low cost. Furthermore, in recent years a variety of cloud-based collaboration tools have been developed [23, 56, 63], with most of them being offered through the SaaS model as well. These cloud-based collaboration tools have a great potential to provide a cost-effective electronic support of open innovation (inter-organizational design and implementation of innovation).

However, the above arguments and expectations have not been empirically investigated based on 'real-life' data; it has not been empirically examined to what extent firms perceive CC as a useful and cost-effective means of supporting open inter-organizational innovation. Furthermore, previous research on CC adoption factors (briefly reviewed in the following Sect. 2.3) has not examined empirically the equivalent question of whether the use of open innovation practices impacts positively CC adoption. Our study contributes to filling this research gap, by investigating this critical question in an 'objective manner', without resorting to subjective perceptions of firms' managers: in particular, it examines empirically the effects of firm's inter-organizational collaboration for the design and implementation of innovations, and also the use of ICT for supporting such collaborations, on firm's propensity to adopt CC.

2.3 Cloud computing adoption factors

As mentioned in the Introduction, the CC can provide significant benefits to firms, but at the same time can pose some risks as well, and this has resulted in much lower adoption of CC by firms than the initial expectations [7]; Low et al. [28, 41, 59]. This has led to considerable research on CC adoption, which aims mainly at the identification of factors affecting it positively or negatively. Most of this research has as theoretical foundation the Technology, Organization and Environment (TOE) theory of technological innovation adoption [4, 64], which identifies three groups of factors that affect the adoption of technological innovations by firms: technological (=perceived characteristics of the, considerable research has been conducted concerning the factors that affect positively or negatively the adoption of CC by firms (a good review of this research is provided by Loukis and Kyriakou [40]). Part of this research examines the effect of some firm's characteristics on CC adoption. The most representative of these studies are reviewed in this section.

Low et al. [41], using the TOE theory as their theoretical foundation, and based on data from a sample of 111 Taiwanese high-tech industry firms, examine the effect of a set of technological factors (relative advantage, complexity and compatibility), organizational factors (top management support, firm size and technology readiness) and environmental factors (competitive pressure and trading partner pressure) on CC adoption. They found that perceived relative advantage, top management support, firm size, competitive pressure and trading partner pressure have statistically significant effects on CC adoption. Another TOE-based study has been conducted by Hsu et al. [28], which examines the effect of perceived benefits and business concerns (technological factors), IT capability (IT personnel and budget—organizational factor) and external pressure (environmental factor) on CC adoption intention, using data from 200 Taiwanese firms. It concluded that the first three of these factors are significant determinants of CC adoption while the fourth is not. Mangula et al. [44], using data from 147 Indonesian firms, examine the effect of a set of technological factors (relative advantage, compatibility, complexity, trialability, observability), organizational factors (organizational readiness, top management support) and environmental context (market pressure, market competition vendor marketing, trust in vendor, government support) on the adoption of Software as a Service (SaaS) services. They found that compatibility, observability, market competition and government support have a positive correlation with SaaS adoption, while complexity has a negative correlation with it. Oliveira et al. [52], using data from 369 Portuguese firms, examine the effects of three CC innovation characteristics (relative advantage, complexity and compatibility), two organizational context characteristics (top management support, firm size), one technological context characteristic (technological readiness) and two environmental context characteristics (competitive pressure, regulatory support). They conclude that relative advantage, technological readiness, top management support and firm size have positive effects on CC adoption, while complexity has a negative effect. Another similar study has been conducted by Gutierrez et al. [31], who using data from 257 UK firms examined the effects of a set of technological factors (relative advantage, complexity and compatibility), organizational factors (top management support, firm size, technological readiness) and environmental factors (competitive pressure, trading partners pressure) on CC adoption. They concluded that competitive pressure, complexity, technology readiness and trading partner pressure have a significant influence on the adoption of CC services. Gangwar et al. [24] investigate CC adoption factors by combining the TOE theory with the Technology Acceptance Model (TAM) [17, 65], based on data from data from 280 companies from the Indian IT, manufacturing and finance sectors. They found that CC relative advantage, compatibility and complexity, as well as organizational readiness, top management commitment and training/education, affect CC adoption intention through perceived ease of use (PEOU) and perceived usefulness (PU) as mediating variables; also, competitive pressure and CC services providers' support were found directly affecting CC adoption intentions.

Another research stream investigates a wider set of firm's characteristics on CC adoption, having as theoretical foundation the Leavitt's Diamond framework [38], which views firms as consisting of four main components: task (=firm's goals/strategies and work processes for achieving them), technology (=technology used for performing work processes), people (=skills of firm's human resources) and structure (=firm's organization in departments and also relationships, communication patterns and coordination among them). Loukis and Kyriakou [40], using data from 676 European firms from the glass, ceramics and cement industries, examine the effects of six firms characteristics on CC adoption propensity: size, adoption of an ICT cost reduction strategy, adoption of an innovation-oriented strategy, employment of ICT specialized personnel, previous experience of ICT outsourcing and ICT infrastructure sophistication. They find that all these characteristics have positive effects on CC adoption propensity, with the sophistication of firm's ICT infrastructure having the strongest effect, followed by the adoption of a strategy of ICT investment reduction, and the possession of previous experience of ICT outsourcing. Kyriakou and Loukis [34], using the same dataset, investigate and compare the effects of a wide range of firm characteristics, which concern firm' s strategy, processes, technology and personnel, on its propensity to adopt CC. They conclude that among the examined characteristics the strongest driver of CC adoption is firm's interest in adopting and exploiting two important new ICT (data warehousing/data mining), followed by the adoption of a strategy of ICT investment reduction, and the employment of ICT personnel.

However, the effect of the adoption of the open innovation paradigm (inter-organizational collaboration for the design and implementation of innovations) on CC adoption propensity has not been investigated, despite the value of the insights that this research can provide, concerning the potential of CC for supporting and promoting open innovation. Our study contributes to filling this research gap.

3 Research hypotheses

Our first research hypothesis concerns the effect of inter-organizational collaboration with other firms for the design of innovations on firm's propensity to adopt CC. As mentioned in Sects. 1 and 2.1 in the modern economy innovation becomes increasingly collaborative: firms are increasingly collaborating with other firms, which possess complementary resources (e.g. knowledge, human skills and equipment and production facilities), in order to design, produce and promote innovative products, services, and also to develop and implement their innovations in their processes [26, 57, 58, 71, 74]. As explained in more detail in Sect. 2.2 this requires extensive exchange of information (both structured and unstructured) between the firms involved in inter-organizational collaborative innovation design, in order to exchange the different knowledge elements that each of them contributes, combine/synthesize them and create the new knowledge required for the design of the innovation; this can be significantly supported and facilitated through the use of appropriate ICT [39, 42, 48, 60]. The use of CC services enables the development, operation and maintenance of this ICT support required for the inter-organizational collaborative innovation design at a low cost, and without having to make additional investments, since a big variety of cloud-based collaboration tools have been developed and offered through the SaaS model [23, 56, 63]. According to Lai et al. [35] and Sultan [62] CC can substantially support internal and external knowledge management processes of firms, and this has led to the development of 'knowledge as a service (KaaS)', which can significantly facilitate the interactions and knowledge exchanges among members of a ‘knowledge network’ at low cost. For the above reasons, we expect that firms having inter-organizational innovation design collaboration with other firms will have a high motivation and propensity to adopt CC. So our first research hypothesis is:

H1 Inter-organizational collaboration with other firms for the design of innovations has a positive effect on firm’s propensity for cloud computing adoption.

Furthermore, there are firms already using ICT for the electronic support of collaborations they have with other firms for the design of various kinds of innovations in their products, services and processes. These firms can substantially reduce the operation, support, maintenance and upgrade cost of this ICT support, and also gain access to better and more extensive collaboration support functionality, by using appropriate CC services (e.g. by replacing existing on-premises collaboration support systems with modern cloud-based collaboration tools offered through a SaaS model). Quite useful for this can be a variety of cloud-based collaboration tools that as mentioned above have been developed [23, 56, 63], which provide a wide range of remote collaboration support functionalities. Sultan [62] argues that most leader ICT firms (such as Microsoft, Google, Salesforce, etc.) are developing applications with rich functionalities that support both internal and external knowledge management, which are offered through the classical ‘on-premises’ model as well as the SaaS model, and this creates big opportunities for firms (and especially SMEs) to obtain high-quality ICT support of both their closed and open innovation design activities. For the above reasons we expect that firms using ICT for supporting innovation design collaborations with other firms will have a high motivation and propensity to replace some of their existing external collaboration support systems, and adopt CC in order to take advantage of the abovementioned highly attractive offerings. So our second research hypothesis is:

H2 The use of ICT for supporting inter-organizational collaboration with other firms for the design of innovations has a positive effect on the propensity for cloud computing adoption.

As mentioned in Sect. 2.1 today firms tend to open not only their innovation design activities but also their innovation implementation ones as well, taking advantage of production equipment and facilities, human skills and relevant knowledge of other firms. This leads to outsourcing some parts of innovative products, or some parts of innovative services, to other specialised firms all over the world [3, 30, 51], increasing significantly the quantity and value of their external procurement, and also its geographical scope, moving from local suppliers, to country level and even international ones. However, this increases significantly firm’s operational complexity and workload, especially in cases of international procurement: having suppliers beyond firm’s country necessitates the management of many different legislations, regulations, taxation systems, payment systems, and currencies, etc. The above lead to high requirements for storage, processing, and exchange of relevant information, and finally to high costs for the development, maintenance and operation of the necessary ICT support, which can increase considerably firm’s operating expenses. The use of existing cloud-based SCM systems [18, 19, 32] is a good option in such cases, as it can provide extensive and high-quality ICT support of the above complex inter-organizational operations, at a low cost, which is mainly an ‘operating expense’, without having to make big ICT investment. For the above reasons, we expect that firms having a wider geographical scope of procurement will have a high motivation and propensity to adopt CC. So our third research hypothesis is:

H3 Increase of the geographical scope of firm’s procurement has a positive effect on the propensity for cloud computing adoption.

Furthermore, there are firms already using ICT for supporting and increasing the efficiency of the operational collaborations they have with other firms for the implementation of various kinds of innovations, such as SCM systems [13, 36, 55, 72]. This ICT support can have high operation, support, maintenance and upgrade costs, so it can be highly beneficial for these firms to use CC services in order to reduce these costs; this can be achieved by using IaaS and PaaS services for hosting such existing applications, or even by using SaaS for replacing some older and/or bespoke applications with more modern standard software packages, such as cloud-based SCM systems [18, 19, 32]. The electronic exchange of orders, invoices, inventory levels and other data required in these operational collaborations can be conducted much easier and at a lower cost if the firms we are collaborating with are given access to appropriate parts of such cloud-based SCM systems (e.g. to some of their data or/and functionality) we are using. This can provide an efficient support of operational collaboration with other firms, which also has high flexibility for addressing changes in our business collaboration networks (new firms can be easily given such access if required, and this will activate immediately electronic collaboration with them). For the above reasons, we expect that firms using ICT for supporting their operational collaboration with other firms will have a high motivation and propensity to adopt CC. So our fourth research hypothesis is:

H4 The use of ICT for supporting firm’s operational collaboration with other firms has a positive effect on the propensity for cloud computing adoption.

4 Data and method

The data used in this study have been collected through the “e-Business Survey”, which has been conducted as part of the e-Business Market W@tch (www.ebusiness-watch.org) initiative of the European Commission, from a sample of 676 firms, from the glass, ceramic and cement manufacturing sectors of six European countries (Germany, France, Italy, Poland, Spain, UK). The composition of the sample of our study by size, sector and country are shown in Table 1. For this survey, a questionnaire was developed, which contained 90 questions structured into the following modules: Use of ICT systems; e-Commerce and automated data exchange; Innovation activity and the role of ICT; ICT skills requirements; ICT investments; ICT, energy efficiency and emissions; Background information about the company. The data collection was conducted through telephone interviews,

Table 1 Composition of the sample of the study by size, sector and country

Size		Sector		Country	
Small (10–49)	53.8 %	Glass	23.5 %	Germany	26.6 %
Medium (50–249)	33.6 %	Ceramic	22.9 %	Spain	18.5 %
Large (250+)	12.6 %	Cement	53.6 %	France	12.7 %
				Italy	14.9 %
				UK	9.5 %
				Poland	17.8 %

using computer-assisted telephone interview (CATI) techniques, with the main ICT decision makers of these firms (who were usually either heads of the ICT department, or had higher management positions, so they had a good knowledge about the use of various ICT in the firm).

The questions of this survey that are used in this study are shown in the Appendix Table 2. As dependent variable has been used the propensity for CC adoption (CLOUD_PROP), which initially has been measured in a three levels scale (very relevant, partly relevant or not relevant for the firm), but as the relative frequency of the first value was very small we merged the first two values, so this variable has been finally recoded as binary (with very relevant or partly relevant coded as 'yes', and not relevant coded as 'no'). We have used five independent variables, with three of them concerning the inter-organizational design of innovations, and the other two concerning inter-organizational implementation of innovations. In particular, the first two independent variables are binary (yes/no) variables assessing whether or not the firm has external collaborations with other firms for the design of product/service innovations and process innovations respectively (i.e. in the development of new products or services are involved other firms or external experts) (COLL_PRODSER_INN and COLL_PROC_INN). The third independent variable is a binary (yes/no) variable assessing whether or not the firm is using ICT for the electronic support of innovation design collaborations with other firms (i.e. uses software applications in order to collaborate with other firms in the development of product/service innovations or process innovations) (EL_COLL_INN). Our fourth independent variable concerns the geographic scope of firm's procurement (GSC_PROC), which is measured in a three levels scale (regional, country or international). The fifth one is a binary (yes/no) variable assessing whether or not the firm is using an advanced ICT application for supporting its operational collaboration with other firms: SCM system (E_SCM). Also, we used for comparison purposes an additional independent variable, which corresponds to the most important CC adoption factor/motivation according to the relevant literature [46, 50, 66]: ICT capital investment reduction. In particular, we used an additionally binary (yes/no) variable assessing whether or not the firm has an ICT investment adoption strategy (ICT_INV_RED), in order to compare the effects of this widely recognized central CC adoption factor/motivation with the effects of the abovementioned five independent factors of our study.

Table 2 Variables definitions—questions

Variable	Definition
Dependent variable	
Propensity for cloud computing adoption (CLOUD_PROP)	How relevant is cloud computing for your company?
Independent variables	
Involvement of other firms in product/service innovations (COLL_PRODSER_INN)	Were external experts or business partners involved in developing new products or services?
Involvement of other firms in process innovations (COLL_PROC_INN)	Were external experts or business partners involved in developing new processes?
Use of software applications to collaborate with other firms for product/service or process innovations (EL_COLL_INN)	Does your company use online software applications other than e-mail to collaborate with business partners in the development of new products, services or processes?
Geographical scope of procurement (GSC_PROC)	Do you procure primarily from suppliers in your region, in your country of from an international supplier base?
Use of SCM systems (E_SCM)	Do you use an SCM (Supply Chain Management) system?
ICT investment reduction (ICT_INV_RED)	Have you cancelled or significantly downsized any ICT or e-business projects

In order to test our research hypotheses H1–H4 initially we estimated the association between the dependent variable and each of the abovementioned independent variables, by calculating: (a) two widely used measures of association between ordinal variables, Somers' d and Kendall's tau-b (they both range from −1 to 1, with the sign indicating the direction of the association, and the absolute value indicating its strength); (b) the widely used Pearson's correlation (which is acceptable for ordinal variables); and (c) the partial correlation, controlling for sector (using for this purpose two sectoral binary dummy variables D_SECT1 and D_SECT2) and size (using two binary size dummies: one taking value 1 for large firms having 250 or more employees (D_LARGE), and 0 for all other firms, and another one taking value 1 for medium size firms having between 50 and 249 employees, and 0 for all other firms (D_MEDIUM)). The calculation of these partial correlations allows the identification of spurious correlations, which are due to similar influences of sector or/and size to both variables (e.g. due to positive effects of size to both variables), by calculating these correlations after the extraction of the influences of sector and size from both variables.

Then we estimated the following regression model:

$$\begin{aligned} \mathrm{CLOUD\_PROP_i} = \mathrm{b_0} &+ \mathrm{b_1 ICT\_INV\_RED}_i \\ &+ \mathrm{b_2 COLL\_PRODSER\_INN_i} \\ &\times (\mathrm{COLL\_PROC\_INN_i},\ \mathrm{EL\_COLL\_INN_i}) \\ &+ \mathrm{b_3 GSC\_PROC_i (E\_SCM_i)} + \mathrm{b_4 D\_MED_i} \\ &+ \mathrm{b_5 D\_LARGE_i} + \mathrm{b_6 SECT1_i} + \mathrm{b_6 SECT2_i} + \mathrm{e_i} \end{aligned} \quad (1)$$

having as dependent variable the abovementioned propensity for CC adoption one (CLOUD_PROP), and as independent variables the adoption of an ICT investment adoption strategy (ICT_INV_RED), one variable concerning inter-organizational collaboration for the design of innovations (initially we entered the COLL_PRODSER_INN variable, then the COLL_PROC_INN and finally the EL_COLL_INN; due to high levels of correlation among these three variables it was not possible to include all of them in the same regression model, as this caused multi-collinearity problems) and one variable concerning inter-organizational collaboration for the implementation of innovations (initially we entered the GSC_PROC variable and then the E_SCM; again due to high levels of correlation among these two variables it was not possible to include both of them in the same regression model, as this caused multi-collinearity problems). Also we, included the abovementioned two size dummy variables D_MEDIUM and D_LARGE (having as reference group the small firms), and also two sector dummy variables SECT1 and SECT2 (having as reference group SECT3 = cement sector). So we estimated six regression models in total. Since the dependent variable (CLOUD_PROP) has been recoded as binary, for these estimations we used logistic regression, which is according to the relevant econometric literature [29, 61] the most appropriate estimation method when the dependent variable is binary.

5 Results

In the following Table 3 we can see descriptive statistics (relative frequencies of all values) for the dependent as well as the independent variables of our study. We can see that 12.4 % of sample firms find CC very relevant or partly relevant; 17.8 and 22.3 % of them have inter-organizational collaborations with other firms for the design of product/service innovations and process innovations respectively, while

Table 3 Descriptive statistics for the dependent and the independent variables

Variable	Yes (%)	No (%)
CC propensity	12.4	87.6
Involvement of other firms in product/service innovations	17.8	82.2
Involvement of other firms in process innovations	22.3	77.7
Use of software applications to colla-borate with other firms for product/service or process innovations	11.1	88.9
Use of SCM systems	13.5	86.5
ICT Investment Reduction	23.2	76.8

Independent variable	From regional suppliers (%)	From country suppliers (%)	From international suppliers (%)	Do not know/no answer (%)
Geographic scope of procurement	25.1	53.3	20.0	1.6

Table 4 Sommer's D, Kendall tau-b, correlation and partial correlations of independent variables with the dependent variable

Independent variable	Sommer's D	Kendall tau-b	Correlation	Partial correlation
Involvement of other firms in product/service innovations	**0.129**	**0.130**	**0.130**	**0.108**
Involvement of other firms in process innovations	**0.160**	**0.164**	**0.164**	**0.136**
Use of software applications to collaborate with other firms for product/service or process innovations	**0.152**	**0.152**	**0.152**	**0.137**
ICT investment reduction	**0.160**	**0.165**	**0.165**	**0.141**
Use of SCM systems	**0.193**	**0.193**	**0.193**	**0.170**
Geographic scope of procurement	0.015	0.017	0.029	-0.009

11.1 % use ICT for the support of such innovation design collaborations, and 13.5 % use e-SCM systems for the support of operational collaboration with other firms. Also, 23.2 % have ICT capital investment reduction strategy, having cancelled or significantly downsized ICT or e-business projects.

In Table 4 are shown for all independent variables the calculated Sommer's D coefficient, Kendall tau-b coefficient, correlation and partial correlation (controlling for sector and size) values with respect to the dependent variable (propensity for CC adoption) (statistically significant values having significance lower than 10 % are shown in bold). Also, in Table 5 are shown the six estimated regression models of CC adoption propensity with the specification of the Eq. 1 of Sect. 4. For each independent variable is shown the exp(b), which is the increase of the odds of CC adoption propensity (=probability of having CC adoption propensity/probability of not having CC adoption propensity) if the independent variable increases by one unit (in bold are shown the statistically significant ones having significance lower than 10 % are shown in bold).

From Tables 4 and 5, we can see that inter-organizational collaboration with other firms for the design of both product/service and process innovations have statistically significant positive effects on firm's propensity for CC adoption. Therefore, research hypothesis 1 is supported. Also, we can see the use of ICT for the support of inter-organizational collaboration with other firms for the design of innovations has statistically significant positive effect on the propensity for CC adoption. So research hypothesis 2 is supported as well. On the contrary, the geographical scope of firm's procurement does not have a statistically significant effect on the propensity for CC adoption, so research hypothesis 3 is not supported. Finally, the use of a SCM system for supporting firm's operational collaboration with other firms has positive effect on the propensity for CC adoption; therefore, research hypothesis 4 is supported.

Table 5 Estimated models of CC adoption propensity

Independent variable	Model 1	Model 2	Model 3
ICT investment reduction	**2.252**	**2.168**	**2.338**
Geographic scope of procurement	0.958	0.939	0.891
Involvement of other firms in product/service innovations	**1.904**		
Involvement of other firms in process innovations		**2.126**	
Use of software applications to collaborate with other firms for product/ service or process innovations			**2.713**
D_medium	1.518	1.408	1.474
D_large	**2.059**	**1.817**	**2.223**
Sect1	**1.654**	**1.711**	**1.611**
Sect2	1.362	1.366	1.226
N	665	665	665
Nagelkerke R^2	0.087	0.094	0.098
Chi square	**31.83**	**34.53**	**36.03**

Independent variable	Model 4	Model 5	Model 6
ICT investment reduction	**2.033**	**1.937**	**2.119**
Use of SCM systems	**2.706**	**2.661**	**2.491**
Involvement of other firms in product/service innovations	**1.861**		
Involvement of other firms in process innovations		**2.033**	
Use of software applications to collaborate with other firms for product/service or process innovations			**2.304**
D_medium	1.421	1.333	1.380
D_large	**1.747**	1.554	**1.859**
Sect1	**1.509**	**1.537**	0.882
Sect2	1.326	1.375	0.692
N	676	676	676
Nagelkerke R^2	0.117	0.122	0.123
Chi square	**43.13**	**45.20**	**44.88**

6 Discussion

The above results provide some interesting evidence concerning the existence of association between two major trends of the modern economy: open inter-organizational innovation and cloud computing. Our results indicate that firms of the three examined manufacturing sectors view CC as a cost-effective means of supporting inter-organizational collaboration with other firms for the design of innovations. The latter necessitates extensive exchange of knowledge among collaborating firms, new combinations of this knowledge, and based on it design of the innovation, initially at a conceptual level, and then more detailed; all these can be significantly supported and facilitated through the use of appropriate ICT [39, 42, 48, 60]. CC is perceived as a cost efficient option for sourcing this ICT support at a low cost, which is an additional operational expense, without having to make additional investments, taking advantage of a big variety of cloud-based collaboration support tools have been developed, and can be offered through the SaaS model as well; these tools can provide a rich set of functionalities that can support both internal and external knowledge management, such as centralized content storage and sharing, forums, instant messaging and other interaction and productivity applications, support of groups, social media type applications, project management, etc., that can be made available to both firm's employees and also external entities [23, 56, 63]. Furthermore, firms of these sectors view CC as a means of reducing the cost and increasing the capabilities and flexibility of already existing ICT support of inter-organizational collaboration they have with other firms for the design of innovations. The abovementioned of cloud-based collaboration support tools offered through the SaaS model are perceived by firms of these sectors as a good alternative to existing on-premises collaboration support systems currently used for the electronic support of open innovation design (i.e. inter-organizational collaboration with other firms for the design of innovations).

Furthermore, our results indicate that at least in the three examined sectors the wider geographic scope of procurement caused by inter-organizational implementation of innovations, which usually necessitates extensive operational collaboration with a big number and variety of firms, and therefore extensive ICT support for the storage, processing and exchange of big amounts of relevant information, is not a driver of CC adoption; firms of these sectors do not view CC as a cost-effective means of providing ICT support of their operational collaboration with multiple geographically dispersed suppliers. A possible reason for this might be that in these three manufacturing sectors the operational collaboration processes exhibit significant specificities and complexities, leading to high levels of 'asset specificity' (e.g. need of highly specialised and customised software applications in the CC services provider side, and also extensive communication and cooperation between experienced and knowledgeable personnel of the CC services provider and the CC services user) and 'uncertainty' (as to whether the CC services provider can meet all the special needs with satisfactory service levels and price). This higher asset specificity and uncertainty, according to the transaction cost theory [69, 70] make the outsourcing of the electronic support of this inter-organizational operational collaboration through the use of CC more difficult and costly to manage, and less attractive and beneficial, in comparison with the on-premises alternative. Another possible reason might also be that the adoption of CC for supporting critical everyday activities (such as the ones of these operational collaborations) is risky, and requires a certain level of 'cloud computing maturity' along various technological and organizational dimensions [53]; there is a chance that the three examined sectors, which as mentioned in the introduction are rather conservative in terms of adoption of new ICT, and innovative business practices in general, do not possess sufficient maturity for this. On the contrary, our results indicate that firms of the three examined sectors view CC as a means of reducing the cost and increasing the capabilities and flexibility of already existing on-premises ICT support of inter-organizational operational collaborations, such as SCM systems. These systems can be quite costly to operate and maintain, and also not provide all the required functionality; so it might be quite attractive to use IaaS and PaaS services for hosting such existing on-premises applications, or even to use SaaS for replacing some older and/or bespoke applications with more modern standard software packages, such as cloud-based SCM systems [18, 19, 32].

Finally, a comparison was made of the effects of the examined independent variables on the propensity for CC adoption, taking into account the calculated Sommer's D, Kendall tau-b, correlation and partial correlation coefficients shown in Table 4, as well as the b coefficients of the estimated regression models shown in Table 5. This comparison leads to the conclusion that the use of SCM systems has the strongest effect, which is stronger than the effect of having an ICT investment reduction strategy, that is regarded by the relevant literature [46, 50, 66] as the most important CC adoption factor/motivation. This indicates that the reduction of the costs of complex on-premises applications, as well as the enrichment of provided functionality, can be a very strong motivations for using CC. Then follow the effects of the use of ICT for supporting inter-organizational collaboration with other firms for the design of innovations, and the existence of inter-organizational collaboration for the design of process innovations, and finally of product/service innovations.

In general, the results shown in Tables 4 and 5 indicate that the inter-organizational innovation design is much stronger associated with propensity to adopt CC than the inter-organizational innovation implementation. A possible explanation for this is that the former has a much smaller scale and is less critical for the everyday operation of the firms (though quite important for their future performance, or even for their survival) in comparison with the latter; therefore, the business uncertainty generated from the use of CC services is lower for the former than for the latter. This lower uncertainty, according to the transaction cost theory [69, 70], leads to a higher propensity to adopt CC for supporting inter-organizational collaborative design of innovations than inter-organizational collaborative implementation of innovations.

7 Conclusions

Two important and widely debated trends in the modern economy are the gradual shift of firms from the 'closed' internal innovation paradigm towards the 'open' inter-organizational innovation paradigm, and also the emergence of cloud computing (CC) as a new more efficient paradigm of business computing. In the previous sections of this paper has been presented an empirical investigation of the association between these two trends. In particular, we investigated empirically the effects of firm's inter-organizational collaboration for the design and implementation of innovations, and also use of ICT for supporting these collaborations, on firm's propensity to adopt CC; in this way we actually examined in an 'objective' manner (without resorting to subjective perceptions of firms' managers) to what extent firms regard CC as a cost-effective means of supporting open collaborative inter-organizational innovation design and collaboration. Our study has been based on a dataset collected through the e-Business Survey of the European Commission from 676 European firms from the glass, ceramics, and cement manufacturing sectors; though most of the previous research on the adoption and exploitation of various ICT focuses mainly on high-tech and in general highly innovative services or manufacturing sectors, our study focuses on three important manufacturing sectors, which are rather conservative in terms of adoption of new ICT, and innovative business practices in general, and therefore more representative of ‘traditional’ manufacturing [21].

Our results provide some first evidence concerning the existence of association between the above two important trends of modern economy. We have found that inter-organizational collaboration for the design of innovations has positive impact on the propensity for CC adoption; also, the use of ICT for supporting inter-organizational collaboration for the design and implementation of innovations, are drivers of CC adoption, aiming at the reduction of the costs and the increase of the capabilities and the flexibility of this ICT support. These results provide valuable insights concerning the perceptions of firms of three important European industrial sectors about the potential of CC to support and promote open inter-organizational innovation. They indicate that firms of these sectors regard CC as a cost-effective means of supporting open inter-organizational innovation design, but not open inter-organizational innovation implementation (i.e. for supporting relevant critical daily operations). This might be due to specificities and complexities of the processes and collaboration practices of the three examined manufacturing sectors, which result in limited supply of corresponding specialised SaaS applications by CC providers. Also, the importance of this operational collaboration with partners for the everyday activities of these firms makes them hesitant to use external providers of ICT support of them. However, the firms of these sectors regard CC much more as a means of reducing the cost and increasing the capabilities and flexibility of already existing ICT support of open inter-organizational innovation design and implementation, probably by using IaaS and PaaS services for hosting some of these applications, or by using SaaS for replacing some older and/or bespoke ones with more modern standard software packages. Summarizing, our study provides some interesting evidence concerning the potential of CC to support and promote this emerging paradigm of open inter-organizational innovation.

This study has interesting implications for research and practice. With respect to research, it makes a contribution to two highly important research streams: (i) CC adoption factors research: this research stream (briefly reviewed in Sect. 2.3) aims to identify the factors affecting positively or negatively the adoption of CC by firms; our contribution lies in the empirical investigation and comparison of the effects of the adoption of several open inter-organizational innovation design and implementation practices at firm level, and also the usage of ICT for supporting them, which had not been dealt with previously. Furthermore, our research is opening up new directions of CC adoption and business value research. (ii) Open innovation and CC research: though this research (briefly reviewed in Sect. 2.2) has revealed to some extent the potential of CC to support and promote open innovation, its arguments and expectations had not been empirically investigated based on ‘real-life’ data; we have made a contribution towards filling this gap, by empirically investigating (in an ‘objective’ manner) the perceptions of firms belonging to three important manufacturing sectors concerning the potential of CC to support and promote open inter-organizational design and implementation of innovation. With respect to practice, our findings provide to CC user (or potential user) firms' management interesting and useful directions for making advanced and multi-dimensional exploitation of CC, towards the support of inter-organizational innovation collaboration, which becomes increasingly important in the modern economy. Our findings indicate that the use of CC for supporting open inter-organizational innovation design can be their first step (e.g. use of the existing rich variety of cloud-based collaboration support systems), as it has a much smaller scale and is less critical for the everyday operations of the firms, but it is quite important for their future performance, or even for their survival. Then, leveraging the experience gained from this first step by both the focal firm and the collaborating firms, a second step can be the use of CC for supporting open inter-organizational innovation implementation, though this step is more difficult and complex, has a larger scale than the first one, and affects more the everyday operations of the firm. Also, our findings can be useful to consulting firms interested in finding and proposing to their customers new ways of CC exploitation, directed towards the electronic support of open inter-organizational innovation. Finally, the findings of this study can be useful to CC services providers, in order to improve and enrich their offerings and value propositions, beyond the 'classical' ones, towards the above directions.

There are four main limitations in this study, which should be addressed by future research. First, it has been based on data from only three manufacturing sectors of six European countries, so its findings may have been influenced to some extent by this particular sectoral and national context. Second, it does not distinguish between different categories of CC services (IaaS, PaaS, SaaS). Third, the dependent and independent variables of this study are measured using only one item (question), and not as multi-item constructs. Fourth, we have examined the effect on CC adoption propensity of the use of only one kind of ICT application for supporting inter-organizational operational collaboration (only SCM). Therefore, further empirical and theoretical research is required on the association between open innovation and CC. It should investigate on one hand different methods and practices of open innovation design and implementation, and on the other hand use of different kinds of ICT applications for supporting them, as to their effects on the adoption of different categories of CC services (e.g. IaaS, PaaS, SaaS), in various sectoral and national contexts. Also, relevant future research should use more detailed measurements of the extent of adoption of various CC services (dependent variables), and also of various open innovation methods and practices (independent variables), through multi-item constructs. Furthermore, it would be useful to conduct research for identifying moderators of the relationships between open innovation and CC adoption (e.g. various characteristics of the firm, including firm's 'cloud computing maturity' along various technological and organizational dimensions [53], and also its external environment), which might increase or decrease the strength of these relationships.

Appendix

See Table 2.

References

1. Ackermann, T., Widjaja, T., Benlian, A., & Buxmann, P. (2012). Perceived IT security risks of cloud computing: Conceptualization and scale development. *Proceedings of 33rd international conference on information systems (ICIS)*, St. Louis, USA.
2. Armbrust, M., Fox, A., Griffith, R., Joseph, A., Katz, R., Konwinski, A., et al. (2010). A view of cloud computing. *Communications of the ACM, 53*(4), 50–58.
3. Arvanitis, S., & Loukis, E. (2013). Outsourcing and firm performance—a comparative study of Swiss and Greek firms. *Industrial and Corporate Change, 22*(3), 771–806.
4. Baker, J. (2011). The technology–organization–environment framework. In Y. Dwivedi, M. Wade, & S. Schneberger (Eds.), *Information systems theory: Explaining and predicting our digital society* (pp. 231–246). New York, NY: Springer.
5. Baraldi, E., & Nadin, G. (2006). The challenges in digitalising business relationships—The construction of an IT infrastructure for a textile-related business network. *Technovation, 26*, 1111–1126.
6. Bellantuono, N., Pontrandolfo, P., & Scozzi, B. (2013). Different practices for open innovation: A context-based approach. *Journal of Knowledge Management, 17*(4), 558–568.
7. Benlian, A., & Hess, T. (2011). Opportunities and risks of software-as-a-service: Findings from a survey of IT executives. *Decision Support Systems, 52*(1), 232–246.
8. Berman, S., Kesterson-Townes, L., Marshall, A., & Srivathsa, R. (2012). *The power of cloud—Driving business model innovation*. New York, USA: IBM Institute for Business Value.
9. Busquets, J. (2010). Orchestrating smart business network dynamics for innovation. *European Journal of Information Systems, 19*(4), 481–493.
10. Chesbrough, H. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Boston: Harvard Business School Press.
11. Chesbrough, H. (2003). The Era of open innovation. *Sloan Management Review, 44*(3), 35–41.
12. Chesbrough, H. (2006). Open innovation: A new paradigm for understanding industrial innovation. In H. Chesbrough, W. Vanhaverbeke, & J. West (Eds.), *Open innovation: Researching a new paradigm* (pp. 1–12). Oxford: Oxford University Press.
13. Chopra, S., & Meindl, P. (2016). *Supply chain management* (6th ed.). USA: Pearson Education Limited.
14. Clohessy, T., & Acton, T. (2013). Open innovation as a route to value in cloud computing. *Proceedings of the 26th bled econference 'einnovations: challenges and impacts for individuals, organizations and society'*, June 9–June 13, 2013.
15. Cui, T., Tong, Y., & Teo, H. H. (2012). Can information technology bridge knowledge distance in organizational open innovation? An absorptive capacity perspective. *International Conference on Information Systems (ICIS 2012)*, Orlando, USA.
16. Cui, T., Ye, H. J., Teo, H. H., & Li, J. (2015). Information technology and open innovation: A strategic alignment perspective. *Information & Management, 52*(3), 348–358.
17. Davis, F. D. (1986). A technology acceptance model for empirically testing new end-user information systems: Theory and results. Doctoral Dissertation, Sloan School of Management. Cambridge, MA: MIT.
18. Demirkan, H., & Goul, M. (2013). Taking value-networks to the cloud services: Security services, semantics and service level agreements. *Information Systems and e-Business Management, 11*(1), 51–91.
19. Demirkan, H., Cheng, H. K., & Bandyopadhyay, S. (2010). Coordination strategies in an SaaS supply chain. *Journal of Management Information Systems, 26*(4), 119–143.
20. Dodgson, M., Gann, D., & Salter, A. (2006). The role of technology in the shift towards open innovation: The case of Procter & Gamble. *R&D Management, 36*(3), 333–346.
21. Empirica GmbH. (2009). *ICT and e-business impact in the glass, ceramics & cement industry*. Brussels: European Commission, DG Enterprise & Industry, Bohn.
22. Felin, T., & Zenger, T. (2014). Closed or open innovation? Problem solving and the governance choice. *Research Policy, 43*, 914–925.
23. Forbes. (2013). *Collaborating in the cloud*. Available at: http://webobjects.cdw.com/webobjects/media/pdf/Solutions/Cloud-Collaboration/White-Paper-Collaborating-in-the-Clouds.pdf.
24. Gangwar, H., Date, H., & Ramaswamy, R. (2015). Understanding determinants of cloud computing adoption using an integrated TAM-TOE model. *Journal of Enterprise Information Management, 28*(1), 107–130.

25. Hakansson, H., & Snehota, I. (Eds.). (1995). *Developing relationships in business networks*. London: Routledge.
26. Huizingh, E. (2011). Open innovation: State of the art and future perspectives. *Technovation, 31*, 2–9.
27. Huston, L., & Sakkab, N. (2006). Connect and develop: Inside Procter & Gamble's new model for innovation. *Harvard Business Review, 84*(3), 58–66.
28. Hsu, P., Ray, F., & Li-Hsieh, S. (2014). Examining cloud computing adoption intention, pricing mechanism and deployment model. *International Journal of Information Management, 34*, 474–488.
29. Greene, W. H. (2011). *Econometric analysis*. New Jersey: Prentice Hall Inc.
30. Gusmano, L., Mancusi, M. L., & Morrison, A. (2009). Globalization of production and innovation: How outsourcing is reshaping an advanced manufacturing area. *Regional Studies, 44*(3), 235–252.
31. Gutierrez, A., Boukrami, E., & Lumsden, R. (2015). Technological, organisational and environmental factors influencing managers' decision to adopt cloud computing in the UK. *Journal of Enterprise Information Management, 28*(6), 788–807.
32. Jede, A., & Teuteberg, F. (2015). Integrating cloud computing in supply chain processes. *Journal of Enterprise Information Management, 28*(6), 872–904.
33. Kajikawa, Y., Takeda, Y., Sakata, I., & Matsushima, K. (2010). Multiscale analysis of interfirm networks in regional clusters. *Technovation, 30*, 168–180.
34. Kyriakou, N., & Loukis, E. (2015). Firm Characteristics and Propensity for Cloud Computing Adoption, Twenty-first Americas Conference on Information Systems (AMCIS), Puerto Rico, August 2015, Puerto Rico
35. Lai, I., Tam, S., & Chan, M. (2012). Knowledge cloud system for network collaboration: A case study in medical service industry in China. *Expert Systems with Applications, 39*(15), 12205–12212.
36. Laudon, K. C., & Laudon, J. P. (2014). *Management information systems: Managing the digital firm* (13th ed.). UK: Pearson Education Limited.
37. Laursen, K., & Salter, A. (2006). Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms. *Strategic Management Journal, 2*, 131–150.
38. Leavitt, H. J. (1964). Applied organization change in industry: Structural, technical, and human approaches. In S. Cooper, H. J. Leavitt, & K. Shelly (Eds.), *New perspectives in organizational research* (pp. 55–71). Chichester: Wiley.
39. Lopez-Nicolas, C., & Soto-Acosta, P. (2010). Analyzing ICT adoption and use effects on knowledge creation: An empirical investigation in SMEs. *International Journal of Information Management, 30*(6), 521–528.
40. Loukis, E., & Kyriakou, N. (2015). Organizational factors affecting propensity to adopt cloud computing. *HICSS 2015*, 5–8 January 2015, Kauai Island, HI.
41. Low, C., Chen, Y., & Wu, M. (2011). Understanding the determinants of cloud computing adoption. *Industrial Management & Data Systems, 111*(7), 1006–1023.
42. Lyytinen, K., Yoo, Y., & Boland, R. J., Jr. (2016). Digital product innovation within four classes of innovation networks. *Information Systems Journal, 26*, 47–75.
43. Majava, J., Isoherranen, V., & Kess, P. (2013). Business collaboration concepts and implications for companies. *International Journal of Synergy and Research, 2*(1), 23–40.
44. Mangula, I. S., Weerd, I.,& Brinkkemper, S. (2014). The adoption of software-as-service: An Indonesian case study. *Proceedings in Pacific Asia conference on information systems (PACIS)*, 2014.
45. Mancinelli, S., & Mazzanti, M. (2009). Innovation, networking and complementarity. Evidence on SME performances for a local economic system in North-Eastern Italy. *Annals of Regional Science, 43*(3), 567–597.
46. Marston, S., Li, Z., Brandyopadyay, S., Zhang, J., & Ghalsasi, A. (2011). Cloud computing—The business perspective. *Decision Support Systems, 51*(1), 176–189.
47. Mell, P., & Grance, T. (2010). The NIST definition of cloud computing. *Communications of the ACM, 53*(6), 50.
48. Meroño-Cerdan, A., Soto-Acosta, P., & Lopez-Nicolas, C. (2008). How do collaborative technologies affect innovation in SMEs? *International Journal of e-Collaboration, 4*(4), 33–50.
49. Mina, A., Bascavusoglu-Moreau, E., & Hughes, A. (2014). Open service innovation and the firm's search for external knowledge. *Research Policy, 43*, 853–866.
50. Müller, S. D., Holm, S. R., & Søndergaard, J. (2015). Benefits of cloud computing: Literature review in a maturity model perspective. *Communications of the Association for Information Systems, 37*, 851–878.

51. Navghavi, A., & Ottaviano, I. P. (2010). Outsourcing, complementary innovations, and growth. *Industrial and Corporate Change, 19*(4), 1009–1035.
52. Oliveira, T., Thomas, M., & Espadanal, M. (2014). Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and services sectors. *Information & Management, 51*, 497–510.
53. Oracle White Paper. (2011). Cloud computing maturity model guiding success with cloud capabilities. Retrieved from http://www.oracle.com/technetwork/topics/entarch/oracle-wp-cloud-maturity-model-r3-0-1434934.pdf.
54. Pisano, G. P., & Verganti, R. (2008). Which kind of collaboration is right for you? *Harvard Business Review, 86*(12), 78–86.
55. Rainer, R. K., Prince, B., & Watson, H. J. (2015). *Management Information Systems* (3rd ed.). USA: Wiley.
56. Ross, P., & Blumenstein, M. (2015). Cloud computing as a facilitator of SME entrepreneurship. *Technology Analysis & Strategic Management, 27*(1), 87–101.
57. Rycroft, R. W. (2007). Does cooperation absorb complexity? Innovation networks and the speed and spread of complex technological innovation. *Technological Forecasting and Social Change, 74*, 565–578.
58. Salavisa, I., Sousa, C., & Fontes, M. (2012). Topologies of innovation networks in knowledge-intensive sectors: Sectoral differences in the access to knowledge and complementary assets through formal and informal ties. *Technovation, 32*, 380–399.
59. Siepermann, M., Sutaj. A., Lübbecke, P., & Lackes, R. (2016). Refuse to walk on clouds—Why firms still do not use cloud computing. An empirical study of barriers and enhancers. *Proceedings of the 49th annual Hawaii international conference on system sciences (HICSS-49)*, Kauai, HI.
60. Soto-Acosta, P., Colomo-Palacios, R., & Popa, S. (2014). Web knowledge sharing and its effect on innovation: An empirical investigation in SMEs. *Knowledge Management Research & Practice, 12*(1), 103–113.
61. Sreejesh, S., Mohapatra, S., & Anusree, M. R. (2014). *Business research methods—An applied orientation*. New York: Springer.
62. Sultan, N. (2013). Knowledge management in the age of cloud computing and Web 2.0: Experiencing the power of disruptive innovations. *International Journal of Information Management, 33*(1), 160–165.
63. Tan, X., & Kim, Y. (2015). User acceptance of SaaS-based collaboration tools: A case of Google Docs. *Journal of Enterprise Information Management, 28*(3), 423–442.
64. Tornatzky, L. G., & Fleischer, M. (1990). *The processes of technological innovation*. Lexington, MA: Lexington Books.
65. Turner, M., Kitchenham, B., Brereton, P., Charters, S., & Budgen, D. (2010). Does the technology acceptance model predict actual use? A systematic literature review. *Information and Software Technology, 52*(5), 463–479.
66. Venders, W., & Whitley, E. (2012). A critical review of cloud computing: Researching desires and reality. *Journal of Information Technology, 27*, 179–197.
67. Willcocks, L., Venters, W., & Whitley, E. A. (2013). Cloud sourcing and innovation: Slow train coming? *Strategic Outsourcing: An International Journal, 6*(2), 184–202.
68. Willcocks, L., Venters, W., & Whitley, E. A. (2014). *Moving to the cloud corporation*. UK: Palgrave Millan.
69. Williamson, O. E. (1985). *The economic institutions of capitalism: Firms, markets, relational contracting*. New York: The Free Press.
70. Williamson, O. E. (1989). Transaction cost economics. In R. Schmalensee & R. D. Willig (Eds.), *Handbook of industrial organization* (Vol. 1, pp. 135–182). Amsterdam: Elsevier.
71. West, J., Salter, A., Vanhaverbekec, W., & Chesbrough, H. (2014). Open innovation: The next decade. *Research Policy, 43*, 805–811.
72. Wu, I. L., & Chang, C. H. (2012). Using the balanced scorecard in assessing the performance of e-SCM diffusion: A multi-stage perspective. *Decision Support Systems, 52*(2), 474–485.
73. Xie, X. M., Zeng, S. X., & Tam, C. M. (2013). How does cooperative innovation affect innovation performance? Evidence from Chinese firms. *Technology Analysis & Strategic Management, 25*(8), 939–956.
74. Zeng, S. X., Xie, X. M., & Tam, C. M. (2010). Relationship between cooperation networks and innovation performance of SME. *Technovation, 30*, 181–194.
75. Zhang, Q., Cheng, L., & Boutaba, R. (2010). Cloud computing: State-of-the-art and research challenges. *Journal of Internet Services and Applications, 1*(1), 7–18.