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Benefits of Cloud Computing: Literature Review in a Maturity Model Perspective

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Abstract:

Cloud computing is drawing attention from both practitioners and researchers, and its adoption among organizations is on the rise. The focus has mainly been on minimizing fixed IT costs and using the IT resource flexibility offered by the cloud. However, the promise of cloud computing is much greater. As a disruptive technology, it enables innovative new services and business models that decrease time to market, create operational efficiencies and engage customers and citizens in new ways. However, we are still in the early days of cloud computing, and, for organizations to exploit the full potential, we need knowledge of the potential applications and pitfalls of cloud computing. Maturity models provide effective methods for organizations to assess, evaluate, and benchmark their capabilities as bases for developing roadmaps for improving weaknesses. Adopting the business-IT maturity model by Pearlson & Saunders (2007) as analytical framework, we synthesize the existing literature, identify levels of cloud computing benefits, and establish propositions for practice in terms of how to realize these benefits.

Keywords: Cloud Computing, Maturity, Disruptive Technology, Innovation.

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1 Introduction

During recent years, IT service offerings have been popular topics in both the academic and corporate world with IT outsourcing, service-oriented architecture (SOA), and cloud computing as major themes[1]. Much of the work surrounding cloud computing applies a technical perspective[2] in describing cloud benefits, but we follow the example and advice of Marston, Bandyopadhyay, Zhang, and Ghalsasi (2011) by applying an organizational and managerial perspective to show how cloud computing may benefit organizations—an aspect afforded too little attention in the literature.

Cloud computing has attracted a lot of attention over the last decade, but critics claim that it is merely old wine in new bottles (Lucas, Ballay, & Lombreglia, 2009). Cloud computing is, however, growing at an unprecedented rate. Gartner has predicted that the cloud market will surge to more than USD$148 billion in 2014 and concludes that "the personal cloud will replace the personal computer at the center of users' digital lives" in an analysis of megatrends (Gartner, 2012). This rapid growth presents new opportunities and will fundamentally change the way we do business. As the World Economic Forum (2010, p. 1) states: "In addition to reducing operational costs, cloud technologies have become the basis for radical business innovation and new business models, and for significant improvements in the effectiveness of anyone using information technology"—individuals, companies, and governments alike. In the eyes of some, cloud computing leads to creative destruction and induces "game-changing innovation and related dislocation" (The Boston Company's Core Research Technology Team, 2012, p. 6). Other industry players such as Intel and IBM are quick to describe cloud computing as a paradigm shift in IT service delivery and promise, among other things, business growth and IT flexibility yet recognizing that, while "the tools, building blocks, solutions, and best practices for the cloud are maturing, challenges to deploying cloud solutions still remain" (Intel, 2013, p. 1).

Large organizations are increasingly adopting cloud solutions such as Office 365, SalesForce.com, and Google Docs. Approximately 77 percent of all enterprises use cloud services to some degree (Skendrovic, 2013). The adoption of such services can, among other things, be ascribed to better networking infrastructures that enable real-time interaction through Internet technology (Lin & Chen, 2012; Mell & Grance, 2010), the convenience and maturity of solutions available (Lin & Chen, 2012), and the fact that cloud computing does not require large upfront investments, which reduces the financial risk to the adopter (Hall, 2008). Cloud computing can be used for various purposes, including 1) business support and cost savings (Hoberg et al. 2012; Iyer & Henderson 2010), 2) business improvement by establishing a common infrastructure (Chen & Liou 2012), and 3) business transformation by enabling faster deployment of solutions (Vouk 2008), realizing business value (Aljabre 2012), and creating flexible and agile business capabilities (Iyer & Henderson 2010). Cloud computing is, however, not a "silver bullet" solution to organizational IT issues since its adoption also raises various questions that need to be considered carefully, such as data lock-in and data confidentiality/auditability (Armbrust et al., 2010; Kim 2011).

Scholars and practitioners alike are currently debating cloud computing's potential, the benefits associated with using the technology, and the need for maturity models to specify best practices, measure progress, identify capabilities, and benchmark performance. Large corporations such as Oracle, Microsoft, and SunGard have already developed assessment and maturity models for cloud computing[3], but searches in citation databases reveal a lack of academic publications distinguishing between levels of cloud computing maturity and associated benefits. Yang & Tate (2012) comprehensively review the cloud computing literature (Yang & Tate, 2012). Our study complements their work by adopting a business perspective on the literature to categorize cloud computing benefits by maturity levels and to establish propositions for practice in terms of how to realize these benefits. Whereas Yang & Tate (2012) descriptively classify cloud computing research in which they distinguish between four categories of literature (i.e., technological issues, business issues, domains and applications, and conceptualizing cloud computing), we focus on business benefits across levels cloud computing maturity. Yang & Tate (2012) emphasize the "urgent demand for articles explaining cloud computing technologies in business-friendly language" (Yang & Tate, 2012, p. 48), and we answer their call for further research that acknowledges the differences across cloud computing applications and explores the implications for businesses. Similarly, Hoberg et al. (2012) investigate the cloud computing literature from a business perspective in which they

[1] See, for example, Gartner Hype Cycles at http://www.gartner.com or Business Source Premier at http://www.ebscohost.com.
[2] Such as image processing (3D), new algorithms, data access and security issues, load balancing optimization, mobility, and new layers/components in the cloud stack (Li, Wang, & Chen, 2012; Maximilien, 2009; Zhang, Cheng, & Boutaba, 2010).
[3] See, for example, http://www.oracle.com/technetwork/topics/entarch/oracle-wp-cloud-maturity-model-r3-0-1434934.pdf.

structure their results according to four dimensions: cloud computing characteristics, adoption determinants, governance mechanisms, and business impact. While the paper provides valuable insight, the authors call for “a comprehensive study which identifies enablers and inhibitors for cloud adoption” (Hoberg et al., 2012, p. 9). Furthermore, they identify the need for additional research on the business impact of cloud adoption on organizations and research focusing on “the appropriateness of cloud services for their particular organization-specific setting” (Hoberg et al., 2012, p. 9). We answer that call by thoroughly reviewing the literature and identifying levels of cloud computing benefits and establishing propositions for practice in terms of how to realize these benefits.

We base our study on Pearlson and Saunders’ (2007) business-IT maturity model. Their model provides a simple yet useful analytical framework as basis for distinguishing between various levels of cloud computing benefits and maturity. Similar models have been developed in areas such as enterprise architecture, IT outsourcing, and service-oriented architecture (Ross, 2003; Gottschalk & Solli-Sæther, 2006; Hirschheim, Welke, & Schwarz, 2010); however, they focus narrowly on certain aspects of their respective domains. Since we examine cloud computing from an IT-business perspective (i.e., investigate the link between the use of cloud computing technologies and business benefits), we chose Pearlson and Saunders’ (2007) general purpose model as our analytical lens. With this paper, we contribute to both theory and practice by synthesizing the existing literature and delineating three levels of cloud computing maturity and benefits. Furthermore, based on our literature review, we propose several propositions for practice at each level

This paper proceeds as follows: in Section 2, we present Pearlson and Saunders’ (2007) business-IT maturity model. In Section 3, we describe our research approach for the literature review. In Section 4, we map the extant knowledge we identified in the literature against the different maturity levels in Pearlson & Saunders’ (2007) model. In Section 5, we discuss key challenges at each maturity level based on the literature review and propose how practitioners may overcome and address these challenges. The section also highlights implications for theory, identifies avenues for future research, and discusses our study’s limitations. Finally, in Section 6, we conclude the paper.

2 Theoretical Background

In this section, we describe the concept of cloud computing before outlining Pearlson & Saunders’ (2007) maturity model.

2.1 Definition of Cloud Computing

Despite numerous business benefits and the topic being an object of extensive research, no universally accepted definition of cloud computing exists (Madhavaiah, Bashir, & Shafi, 2012). As a concept, cloud computing is not new but has evolved from earlier technologies such as grid computing, cluster computing, utility computing, virtualization, and application service provider hosting (Armbrust et al., 2010; Kim, 2011). Cloud computing shares certain characteristics and similarities with these technologies both in terms of the underlying technology and the goal of providing computing resources on a pay-per-use basis (Armbrust et al., 2010; Buyya, Yeo, Venugopal, Broberg, & Brandic, 2009; Liang & Wen, 2011; Thomas, 2011; Zhang et al., 2010). While the concept of cloud computing has rapidly matured since its inception in the late nineties (Mei, Chan, & Tse, 2008), much research still focuses on technological challenges such as technical incompatibility, smooth resource scaling, and performance unpredictability, which must be overcome for the technology to gain commercial traction (Sultan, 2010).

While the literature contains many definitions of cloud computing, recent research seems to have converged on the definition proposed by the National Institute of Standards and Technology (NIST) (Brandabur, 2013; Goth, 2011; Sun, 2013; Xu, 2012; Zhang et al., 2010). It includes five essential characteristics, three service models, and four deployment models (Mell & Grance, 2010). NIST’s definition of 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* (Mell & Grance, 2010, p. 2).

The five essential characteristics are: 1) flexibility in scaling resource use (Vaquero, Rodero-Merino, Caceres, & Lindner, 2009), 2) resource pooling enabled through technologies such as virtualization and multi-tenancy accessible via the Internet (Vaquero et al., 2009; Vouk, 2008), 3) objective measures of the services used to enable consumption-based billing (Leavitt, 2009), 4) self-service provisioning of computing resources (Mell & Grance, 2010), and 5) broad network access where resources are used through standardized mechanisms over a network (Mell & Grance, 2010). We adopt this definition, which, in turn, helps guide our selection of papers to include in the review.

2.2 The Business-IT Maturity Model

As we mention in Section 1, numerous IT maturity models exist on a broad range of topics related to cloud computing. For example, Ross (2003) focuses on IT architecture, Gottschalk and Solli-Sæther (2006) on IT outsourcing, and Hirschheim et al. (2010) on service-oriented architecture. We chose Pearlson & Saunders' (2007) business-IT maturity model as our analytical framework because it is well suited for investigating our research objective of understanding cloud computing's benefits. It draws attention to the need for collaboration and alignment between an organization's IT department and its other parts to maximize IT's value—whether for supporting, incrementally improving, or radically innovating the business (Henderson & Venkatraman, 1993). As the model does not focus narrowly on technology but on the relationship between IT and business in using the technology—in a broad sense—to increase efficiency, effectiveness, or transform the business, the business-IT maturity model is an ideal lens through which to view cloud computing's potential.

The model includes three stages viewed from two different perspectives: business demand and IT supply. Like other maturity models, it shows an evolutionary path for companies wanting to increase the value from IT and suggests that lower level requirements be satisfied first. Business demand is basically the business' needs for IT, while IT supply is the ability to meet those needs. More specifically, IT supply plays a dual role in this model: an IT organization's ability to satisfy the business demand for IT by providing solutions on the one hand and the stimulation of business demand for further IT capabilities to maximize benefits on the other hand (Pearlson & Saunders, 2007). The model depicts an S-shaped learning curve, which reflects the learning process associated with increasing levels of maturity. The three levels, therefore, entail very different processes and practices and require radically different organizational thinking, which is why higher levels of maturity build on preceding levels (Pearlson & Saunders, 2007).

The three levels of business-IT maturity are: business efficiency, business effectiveness, and business transformation. Figure 1 (below) shows the model. To fully harvest IT's potential, one may use the model as an analytical framework to understand the as-is state, but one can also use it for constructing a road map of how to reach a future to-be situation.

The model draws on some of the same characteristics as the framework by Applegate, Austin, and Soule (2008) who mention similar IT-enabled capabilities; namely: 1) cost savings, 2) asset efficiency, 3) revenue growth, and 4) sustainable competitive advantages (Applegate et al., 2008). These capabilities are represented in the three maturity levels of the business-IT maturity model.

2.2.1 Level 1: Business Efficiency

We can characterize IT at maturity level 1 as an expense that must be minimized and where IT is something that the IT organization is expected to maintain with minimal disruption to the business (Pearlson & Saunders, 2007). The IT demand is focused on efficiency and often originates in independent business units with the purpose of automating transactions and minimizing costs. It is equivalent to enterprise architecture's "business silos" stage described by Ross, Weill, and Robertson (2006). These silos are built around business or organizational units and usually prevent interdepartmental issues from being resolved (Pearlson & Saunders, 2007). Each silo is typically preoccupied with its own goals rather than those of the enterprise and integration between business silos is at a minimum (Rummler & Brache, 2012). As a consequence, the IT department's goal is often to "keep the lights on" and provide a reliable and stable IT infrastructure in support of each silo (Pearlson & Saunders, 2007).

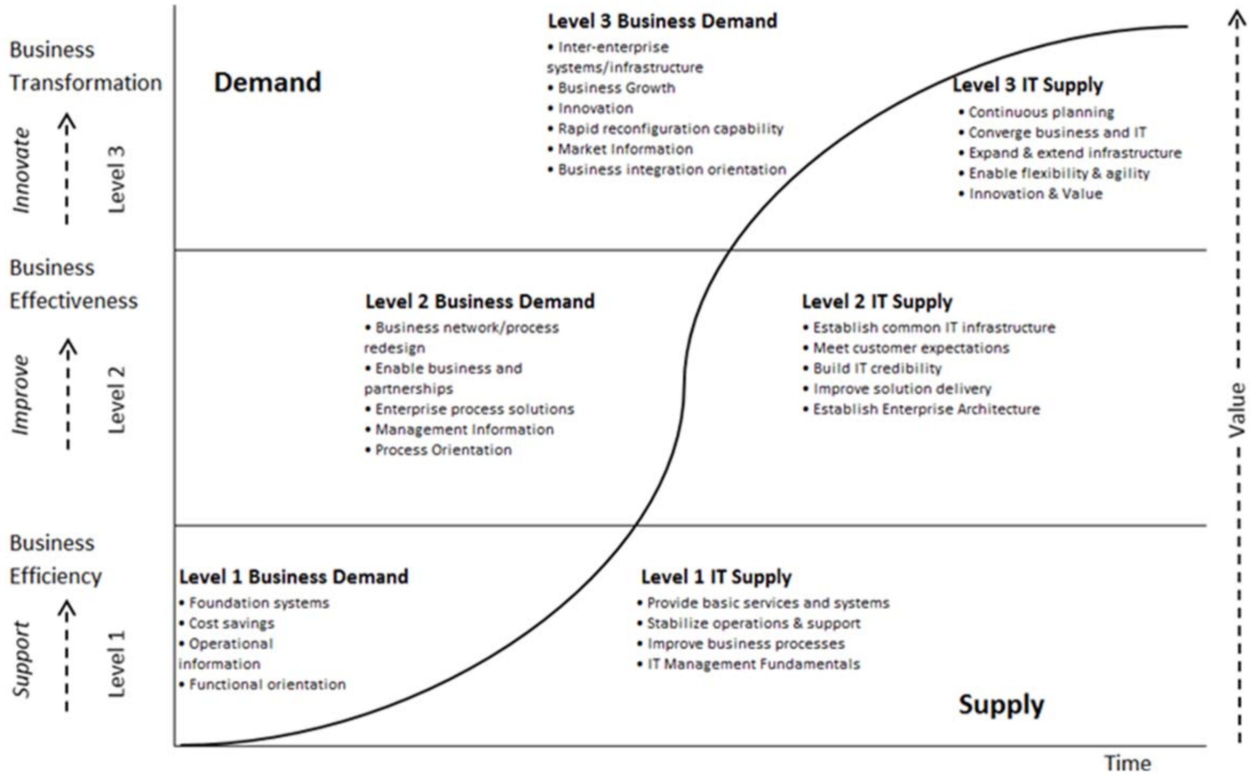

Figure 1. The Business-IT Maturity Model (Pearlson & Saunders, 2007)

2.2.2 Level 2: Business Effectiveness

At level 2, organizations shift their focus from cost to enterprise process awareness. Initiatives at level 2 aim at increasing business integration for the company to become more effective as an enterprise and to break down the silo mentality at level 1 (Pearlson & Saunders, 2007), which is typically accomplished via implementing enterprise-wide systems, pursuing business process improvement (BPI) and reengineering (BPR) initiatives, and establishing a common IT infrastructure. This focus also implies a shift from a technical orientation at level 1 to a more business-oriented view, which lowers total IT costs, reduces redundancy, and supports business integration through IT customization. IT sourcing shifts to a more flexible and integrated approach with a limited set of strategic partners, and basic IT services are often outsourced (Pearlson & Saunders, 2007).

2.2.3 Level 3: Business Transformation

IT-enabled business growth, innovation, and collaboration are topics typically addressed at level 3. In continuation of level 2, the focus extends beyond the organization itself and emphasizes business partner collaboration and rapid experimentation—both with other business units and with customers and suppliers (Pearlson & Saunders, 2007). Rather than delivering service, the IT organization generally focuses on co-creating value in collaboration with the business. The role of IT shifts from being a service provider to becoming a business partner by, for instance, enabling business agility (Pearlson & Saunders, 2007). Critical IT assets are structured and managed as a portfolio of capabilities to innovate quickly and seize new opportunities. IT is a tool to be used as part of the organization's value proposition and the enterprise architecture is used as a flexible platform with standard interfaces to business partners, which emphasizes business agility. The goal of IT is to maximize value realization of information, technology, and technology-based initiatives for the business (Pearlson & Saunders, 2007).

In Section 3, we present our approach to analyzing and categorizing the existing literature.

3 Review Methodology

We based our research methodology largely on Webster & Watson's (2002) overall guidance on how to write a literature review. They argue for systematic and synthesized reviews based on concept-centric frameworks. Furthermore, Okoli and Schabram (2010) stress the importance of 1) applying a systematic review approach, 2) explicitly explaining the process, 3) being comprehensive in scope, and (4) ultimately securing reproducibility, which allows others to follow the same approach in reviewing the topic (Okoli & Schabram, 2010). In addition to Webster & Watson's guidance, we were inspired by Müller and Ulrich (2013) and followed them in adhering to Okoli and Schabram's (2010) step-by-step guide to conducting systematic literature reviews in the information systems (IS) field.

We chose the Web of Science and Scopus databases for this particular review. Combined, the two databases complement each other both thematically and geographically. Both contain comprehensive collections of academic research spanning numerous research fields and multiple geographical regions. Covering journal publications since 1869, they support an in-depth review of the literature.

3.1 Searching for the Literature

We searched for papers on cloud computing in journals in the IS field. However, since IS is an interdisciplinary field (Webster & Watson, 2002), a comprehensive review necessitates a broader view. Therefore, we searched for cloud computing literature beyond the social sciences and humanities to also include computer science. Figure 2 illustrates our literature search and selection process.

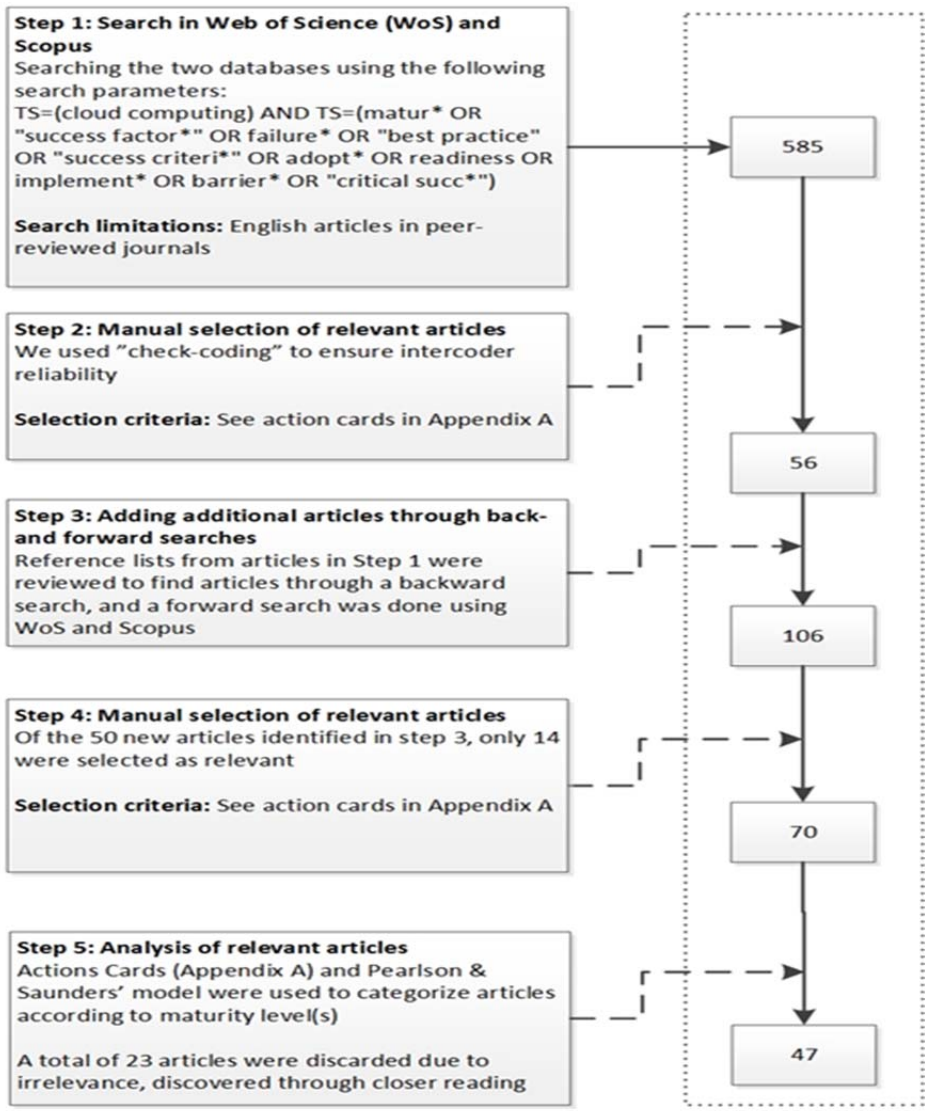

Figure 2. Literature Search and Selection Process

3.1.1 Step 1

We began the review process in May 2013 and limited it to peer-reviewed papers in academic journals published in English. As such, we excluded books, conference proceedings, reviews, and so on. We combined “cloud computing” with additional search terms that encapsulate best practice or guidelines with respect to cloud computing. We used the following search string: *TS=(cloud computing) AND TS=(matur* OR "success factor*" OR failure* OR "best practice" OR "success criteri*" OR adopt* OR readiness OR implement* OR barrier* OR "critical succ*")*. The search yielded 585 papers across more than 250 journals.

3.1.2 Step 2

We strictly followed Okoli & Schabram’s (2010) advice for screening papers. We screened the papers by using three action cards (see Appendix A) to discard non-relevant papers. By using these action cards, we were able to identify relevant papers that 1) concerned information technology, 2) focused on cloud computing as the main topic, and 3) emphasized organizational and managerial aspects. The third action card enabled us to sort out, for example, papers with technical foci not dealing with cloud computing benefits. Similarly, we omitted papers that focused on compliance and regulatory aspects of cloud computing (third action card) because they focused on challenges in adhering to technology standards rather than benefits to the business. Examples include Farrell (2010) who discusses governance, risk, and compliance issues related to ensuring service-level agreement compliance in a cloud computing context and Takabi et al. (2010) who focus on jurisdictional and law enforcement issues of widely dispersed cloud computing resources. Appendix A shows the action cards. Through this step, we identified 56 relevant papers out of the 585. Furthermore, we applied check-coding to ensure consensus among the reviewers. Intercoder reliability was subsequently estimated at around 85 percent, which is close to the suggested 90 percent and above the average 70 percent (Miles & Huberman, 1994).

3.1.3 Step 3

We followed Webster & Watson (2002) in conducting forward and backward searches to further strengthen the literature review’s reliability. The forward search resulted in 9 papers, while the backward search yielded 41 papers.

3.1.4 Step 4

With these additional 50 papers, we repeated the screening process (step 2), which resulted in our deeming 14 of the 50 papers as relevant for our study.

3.1.5 Step 5

During the final step of the search and selection process, we read all 70 papers. As a result, we discarded another 23 papers because they did not focus on organizational or managerial aspects of cloud computing despite abstracts to the contrary and, thus, failed to meet the third selection criteria (see Appendix A).

We analyzed the final pool of 47 papers and categorized them according to the maturity levels in Pearlson & Saunders’ (2007) model. We elaborate on the process of categorizing and analyzing in Sections 3.2.

3.2 Analyzing the Literature

To analyze and categorize the literature, we searched the papers for examples and case descriptions related to the business and IT characteristics described by Pearlson & Saunders (2007). More specifically, we searched papers at the level of sentences and paragraphs, with some paragraphs relating to more than one characteristic. An example of such ambiguity and richness is seen in Berman, Kesterson-Townes, Marshall, and Srivathsa (2012, p. 28):

> *Organizations are not only relying on cloud services to enhance internal efficiencies, but also to target more strategic business capabilities. In fact, our respondents’ number-one objective for adopting cloud services is an external capability—that of increased collaboration with external partners.*

However, although the quote has much in common with the characteristics of level 1 and 3, from a broader perspective, the paper deals with cloud computing as a driver for business transformation and innovation (level 3) and not merely business efficiency (level 1). As such, we categorized it as relating to level 3. In a similar vein, we categorized the 47 papers according to the three maturity levels in Pearlson & Saunders' (2007) model. However, some papers addressed several benefits and were related to more than one maturity level. Misra and Mondal (2011) is an example of such a paper because it equally addresses the cost reduction benefit of level 1 and how cloud computing may enable a company to focus on core competencies at level 2.

3.3 Research Limitations

Despite adopting a rigorous approach to reviewing the literature, we face the risk of having overlooked important contributions by excluding books and conference papers from the search because the latter, in particular, often report preliminary results of ongoing research. Since cloud computing as a research topic is still embryonic in nature, it stands to reason that results are currently being presented at conferences before finding their way into peer-reviewed journals. However, assessing the quality of research in progress reported in, for example, conference proceedings is an arduous and error-prone task. By limiting the review to peer-reviewed papers published in academic journals, we focus on mature research adhering to the high-quality standards of these research publication outlets—a pragmatic approach to reviewing the literature, which, in turn, ensures quality in the reported findings.

Another limitation is in our using Pearlson & Saunders' (2007) model. We used the model to categorize the literature, but several papers were not limited to only one maturity level, which made analysis based on their framework a challenge. Furthermore, the model adopts a classical perspective according to which the business side of organizations demands IT resources as re- or proactive responses to changing market conditions, which implies a curvilinear relationship (see Figure 1) between IT supply and demand. Researchers have argued that cloud computing alters this relationship because consumption is not constrained by access anymore since companies have limitless supply of best-of-breed IT services over the Internet. Consequently, the notion of increasing "maturity" is drawn into question because traditional constraints on resource availability are eliminated and IT supply is no longer dependent on business-IT maturity but is a bountiful resource commodity such as electricity and water. Although we acknowledge this criticism, Pearlson & Saunders' (2007) model provides a useful classification of different levels of benefits that is instrumental in investigating the link between the use of cloud computing technologies and business benefits. We use the model as an analytical framework without assuming that attaining low-level benefits is a necessary precondition for high-level benefits. In other words, we recognize the possibility of leapfrogging maturity levels and reaping the associated benefits.

4 Literature Findings

From our literature search, we identified 47 papers across the three business-IT maturity levels and Table 1 presents our findings. Figure 3 illustrates the distribution of papers across maturity levels.

The distribution of papers shows an interesting result; namely, that the third level of cloud computing concerning business transformations has not received as much attention as more basic applications of the technology. While 41 percent of the literature spoke about how cloud computing may create business efficiency and 40 percent focused on business effectiveness, only 19 percent were related to level 3 (i.e., innovation and business transformation). This distribution shows that, in investigating this relatively new phenomenon, scholars have focused on simple uses and benefits of cloud computing technologies. Table 1 presents the review results: it distinguishes between three levels of benefits and various themes for each level. These themes emerged through synthesizing the literature and outline central categories of benefits described in the papers.

In Sections 4.1 to 4.3.3, we elaborate on each of the eight themes to describe trends across the existing literature on cloud computing.

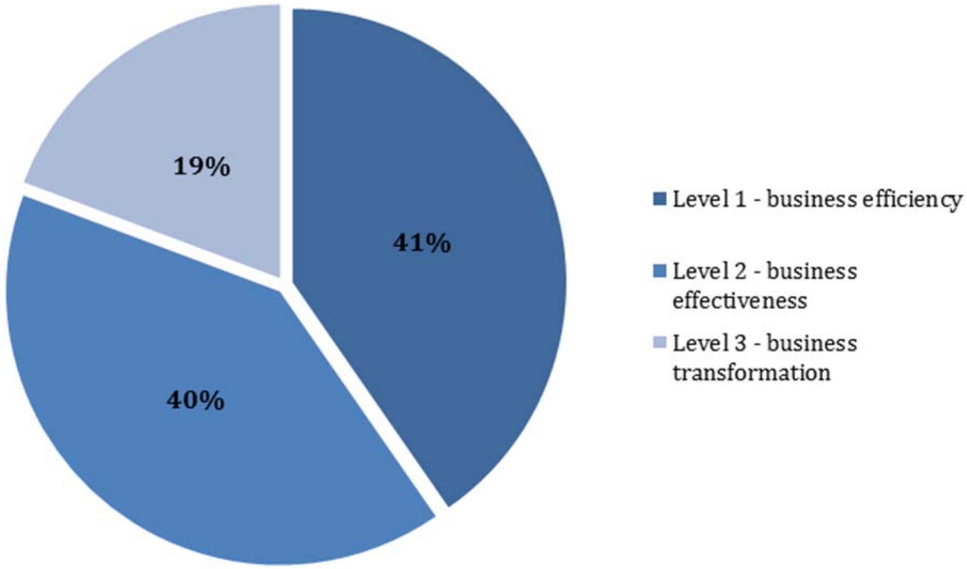

Figure 3. Distribution of Papers across Maturity Levels

Table 1. Literature Findings

Level	Theme(s)	Authors(s)
Level 3: innovate: business transformation	Business growth through innovation	Berman et al. (2012), Kambil (2009), Liang & Wen (2011), Subramanian (2012)
	Agile capabilities	Berman et al. (2012), Buttell (2010), Kloch, Peterson, & Madsen (2011), Marston et al. (2011), Xu (2012)
	Business partner collaboration	Berman et al. (2012), Lai, Tam, & Chan (2012), Li et al. (2012), Subramanian (2012), Zaerens (2012)
Level 2: improve: business effectiveness	Enhanced intra-enterprise collaboration	Arinze (2012), Lin & Chen (2012), Low, Chen, & Wu (2011), Pang (2009), Park & Ryoo (2013), Sultan (2010), Sun (2013), Thomas (2011), Xu (2012)
	Business integration & common IT infrastructure	Armbrust et al. (2010), Chen & Liou (2012), Corsello (2012), Garg, Arora, & Gupta (2011), Goth (2011), Grossman (2009), Li, Wang, Wu, Li, & Wang (2011), Liang & Wen (2011), Luo (2012), Marston et al. (2011), Park & Ryoo (2013), Tsukahara, Takao, Tsuji, Hitsho, & Futoshi (2010)
	Focus on core competencies (business effectiveness)	Corsello (2012), Lee & Kim (2013), Lin & Chen (2012), Loebbecke, Thomas, & Ullrich (2012), Misra & Mondal (2011), Thomas (2011), Xu (2012)
Level 1: support: business efficiency	Cost reduction	Armbrust et al. (2010), Benlian & Hess (2011), Brandabur (2013), Buttell (2010), Cleverley (2009), Creeger (2009), Galih (2012), Han (2010), Khajeh-Hosseini, Greenwood, Smith, & Sommerville (2012), Kim (2009), Kim (2011), Lee & Kim (2013), Li et al. (2012), Marston et al. (2011), Misra & Mondal (2011), Sharif (2010), Sultan (2010), Sultan (2011), Walters (2012), Zhang et al. (2010)
	Business process efficiency	Behrend et al. (2011), Chang, De Roure, Wills, Walters, & Barry (2011), Kuo (2011)

4.1 Level 1: Business Efficiency

Among the 47 papers, the question of how businesses achieve efficiency was primarily investigated from a cost-savings perspective based on the general premise that a vendor's specialization (and, to a certain degree, standardization) and economy of scale will, all things being equal, permit a lower price per unit and, thus, make it desirable for customers to buy the services (Benlian & Hess, 2011; Marston et al., 2011). Moreover, a total of three studies focused on how cloud computing can create business efficiency by facilitating more efficient processes. The literature reveals that cloud computing creates business efficiency in two areas; namely, "cost reduction and variabilization" and "business process efficiency".

4.1.1 Cost Reduction and Variabilization

In total, 20 papers focused on how cloud computing can be a valuable tool in reducing both investment costs (CAPEX) and ongoing operation costs (OPEX) in the pursuit of business efficiency. Cost savings is a key factor behind many companies' decision to adopt cloud computing (Benlian & Hess, 2011; Creeger, 2009; Sultan, 2010; Zhang et al., 2010). According to Sultan (2010), this is most likely a consequence of the current financial crisis, which means that the economic crisis of the late 2000s and onward has been a catalyst for the adoption of cloud computing. Moving to the cloud is a popular strategy to alleviate upfront investments in expensive hardware and infrastructure due to its pay-per-use nature (Sharif, 2010), which allows companies to pay only for the amount of computer resources and services they use (Armbrust et al., 2010; Han, 2010; Kim, 2009; Zhang et al., 2010). This change in the IT cost structure and the possibility of avoiding heavy CAPEX investments and inadequate funding make it possible for companies to implement a "zero-to-a-million-miles-an-hour" business plan overnight (Creeger, 2009). Moreover, the benefit of cost reduction directly supports business agility at maturity level 3. The nature of cloud computing reduces the need for capital investments (Han, 2010; Kim, 2009; Marston et al., 2011; Walters, 2012; Zhang et al., 2010), which is particularly interesting to small and medium-sized enterprises (SMEs) and start-ups that would otherwise not have access to cutting-edge technology and services due to limited capital (Kim, 2011; Li et al., 2012; Sultan, 2010; Sultan, 2011). The added benefit to start-ups is not having to invest in IT infrastructure that easily becomes expensive legacy systems (Buttell, 2010; Misra & Mondal, 2011; Sultan, 2011). Some authors argue that this advantage also extends to developing countries that similarly may gain access to otherwise inaccessible technology due to the lower investments needed (Cleverley, 2009; Marston et al., 2011; Sultan, 2010). In other words, start-ups, SMEs, and developing countries should pay attention to the benefits of the OPEX model since they have the least amount of upfront capital available for investment and are not burdened by IT legacy systems.

Adopting an OPEX model also transfers some of the business risks associated with running the IT systems, such as hardware failure and increasing overhead costs, to the provider (Brandabur, 2013; Zhang et al., 2010). In partially migrating to the cloud, estimates show that cutting internal IT resources to 30 percent above average instead of allocating according to maximum consumption is sufficient to handle peak loads while significantly reducing the number of internal servers to maintain (Misra & Mondal, 2011). Thus, cloud computing can transform fixed costs—incurred regardless of whether resources are needed—to variable costs that are only charged whenever resources are used. An example of such a scenario is a data warehouse that is seldom needed 24-hours a day but maybe only two hours a week (Creeger, 2009). Because OPEX uses a pay-per-use scheme and avoids the risk of incurring additional maintenance costs, switching to an OPEX model is said to lower total cost of ownership (TCO) and optimize cash flow management (Benlian & Hess, 2011; Creeger, 2009; Li et al., 2012; Marston et al,. 2011; Sultan, 2010). The transfer of resource ownership means that companies do not have to deal with maintenance activities such as network optimization, tedious software updates, and security measures. Although the cloud solution still runs on a network with access points that need to be secured, these maintenance activities are typically outsourced to the vendors (Buttell, 2010). Such activities are not only costly but also take up time that could have been spent on value-adding activities—a perspective addressed at level 2 of the model. Without such maintenance activities, reduced labor costs are also likely since fewer IT employees are needed (Marston et al., 2011; Sultan, 2010).

Cloud computing also offers cost savings in terms of batch processing of data, the so-called "cost associativity" concept, because computations are done faster at the same cost. For example, using 1000 computers for one hour might cost the same as using one computer for 1000 hours (Armbrust et al., 2010; Li et al., 2012; Marston et al., 2011), which ultimately enables organizations to perform computations more cost-effectively. This concept is closely related to the next theme at level 1; namely, improving business processes to increase efficiency (see below).

Cloud computing can potentially provide a more cost-effective alternative to acquiring and maintaining large-scale systems operations in-house (Galih, 2012; Misra & Mondal, 2011; Sultan, 2010), and the overall cost savings enabled by cloud computing have even been referred to as the principle advantage of cloud computing (Kuo, 2011). However, moving from a CAPEX to OPEX model requires planning, and careful analyses should reveal whether, for example, IT resources that cost more per unit from the cloud provider are still preferable to purchasing IT resources when taking to degree of use and expected overhead into consideration (Armbrust et al., 2010). Furthermore, the cost of cloud computing might not be lower than, for example, on-premises IT with virtualization given a sufficient number of users.

4.1.2 Business Process Efficiency

The second stream of papers focused on improving process efficiency through cloud computing, achieved through a more efficient technical infrastructure. In general, cloud computing is a means to, or a platform for, automating concurrent tasks (Chang et al., 2011; Kuo, 2011), which reduces the time needed to carry out specific business processes and, consequently, increases efficiency (like the above-mentioned example of "cost associativity"). Platform as a service (PaaS) solutions often increase process efficiency, and Chang et al. (2011) provide the example of a healthcare service organization improving its technical infrastructure by shortening computational lead time[4] and, subsequently, optimizing process efficiency. The organization accomplished this task through automation to handle tasks concurrently, which reduced the overall processing time and the potential waiting time for system users. Another study, also focusing on health care services, argues that process optimization not only supports greater business efficiency but also eliminates tedious manual work and the possibility of human errors (Kuo, 2011). Cloud computing also speeds up systems deployment by reducing the need for major and sometimes slow changes to the IT infrastructure and, thereby, supports the process flexibility and changing business needs that characterize many modern business models (Kuo, 2011).

Behrend, Wiebe, London, and Johnson (2011) study cloud computing adoption in community colleges and identify factors impacting students' successful adoption of the technology as part of the e-learning tools the colleges used. With the purpose of facilitating student learning, their study reveals that integrating cloud computing into courses gives students greater flexibility and supports independent study, which is often needed in rural areas where students are more likely to have long commutes to class or full-time jobs, which makes it possible for them to study wherever and whenever possible (Behrend et al., 2011). By supporting communication and collaboration between students, instructors, and administration, cloud computing increases business process efficiency. Such efficiency may also be achieved through business process automation. Kuo (2011) provides the example of a cloud-based medical system connected to legacy equipment and sensors. The system delivers patient critical data in real-time round the clock to a medical center's cloud-based storage, processing, and visualization system, which enables the medical team to respond quickly.

4.2 Level 2: Business Effectiveness

We can divide the papers we identified at level 2 into the following themes: 1) intra-enterprise collaboration, 2) business integration and common IT infrastructure, and 3) core competencies. One paper mentions cloud computing as an enabler of improved effectiveness through greater IT resource availability and easier collaboration (Sultan, 2010). Cloud computing-enabled collaboration is not restricted to one industry or sector but includes both private companies and government agencies and institutions. For example, the Taiwanese Government and American colleges have also shown interest in cloud computing (Arinze, 2012; Low et al., 2011; Pang, 2009; Thomas, 2011; Tsui, Lee, & lin, 2010). Other studies show how cloud computing enables better data and process integration across an organization to free up organizational resources that can be invested in more value-adding activities (Chen & Liou, 2012; Li et al., 2011).

The literature addresses benefits of cloud computing related to business effectiveness in three groups; namely, "intra-enterprise collaboration", "business integration and common infrastructure", and "focus on core competencies".

[4] Chang et al. (2011) applied the capital asset pricing model (CAPM) and complex statistical computations to compare computational lead time before and after PaaS adoption.

4.2.1 Intra-enterprise Collaboration

Collaboration stimulates innovation and increases productivity because it is key to the majority of organizational tasks (Arinze, 2012; Low et al., 2011). Arinze (2012) also describes how deploying e-research [5] collaboration infrastructures stimulate innovation and serve to make researchers more productive by launching research projects faster due to greater interconnectivity between them. The benefits are, however, not limited to research. Large enterprises and public organizations also benefit from cloud office applications such as Office 365 due to their ability to enable cross-boundary collaboration without requiring high upfront investments (Pang 2009; Sultan 2010; Thomas 2011). In the pre-cloud era, users' information was usually associated with software available on a limited number of devices, which hindered higher productivity (Park & Ryoo, 2013). Cloud services deal with this “information dilemma” by seamlessly making documents available anywhere on any device (Park & Ryoo, 2013). Due to the increased globalization and the fact that many organizations are geographically dispersed, online collaboration is required. Because of services such as Facebook, YouTube, and LinkedIn—where the news flow is dynamic and constant—consumers expect purchasing related information to be pushed in real time (Park & Ryoo, 2013). In the past, collaboration and sharing documents necessitated face-to-face meetings. Today, however, collaboration is ever more complex and large projects require participants to contribute concurrently in real time from all over the world (Luo, 2012). Another benefit of cloud-based office applications such as Google Docs is that they avoid multiple versions of the same document existing side by side in an organization (Lin & Chen, 2012). Other scholars praise the emergence of cloud computing for providing a flexible platform for collaboration, data sharing, and transparency (Sun, 2013).

Cloud computing is a powerful tool in industries or fields of work that need a high degree of collaboration, data sharing, and transparency, such as in watershed management [6] where many independent government agencies have to collaborate (Sun, 2013). These technologies are particularly relevant to small enterprises with insufficient resources for large capital investments. Cloud computing is also quickly spreading to the manufacturing industry (Xu, 2012) and impacting business models and aligning product innovation efforts with business strategies while creating intelligent factory networks that encourage effective collaboration (Xu, 2012).

4.2.2 Business Integration and Common Infrastructure

Virtualization and cloud computing are accelerating the commoditization of IT (Chen & Liou, 2012) and helping streamline operations and services (Liang & Wen, 2011). Consequently, companies have more resources to invest in innovation while improving current IT services (Chen & Liou, 2012), which has implications for IT's role in an organizational context since focus shifts from operational maintenance to improved service delivery (Marston et al., 2011). Cloud computing presents a dynamic, Internet-optimized infrastructure for hosting applications and has the potential to eliminate many support issues via minimizing maintenance of physical infrastructure (Li et al., 2011). Similarly, when a provider handles operational maintenance, cloud applications and their users benefit from more frequent service updates because the provider's investment is channeled into application upgrades and improvements (Corsello, 2012). According to Corsello (2012), the result is more dynamic and customer-centric technologies, which is configurable and adaptable to processes, organizational structures, and changing business needs of contemporary organizations.

Tsukahara et al. (2010) write that standardizing the IT landscape for more easily integrating resources through virtualization (e.g., hardware, software, and networks) is an important part of cloud computing. Optimizing IT resource use through enterprise-wide consolidation often comes at the price of local flexibility. However, IT resources can be shared across organizational boundaries through virtualization (e.g., between government agencies), which leads to better asset use as the amount of unused resources in individual IT departments is minimized by consolidating resources into a single pool (Goth, 2011). Most cost savings through cloud computing are indeed enabled by resource consolidation and technical scalability offered by virtualization, whereas resource use is optimized across both peak and off-peak periods (Garg et al., 2011; Marston et al., 2011). A prerequisite for this elasticity in allocating resources is the response time in adding or removing resources that should be measured in minutes rather than weeks

[5] A term describing virtual research collaboration via using IT (Arinze, 2012).
[6] The discipline of controlling water supply, water quality, drainage, stormwater runoff, and water rights to and from a river, creek, ocean, and so on (Sun, 2013).

(Armbrust et al., 2010). However, standards adopted by one provider, community, or single organization may differ from those of others and, thus, inhibit integration and optimization across boundaries (Grossman, 2009). Grossman (2009) further suggests that the cloud industry find inspiration in how Internet standards were developed in efforts to overcome “silos of clouds”. Such standardization would further optimize cloud benefits in terms of better asset utilization and enable novel applications. Similarly, Li et al. (2011) address the challenge of integrating multiple cloud solutions with intra-enterprise IT, and, although manual integration is possible, large-scale communication should be automated to enable scalability and optimization of asset use. In summary, Goth’s (2011) discussion of asset use and optimization through virtualization argues for technically integrating different parts of a company to allow for higher business effectiveness, and Grossman (2009) elaborates on Li et al.’s (2011) concerns regarding the possibility of establishing a common infrastructure by standardizing cloud computing technology.

4.2.3 Core Competencies

Effectiveness is the degree to which a goal is achieved, which requires the organization to focus on its core competencies. At level 2, commodity IT is outsourced or integrated into the cloud to free up resources that can be refocused on core competencies (Lin & Chen, 2012; Loebbecke et al., 2012) and, thereby, deliver better services to business stakeholders (Misra & Mondal, 2011). Cloud users do not, for instance, deal with purchasing, configuring, administering, and maintaining their own IT infrastructure, which, in turn, allows them to focus on value-creating activities (Thomas, 2011). Misra and Mondal (2011) put forward a similar argument by stating that development and improvement of products and business proposals can be prioritized when a cloud vendor provides the infrastructure, maintenance, and resources. In addition to resource provisioning, Lee and Kim (2013) illustrate how cloud computing has made managing personnel resources in the Korean Government more efficient. Along similar lines, Corsello (2012, p. 30) argues that:

> *cloud computing can help HR specialists to overcome many of the barriers to effective talent management, because it can help to address key issues of accessibility, affordability, timeliness, ease of use and integration. Moreover, it offers a technological solution that can change organically in step with the organization’s own changing needs.*

Moving from production-oriented manufacturing to service-oriented manufacturing, cloud manufacturing provides plug-and-play capabilities and supports manufacturing capabilities:

> *Manufacturing capabilities are intangible and dynamic resources representing the capability of an organization undertaking a particular task with competence. These may include product design capability, simulation capability, experimentation, production capability, management capability, and maintenance capability* (Xu, 2012, p. 79).

Cloud computing can, thus, help an organization free up resources to focus on being better and more effective and, thus, ensure improved service delivery (Corsello, 2012; Lee & Kim, 2013; Xu, 2012).

4.3 Level 3: Business Transformation

In general, the literature on how cloud computing enables business transformation drew on the philosophy behind service-oriented architecture and the decoupling of business processes from technological constraints and focused on loosely tied services. In addition, the literature described how technological advances in general will enable the creation of new products and markets (i.e., how IT-enabled innovations facilitates business growth). The literature reveals that cloud computing supports business transformation in three areas; namely, “business growth through Innovation”, “agile capabilities”, and “business partner collaboration”.

4.3.1 Business Growth through Innovation

Kambil (2009) notes that cloud computing enables companies to explore new ways of creating revenue by using Amazon as an example. He describes how Amazon’s existing capabilities in terms of online retail sales were further developed to offer new products such as Amazon Web Services (AWS) to new customers and new markets. By building on existing company capabilities, Kambil (2009) argues that the increasing level of Internet-connected devices and he Internet of things[7] will create new markets and new products for new customer segments with cloud computing as both an accelerator and enabler. As an example of this, 3M, the multinational conglomerate, has used cloud computing to eliminate the need for locally installed and highly specialized software on customers' computers and now offers the computational service online without requiring any installation of software, which has increased 3M's revenue because it is now able to reach new customers in new markets (Berman et al,. 2012). Subramanian (2012) emphasizes how cloud computing enables new business opportunities and gives the example of how pharmaceutical companies in cooperation with Hewlett Packard (HP) have used the technology to track counterfeit products around the globe. The innovation of such "real-time product assessment" is made possible by the data sharing capability of the cloud not previously accessible.

By using cloud computing, new start-ups and small organizations can deploy whole new business models to differentiate themselves in the market place by, for instance, exploiting the reduced need for IT investments (Creeger, 2009). They capitalize on common, optimized infrastructures to free themselves from routine tasks and to focus on developing core capabilities (Subramanian, 2012). Liang et al. (2011, p. 385) likewise characterize cloud computing as "a model where new business opportunities can be created" and describe how the Taiwanese Government has embraced cloud computing to offer better services to its citizens not otherwise technologically possible. The new opportunities are largely made possible due to cross-agency integration and accessibility offered by cloud computing and due to general IT advancements that have triggered a new demand for faster and richer government services. Thus, cloud computing may help enhance, extend, and invent new customer value propositions while also improving, transforming, and creating new value chain models (Berman et al., 2012).

4.3.2 Agile Capabilities

As we describe previously, cloud computing supports the consolidation of enterprise-wide IT resources. The technology, however, may also support local and adaptive capabilities by using virtual integration to swiftly allocate IT resources to specific business processes whenever needed. Kloch et al. (2011) discuss how cloud computing may enable such agile business processes based on a low-cost, flexible, and scalable infrastructure platform. Establishing such an infrastructure requires standardization and a shared vision of common business processes that separates logical business processes from physical technology to facilitate management of the infrastructure (Kloch et al., 2011), which is also known as the concept of a service-oriented architecture—a key benefit of cloud computing (Kloch et al., 2011; Marston et al., 2011; Xu, 2012). Such agile and scalable capabilities—enabled by the virtual integration of IT resources to promote local flexibility—make IT a competitive tool that enables companies to meet customer demands promptly by seamlessly creating, moving, and dissolving services on the go as needed (Buttell, 2010; Marston et al., 2011). For example, the popular provider of on-demand Internet streaming Netflix takes up a third of North American Internet traffic during peak hours between 9 and 12pm and appropriately up- and downscales resources accordingly through their cloud platform (Berman et al., 2012).

4.3.3 Business Partner Collaboration

As an enabler of more extensive business partner collaboration, some authors referred to cloud computing as knowledge networks and saw it as the latest generation of knowledge management systems that extend beyond organizational boundaries (Lai et al., 2012; Zaerens, 2012). Zaerens (2012) states that cloud computing empowers public authorities through greater information sharing, especially during times of crisis where, for example, military, police, healthcare, and other services must work closely together to deal with threats, disasters, and other emergencies. Berman et al. (2012) provide a similar example of horizontal value-chain collaboration with the example of HealthHiway, a cloud-based health information system that connects more than 1100 hospitals and 10000 doctors for exchanging information and facilitating transactions among healthcare providers, employers, patients, practitioners, third-party administrators, and patients in India. By harnessing the power of Web services to create cross-boundary networks, cloud computing also enables SMEs to collaborate through interconnected networks to spur innovation (Moch, Merkel, Günther, & Müller, 2011). According to Moch et al. (2011), trust is crucial, but, by participating in cross-boundary networks, companies benefit from the innovations and creative input of others by sharing information themselves.

[7] A somewhat vague concept that refers to the basic idea that things and objects around us are increasingly communicating and cooperating wirelessly (Atzori, Iera, & Morabito, 2010).

Furthermore, as Li et al. (2012) show, cloud computing may also create vertical value-chain collaboration spanning multiple organizations and partners across the entire value chain from supplier to customer. Their study suggests that Cold Chain Logistics[8] may greatly benefit from the open structure of the cloud where customers and vendors can access the same systems and databases and so increase and improve collaboration. Similar collaboration opportunities are found in research and development departments in pharmaceutical companies that benefit from using the cloud as collaboration network. Peers outside the company's usual network can submit ideas, results, and innovations for the company to consider (Subramanian 2012).

5 Discussion

This literature review highlights the applications and benefits of cloud computing across the three maturity levels of Pearlson & Saunders' (2007) business-IT maturity model. In doing so, we answer Yang & Tate's (2012) call for further research that acknowledges the differences across cloud computing applications and explores the implications for businesses. Among the questions that Yang & Tate (2012) raise includes how cloud computing impacts IT management practices and whether cloud computing improves IT business alignment and IT agility (Yang & Tate, 2012)? Our research addresses these questions from the perspective of increasing cloud computing maturity and benefits. Our research reveals implications for both practitioners and researchers, and, in Section 5.1, we discuss propositions for practice in terms of how companies may realize benefits as they adopt and mature when applying cloud computing technology. Subsequently, in Section 5.2, we point to avenues for future research to validate and extend our findings.

5.1 Implications for Practice

While the studies in our sample raise many concerns, some also argue that firms need to move from the fundamental decision of adoption to managing the adoption and use of cloud computing because adoption is inevitable because employees are already using cloud services such as Gmail, OneDrive (formerly SkyDrive), or Dropbox in their private lives, which forces companies to adopt the same technologies (Goth, 2011). Therefore, companies not adopting cloud computing will experience "shadow IT" costs as employees circumvent or change business processes by implementing non-authorized technology such as file sharing through Dropbox. Such actions affect IT budgets and may lead to vulnerability. Lin & Chen (2012) describe such a scenario by detailing how employees in one organization used Google Docs to share documents against company policy. Increasingly, employees expect progressive IT policies (e.g., bring your own device (BYOD)) that allow them to access privileged enterprise data and systems using personal devices. Therefore, companies should embrace the technology and not ask "should we use cloud computing?" but rather "how do we use cloud computing?". Galih (2012) applies a simple method of determining value and readiness to pick IT services best suited for cloud computing, but Loebbecke et al. (2012), Kuo (2011), and Brandabur (2013) provide more detailed advice. Table 2 summarizes the propositions for practice, which we discuss in Sections 5.1.1 to 5.1.3.

Table 2. Propositions for Practice

Level 3: business transformation	• Embrace the changing role of IT and build digital capabilities required by new and disruptive technologies • Leverage the power of service-oriented architecture and virtualization in establishing a cloud-based Enterprise Architecture • Use cloud computing to drive management innovation
Level 2: business effectiveness	• Minimize risk of vendor lock-in by focusing on interoperability standards • Avoid cloud silos by using standardized virtual server catalogue • Ensure common cloud solution by facilitating a user-centric cloud strategy

[8] The distribution and logistics of temperature-regulated goods (Li et al., 2012).

Table 2. Propositions for Practice

Level 1: business efficiency	• Increase cost savings by mastering IT resource predictability • Adapt SLAs to the new cloud computing paradigm • Calculate ROI based on firm-specific variables as well as the nine listed context-independent variables to minimize unforeseen costs

5.1.1 Level 1: Business Efficiency

Reaching level 1 is largely a matter of achieving short-term operational benefits. Cashing in on these benefits depends on several factors.

First, actual cost savings depend greatly on the deployment model[9] (Brandabur, 2013), and meticulous analyses of expected financial benefits are necessary (Lee & Kim, 2013). Studies show that an in-house server costs about USD$800-1000 per month regardless of use, whereas renting similar computer power from a cloud provider costs about USD$72-108 per month (Creeger, 2009), which makes the potential cost savings apparent. These figures, however, simplify the cost savings. Khajeh-Hosseini et al. (2010), who compare the costs of outsourcing to a traditional data center, have made similar calculations: they conclude that the cloud is favorable in each of their nine compared scenarios. A comprehensive cost-benefit analysis is complicated by the number of variables in the utility billing model (Khajeh-Hosseini et al., 2012), but research indicates that a financial analysis must at least consider: 1) costs of establishing sufficient security, 2) reduction in management costs, 3) tangible cost savings in maintaining fewer assets and indirect savings such as energy consumption, 4) software license savings, 5) increased profitability from agile processes, 6) value of faster time to market, 7) increased profits due to higher customer satisfaction, 8) productivity improvements because of freed up resources and focusing on core competencies, and 9) savings in precautionary disaster recovery measures[10] (Misra & Mondal, 2011; Sultan, 2011). Using cloud computing solely to avoid CAPEX investments reflects a lack of understanding of its potential value. As with any investment, calculating return on investment is a decision making tool, and decisions based on incomplete information may in the context of cloud computing result in vendor lock-in, integration issues, and unmanageable cloud environments. Therefore:

- To minimize the risk of unforeseen costs, adopting companies must proactively 1) manage server (and virtual machine) sprawl[11], 2) ensure transparency in usage and funding of IT resources, 3) minimize vendor lock-in that limits integration of solutions across solutions, and 4) avoid lofty service-level objectives (SLOs) that cannot be linked to operational needs.

Second, successfully adopting cloud computing requires accurate IT resource predictability. By transitioning to cloud computing but sticking to the traditional “always-on” approach, companies do not fully exploit the financial benefits of the pay-per-use scheme that resource scalability and elasticity enable (Khajeh-Hosseini et al., 2012). Therefore, the greater the variation in demand for computer resources a company experiences, the larger the potential savings. However, when resources cannot be provided on demand, inefficiency and limited cost savings result. Optimization requires predictable resource demand for providers to be able to use and scale resources[12]—an overlooked premise of the OPEX and pay-per-use model of cloud computing (Armbrust et al., 2010; Khajeh-Hosseini et al., 2012). Researchers and other stakeholders are, however, currently working on optimal cloud resource provisioning (OCRP) models and algorithms to improve the predictability of cloud scaling (Caron, Desprez, & Muresan, 2010; Chaisiri, Lee, & Niyato, 2012). Therefore:

- Adopting companies must take proactive measures to ensure best resource use; companies should predict cloud resource demand to increase the likelihood of optimal provisioning that balances cost savings and flexibility.

[9] See Mell & Grance’s (2010) definitions of private, public, hybrid, and community clouds.
[10] Costs incurred when addressing unforeseen or uncontrollable disruptions to IT such as power failure, fire, or natural disasters that potentially cripple the entire organization.
[11] Many definitions of cloud sprawl exist. See, for example, ZDNet: “The uncontrolled use of public cloud services in a company with little or no input from management or IT” (see http://www.zdnet.com/article/just-when-you-thought-it-was-safe-to-byoc-now-theres-cloud-sprawl/).
[12] “Automatic computing” could in theory eliminate the need for pro- or reactive human involvement, but it is not yet ready for implementation due to technical challenges (Zhang et al., 2010).

While providing short-term on-demand resources is essential to cloud computing, reserving resources in the long term is generally cheaper because the provider is paid in advance (Chaisiri et al., 2012). Companies should, therefore, seek to strike a balance between maximizing resource flexibility and minimizing resource costs by understanding that minimizing total cost of resources requires (accurate) estimating the cheaper long-term resource reservation to reduce the need for more expensive on-demand resources.

Last, service-level agreements (SLAs) give added complexity in engaging with vendors and using their services. Shifting away from the CAPEX model of long-term investments in IT assets may seem desirable to shareholders and investors when looking at the balance sheet, but it is imperative to remember that, regardless of asset ownership, quality of service and associated costs still need managing. Hence, SLA requirements and vendor collaboration should be given close attention (Kim, 2009). Cloud computing performance is often measured by the corresponding SLA (Chang et al., 2011) and, since the pay-per-use scheme is a cornerstone of cloud computing, such SLAs tend to focus on optimizing usage per hour from an operational perspective. A clear drawback is the lack of strategic focus with cost savings detracting attention from long-term infrastructure efficiency and other benefits associated with maturity level 2 and 3. Furthermore, IT service management is essential because cloud computing is not a silver bullet that solves traditional IT issues by merely transferring IT beyond company boundaries. Moreover, reaching a desired service level may entail "hidden costs" due to, for example, network upgrades, change management (Lin & Chen, 2012), shifts in bargaining power, changing requirements, or poor service-level management (Benlian & Hess, 2011). Performance measurements and desired service levels depend heavily on the service model (PaaS, IaaS, and SaaS)—see Alhamad et al. (2010)—and the customer must keep strategic direction in mind when drawing up the SLA. From a customer perspective, such agreements should 1) facilitate easy and swift calibration of agreements according to business results, 2) incorporate user feedback and ongoing customization needs, and (3) ensure remedial action if the provider fails to meet agreed-on service levels. Finally, SLAs should not restrict the customer from changing cloud provider by locking the customer in long-term relationships. Therefore:

- Adopting companies need to implement service-level management mechanisms to cope with complex cloud computing provider relationships.

Added complexity introduced by the cloud includes how to manage pay-per-use billing, data's geographic location (often unknown to the customer but subject to local laws), and remedial action if agreements are not honored[13].

5.1.2 Level 2: Business Effectiveness

Moving to the next level requires more than excelling at level 1 activities. The organization has to do new things and perform old activities in new ways (Pearlson & Saunders, 2007). Level 2 focuses on deploying a common infrastructure and ensuring seamless interoperability between different systems in the organization as the focus shifts from business silos to the enterprise level.

Standards are key to innovation because they establish the foundation on which new products and technologies are developed. The importance of standards applies to cloud computing in terms of ensuring that the underlying technologies are interoperable both with each other and with legacy systems (Brandabur, 2013; Mell & Grance, 2010). Organizations should be able to shift from private to public clouds without rewriting a lot of code (Kuo, 2011), but this is not yet the case on today's cloud market. Several professional organizations are, therefore, working on developing common cloud computing standards, including:

- The Standards and Interoperability for e-Infrastructure Implementation Initiative (SIENA) (see http://www.sienainitiative.eu): coordination among various national and pan-European initiatives to break down interoperability barriers impeding cloud implementation.
- The National Institute of Standards and Technology (NIST) (see http://www.nist.gov): non-regulatory agency of the U.S. Department of Commerce spearheading the development of cloud computing standards, including security, interoperability, and portability requirements.

[13] Cloud outages are not uncommon and, because such outages often affect multiple companies, the consequences may be severe if services are unavailable for an extended period of time (Kim, 2009; Lin & Chen, 2012).

- Key members of the cloud community have worked together to produce the Open Cloud Manifesto establishing a "set of core principles that ensure that organizations will have freedom of choice, flexibility, and openness as they take advantage of cloud computing. While cloud computing has the potential to have a positive impact on organizations, there is also potential for lock-in and lost flexibility if appropriate open standards are not identified and adopted" (http://www.opencloudmanifesto.org). With more than 400 supporting and trendsetting companies, the Open Cloud Manifesto exerts influence in the fight for open cloud standards.
- The International Organization for Standardization (ISO) (see http://www.iso.org): an independent, non-governmental organization of members from national standards bodies (NSBs) of 163 countries. ISO is the world's largest developer of voluntary international standards and works on several cloud computing standards such as the ISO/IEC 27018: 2014[14], which focuses on how to protect personally identifiable information (PII) in public cloud computing environments.

However, because common standards are yet to be adopted, customers are often reluctant to commit to a single vendor and bestow control of critical applications/business processes to cloud providers (Taher, Nguyen, Lelli, van den Geuvel, & Papazogloum, 2012; Xu, 2012). The absence of standardization across cloud vendors results in lack of interoperability, high switching costs, and potential vendor lock-in (Brandabur, 2013; Kim, 2009; Taher et al., 2012). Furthermore, the lack of common standards is believed to lock-in cloud customers with vendors charging more and more over time for the use of proprietary systems (Marston et al., 2011; Sultan, 2010). Therefore:

- Adopting companies should choose a cloud provider that supports interoperability standards, which minimizes the risk of vendor lock-in in the long run. Companies should check whether their business partners support the Open Cloud Manifesto or not[15].

Organizations can expect more "shadow IT" with the increasing adoption of cloud solutions as business units bypass the IT department and order off-the-shelf applications fitting their purposes but with little consideration for the existing IT architecture. Software as a service (SaaS) solutions, such as SalesForce.com's CRM service, are relatively easy to implement and could cause what is known as "cloud sprawl" if not managed properly. An example of this is the more than 30 different uses of SalesForce.com in the same organization, none of which was connected nor audited (Walters, 2012). Therefore:

- To avoid "cloud sprawl", CIOs and their business counterparts need to cooperate in formulating a cloud strategy that uses the flexibility of the technology while ensuring a manageable architecture. We recommend a user-centric cloud strategy that embraces the possibilities of the cloud while ensuring sufficient data protection, interoperability, and privacy.

The risk of such sprawl is not limited to off-the-shelf SaaS solutions but also applies to an organization's virtual environment (whether hosted externally by a cloud provider or internally as a private cloud). Some scholars argue that standardization through virtualization breaks down technological barriers of incompatibility and that virtual integration of IT resources minimizes the resource overhead of individual businesses (Tsukahara et al., 2010). However, others point to difficulties in integrating cloud solutions into existing IT architectures (Armbrust et al., 2010; Grossman, 2009; von Solms & Viljoen, 2012). Since creating virtual machines (software-based emulation of computers) is trivial, many organizations risk ending up with more servers than can be managed effectively. Therefore:

- Adopting companies should establish a standardized IT service catalogue from which employees can choose different options.

Such standardization enforces a uniform server landscape, which facilitates maintenance and control and helps avoid virtual server sprawl. If each server instantiation is tailored to individual needs, savings from virtualization are lost due to configuration and management costs. Incidentally, this recommendation is in harmony with other best practices regarding IT management as described in, for example, the Information Technology Infrastructure Library (ITIL).

5.1.3 Level 3: Business Transformation

Although many companies constantly strive to innovate and gain competitive advantages by using technology, this goal is not achieved through the efforts of the business or IT side of the organization

[14] See for example http://www.iso.org/iso/catalogue_detail.htm?csnumber=61498.
[15] See http://www.opencloudmanifesto.org/supports.htm for the full list.

alone. It is a shared responsibility requiring concerted efforts to change the organizational culture, mindset, and business processes. According to Pearlson & Saunders (2007), reaching the highest level of business-IT maturity depends on strategic alignment, a modularized enterprise architecture, governance mechanisms, and project portfolio management. The same is true for cloud computing, which we discuss from here.

First, the IT department's authority risks being undermined by cloud computing (Khajeh-Hosseini et al., 2012) because the role of project and business-IT relationship managers is changing. A case in point is BP in which a team bypassed the internal IT department and used Amazon Web Services (AWS) to meet customer demands (Khajeh-Hosseini et al., 2012). Industry reports show that CIOs are increasingly reporting stories like this[16], which reflects that IT is no longer involved in systems requirements definitions, development, and implementation activities because the cloud is increasingly turning "users" into "choosers" (Yanosky, 2010). The IT department's role is changing and somewhat unclear, and cloud computing is adding new responsibilities in terms of managing and procuring IT (Erbes, Motahari-Nezhad, & Graupner, 2012; Marston et al., 2011). Short-term business growth may be driven by innovative cloud solutions, but long-term growth requires that roles and responsibilities of the IT department are clearly defined. Therefore:

- Adopting companies should define the IT department's roles and responsibilities, adjust IT governance structures, and adapt business-IT alignment mechanisms to take cloud computing challenges and possibilities into account.

Based on existing literature (e.g., Dewett & Jones, 2001; Sambamurthy, Bharadwaj, & Grover, 2003), companies should proactively embrace the changing role of IT as emerging technologies such as cloud computing erase organizational boundaries and shift IT's role from enabling business efficiency and effectiveness to becoming a catalyst for product and organizational innovation. This change requires new roles, organizational routines, and contingency planning. For example, companies need to consider how to handle cloud outages since cloud providers such as Amazon and Google cannot be expected to prioritize any particular company. Furthermore, companies should focus on building capabilities that enable them to leverage technology and allow employees to fulfill new roles in a digital age (Dewett & Jones, 2001; Sambamurthy et al., 2003).

Second, the continued importance of enterprise architecture (EA) must not be forgotten. While level 2 addresses the need for IT service management (e.g., to avoid cloud sprawl), the goal at level 3 is an enterprise architecture that integrates external (cloud) and internal IT environments and supports business transformation (Ross et al., 2006). The focus on enterprise architecture allows companies to build on the benefits of business integration and common infrastructures at level 2 to increase business agility. However, the agile capabilities fostered by cloud computing should not be confused with local flexibility, which the many examples of cloud usage by low maturity-level companies illustrate. When departments or business units in large enterprises adopt services such as SalesForce.com's CRM system without taking enterprise-wide needs into consideration, local benefits are quickly reaped but the overall business value is limited. Additional value requires data and process integration at the enterprise level in support of end-to-end transactions. Without proper EA at level 3, scattered cloud adoption throughout the enterprise creates both "shadow IT" and information silos. However, since the enterprise architect no longer controls, for instance, data schemes, messaging formats, and API definitions, EA's role and responsibilities are changing. While EA's role in cloud computing is largely unexplored and currently being debated[17], sound EA is still important. Believing that cloud computing will eliminate the EA challenges of managing and organizing data, software, and infrastructure leaves the question about how to govern and integrate standalone services in support of the business. Cloud computing introduces new types of services, but EA is still required to organize and manage these services (Khan & Gangavarapu, 2009; Wang, He, & Wang, 2012). As one of the early EA pioneers, John Zachman, has stressed, underestimating the importance of architecture is a common mistake and companies run the risk of cloud sprawl (Zachman, 2011) and ending up being unable to deliver the agile capabilities essential to level 3. While the well-known Zachman framework and TOGAF version 9[18] try to incorporate cloud computing into their EA mechanisms, actual EA cloud computing frameworks are still gaining traction, such as Zhang and Zhou's (2009) cloud computing open architecture (CCOA) and Tang, Dong, Zhang, and Zhang's (2010) enterprise cloud

[16] For example PwC's report on "Opportunities and Roles in the Cloud" (PwC, 2011).
[17] Academic writing on the subject is mostly conference proceedings, indicating that it is an important yet relatively unexplored topic.
[18] Two of the most well-known EA frameworks, the Zachman and TOGAF frameworks, provide comprehensive approaches to designing, planning, implementing, and governing enterprise information architectures.

service architecture (ECSA). These frameworks suggest how the hardware and software resource sharing of virtualization and the reusability, extensibility, and flexibility of a service-oriented architecture may be incorporated into an architecture that supports global agility and local flexibility in maximizing cloud computing's business value. Therefore:

- In support of business transformation, companies must evolve their enterprise architecture to accommodate new cloud-based solutions by 1) considering the possibilities and limitations of cloud technologies, 2) adopting the key principles behind service-oriented architecture (SOA), and 3) using the power of virtualization to support the scalability and resource flexibility offered by cloud computing.

Finally, companies should not expect cloud computing to create sustainable competitive advantages by itself. Like any other innovation, using cloud computing for researchers believe neither product nor process innovation creates sustainable competitive advantages (Hamel, 2006). Though valuable, cloud computing is not a scarce resource (Mata, Fuerst, & Barney, 1995). Sustainable competitive advantages require that cloud computing is integrated into management processes to empower and support managers (Hamel, 2006). Reaching the highest level of cloud computing offers significant benefits, but failure may result in only short-term advantages easily copied by competitors. Amazon is an example of a company that, through strategic adaptation and management innovation, has managed to reinvent its business model by using cloud computing. Amazon started as a Web-based bookseller, grew into an online retail platform, evolved to a digital media house, and is now also a worldwide provider of cloud computing products (Hamel, 2013). Therefore:

- Adopting companies should look beyond the immediate operational and tactical benefits of cloud computing and use cloud technology in support of management innovation.

In the hands of visionary business leaders, cloud computing is a powerful tool that allows for business model innovation, which enables companies to transcend the limitations of both brick-and-mortar and click-and-mortar business models. Examples from the media include Adobe's Creative Cloud with their cloud-based desktop apps, OnLive's online video game streaming, and Box's cloud storage and sharing service. These and many other companies use cloud computing to offer new value propositions, create new revenue streams, provide services and products through digital channels, and quickly respond to changes in customer demands.

5.2 Future Research

Many authors have studied critical obstacles and corresponding opportunities of cloud computing (Benlian & Hess, 2011; Hochstein, Schott, & Graybill, 2011; Khajeh-Hosseini et al., 2012; Kloch et al., 2011; Kuo, 2011; Li et al., 2011; Lin & Chen, 2012; Loebbecke et al., 2012; Misra & Mondal, 2011), but none of these studies explicitly deals with the different levels of cloud computing maturity and associated benefits. The obstacles they identify, such as security concerns, data lock-in, resource scaling, and software licensing, are all operational concerns related to rather immature applications of cloud technology. Figure 3 shows the distribution of reviewed papers across three levels of maturity, and, while studies have explored issues and applications at all levels, we need more research to identify additional organizational and managerial obstacles in realizing the cloud computing benefits at each level. Such obstacles include, but are not limited to, the impact on governance mechanisms, organizational structures and stakeholders, alignment mechanisms, and strategic recruitment.

Furthermore, we found few empirical studies on cloud computing (Hoberg et al., 2012), and, because we based our findings solely on a review of the existing literature, our propositions need to be tested through future research (Gregor, 2006). We urge other researchers to undertake empirical research to validate and further develop our propositions, which is in agreement with Hoberg et al. (2012, p. 9), who emphasize that "empirical research on factors driving or inhibiting the adoption of cloud services, as well as research investigating its business impact, is limited".

Finally, we need for future studies that can provide cloud providers and customers with practical guidelines for strengthening enablers and reducing inhibitors. Such research includes—but is not limited to—design science research into models, methods, and tools for managing cloud-based systems or portfolios of systems (e.g., tools and methods for EA or IT service management). Such tools and methods are important in support of effective cloud governance (Hoberg et al., 2012).

6 Conclusion

Business and technologies are merging at an unprecedented level. Organizations are increasingly facing pressures to be more creative, innovative, sustainable, transparent, and to increase operational excellence while, at the same time, minimizing costs. The emergence of cloud computing offers new possibilities for organizations to cope with long-term and day-to-day challenges. We need to understand how to effectively apply and exploit the new cloud-enabled opportunities. Cloud computing enables organizations to both mitigate risks[19] in hostile business environments and use the technology for competitive advantages (Iyer & Henderson, 2010).

In reviewing the literature, we identify benefits across three levels of business-IT maturity (Pearlson & Saunders, 2007). In particular, our findings are based on a literature review of 47 papers, which we analyzed and categorized using our model. From synthesizing the literature, we discover the business benefits enabled, supported, and facilitated by cloud computing. Furthermore, we identifies success factors at each level and guides practitioners in how to move forward to successfully harvest the benefits of cloud computing in their organizations. We offer advice about operational activities such as mastering IT resource predictability, tactical activities to minimize the risk of vendor lock-in, and strategic activities of incorporating cloud computing into an existing enterprise architecture. Our review, analysis, and discussion identify diverging applications of cloud computing in contemporary organizations and contribute to establishing links between business applications and cloud computing benefits. We also mention potential avenues for future research on cloud computing: in particular, we emphasize that studies that itemize, validate, and ultimately extend the work presented in this paper are good starting points.

[19] By lowering entry-barriers and “experimental” costs.

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Appendix A: List of Selection Criteria

Does the paper concern information technology?	
If	**Action**
Yes	Keep
No	Remove

Does the paper concern cloud computing as its main topic?	
If	**Action**
Yes	Keep
No, cloud computing is only mentioned as an example or peripherally mentioned	Remove

Does the papers focus on cloud computing from a business perspective?	
If	**Action**
Yes, main emphasis is on organizational and managerial factors	Keep
No, focus of the paper is on, e.g., regulatory/compliance issues or technology adoption and implementation	Remove

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