Global Journal of Flexible Systems Management (March 2014) 15(1):59–68
DOI 10.1007/s40171-013-0055-4

ORIGINAL ARTICLE

Characteristics of Cloud Computing in the Business Context: A Systematic Literature Review

Mark Stieninger · Dietmar Nedbal

Received: 13 September 2013 / Accepted: 17 December 2013 / Published online: 8 January 2014

Abstract *Cloud Computing services have become more cost effective and technically flexible than traditional solutions. Therefore they are gaining more and more attention among organizations. But there is still disagreement about the exact meaning of Cloud Computing. This paper evaluates the current status concerning the conceptualization of Cloud Computing research by reviewing and classifying existing scientific literature. A comprehensive analysis of the Cloud Computing literature is drawn by identifying and discussing core concepts and characteristics within that literature. The paper concludes with possible further research areas in the field of Cloud Computing from a broad perspective.*

Keywords Cloud characteristics · Cloud Computing · Literature review

Introduction

For a couple of years the use of Cloud Computing services has been influencing the IT landscape (Repschläger et al. 2012). Due to the availability of complex cloud based information systems (such as enterprise resource planning, customer relationship management, document sharing, collaboration and communication systems), Cloud Computing has gained increased attention and diffusion among organizations (Opitz et al. 2012). Supporting all kinds of different service scenarios, the dynamic purchase and procurement of resources in the cloud has become much more cost effective and technically flexible than traditional solutions (Weinhardt et al. 2009; Amato et al. 2014). Flexibility, defined as "the ability to respond quickly to changing capacity requirements", has been identified by science and industry as a relative advantage of Cloud Computing (Repschläger et al. 2012). Nevertheless, a recent study concerning the attitude of decision-makers towards Cloud Computing in German companies revealed that there is a growing group of both supporters and opponents. The group of supporters grew from 28 percent to 35 percent, and the group of opponents grew from 38 to 44 percent from 2011 (sample size $n = 411$) to 2012 (sample size $n = 436$) as well (KPMG 2013) As a consequence of this the only shrinking group is the group of waverers.

One possible reason for these different attitudes and polarizing opinions is the disagreement about the exact meaning of Cloud Computing among basic and applied researchers. Due to the rapid development of information technology in general, this often conflicts with the formation of a solid, systematic and consistent concept (Thomas 2005). This especially applies to Cloud Computing, because it is developing at a very fast pace.

Another aspect is the complexity of innovative technologies and services. Viewing Cloud Computing from a technical perspective may be too narrow to comprehensively analyze such a complex innovation. Instead, complexity can originate from many other sources than the service system itself (Benedettini and Neely 2012). In IS research, such systems are considered as socio-technical systems involving technological components as well as people and the organizational environment interacting with

M. Stieninger · D. Nedbal (✉)
Digital Business, University of Applied Sciences Upper Austria, Wehrgrabengasse 1-3, 4400 Steyr, Austria
e-mail: dietmar.nedbal@fh-steyr.at
URL: www.fh-ooe.at

M. Stieninger
e-mail: mark.stieninger@fh-steyr.at
URL: www.fh-ooe.at

it (Picot and Baumann 2009; Orlikowski 1992; Belfo 2012). We follow this research discipline and see Cloud Computing as a concept involving engineering as well as various management aspects. Thus, it needs a socio-technical approach to assess its characteristics from a holistic view.

The main objective of this paper is to identify the current status of the conceptualization of Cloud Computing research. Therefore, an overview of the term Cloud Computing itself based on existing literature needs to be created to establish an integrated and broad understanding of the abstract concept. Furthermore, it is important to identify the core concepts and components used within literature in order to address further research by classifying the literature (Brooks et al. 2010). For example, Yang and Tate (2012) identified relevant topics such as technological issues, business issues, conceptualization of Cloud Computing and domains and applications across the literature. Another literature review on the use of Cloud Computing in the public sector was provided by Tsaravas and Themistocleous. They identified benefits and obstacles for e-government (Tsaravas and Themistocleous 2011). Despite the existence of literature reviews on this topic, there is still a lack of reviews with a focus on definitions and characteristics of the term Cloud Computing.

The remainder of the paper is structured as follows. Section "Research Methodology" outlines the research methodology. Section "Concept-Centric Literature Overview" provides a concept-centric overview of the literature considered for this research. Section "Discussion of Research Topics" discusses the findings of the analysis concerning conceptual topics within the literature. This followed by an assessment of. Conclusions concerning the current state of Cloud Computing research and recommendations for the need of further research are drawn in "Conclusion" section.

Research Methodology

The systematic review of relevant literature is an established research methodology that supports the development of theories. Reviews provide overviews of certain objects of research and identify areas where extensive research has already been done or where there is a lack of research results (Webster and Watson 2002; Schryen 2010). The research methodology followed Webster and Watson and included the following steps: (i) identification of relevant literature sources; (ii) selection of relevant articles; (iii) classification of the literature according to concepts; (iv) discussion of findings and implications for future research.

In the first step relevant literature sources had to be identified. Because of the timeliness of the topic both papers in peer reviewed scientific journals and conference proceedings were considered for the review. Literature was divided into the two categories basic research and applied research according to Brooks et al. (Brooks et al. 2010). From the perspective of the applied research literature the authors concentrated on peer reviewed practitioner related journals and professional papers. Relevant papers were found in Communications of the Association for Computing Machinery (CACM), Communications of the Association for Information Systems (CAIS), CIO Magazine (CIO Mag.), IEEE Spectrum (IEEE Spec.), and HMD, which is a relevant German journal for applied research.

For the literature targeting on basic researchers we considered papers from the premier academic IS journals which are the Journal of Management Information Systems (JMIS), Journal of the Association for Information Systems (JAIS), Management Information Systems Quarterly (MISQ), Information Systems Research (ISR), European Journal of Information Systems (EJIS), the Information Systems Journal (ISJ), and Management Information Systems Quarterly Executive (MISQ Exec.) (Brooks et al. 2010). As already stated, we additionally included proceedings of the widely recognized IS conferences the International Conference on Information Systems (ICIS), the Hawaii International Conference on System Science (HICSS), the Pacific Asia Conference on Information Systems (PACIS), and the America's Conference on Information Systems (AMCIS).

For the selection of relevant articles we used the online archives of the journals/conferences and their search functions provided. In the first round we searched for articles containing the keyword "Cloud Computing" within the title. In this way, 86 papers were identified. After a stepwise refinement towards papers that aim at providing a general understanding of different conceptual areas a total of 21 were considered as relevant for this review. The review does not include papers that focus on a certain application domain, or a specific technical asset of it.

A structured approach of literature reviews implies to synthesize the source material according to concepts (Webster and Watson 2002). In the course of this review nine essential concepts were identified. These concepts were discussed and implications for future research were identified as final step in this review.

Concept-Centric Literature Overview

In this section an overview of the analyzed papers and articles is provided. The overview is concept-centric and divided into two parts. At first, the literature targeting on applied researchers and practitioners ("applied literature") covering twelve papers is presented in Table 1. The second

table covers nine papers for the academic community ("basic literature").

The papers mainly deal with nine topics in the context of Cloud Computing. Twelve papers explicitly address definitions of Cloud Computing and nine papers refer to the definition of the National Institute of Standards and Technology (NIST). Further emphasis is given on success factors, potentials and challenges, requirements, consequences, risks, decision guidance, business models, and provider topics. These topics are discussed in the following.

Definitions As already stated, one focus of this paper is to provide a broad definition of Cloud Computing across the literature. Therefore special attention was given to explicit definitions of the term Cloud Computing within the papers. As the NIST definition of Cloud Computing (Mell and Grance 2011) turned out to be the most widely used definition, this is subject to further investigation. The NIST definition is used both as working definition and as starting point for providing extensions within the literature. The sources which are oriented towards the NIST definition are marked separately (column "NIST oriented"). Besides this predominant definition there are several different approaches to define Cloud Computing (Armbrust et al. 2010; Creeger 2009; Fogarty 2009; Repschläger et al. 2010; Linthicum 2009; Leimeister et al. 2010; Son et al. 2011) which were regarded as relevant and thus included within this investigation (Table 2).

Potentials and challenges The adoption of Cloud Computing entails both potentials and challenges. It is crucial to be aware of these in advance to gain benefit in the long term (Armbrust et al. 2010; Creeger 2009; Garrison et al. 2012; Hayes 2008; Fogarty 2009; Repschläger et al. 2010; Hoberg et al. 2012; Marston et al. 2011; Iyer and Henderson 2010).

Success factors Successful adoption of technological innovations like Cloud Computing depends on certain factors originating from different areas within the companies. Regarding the polarized attitudes among companies concerning Cloud Computing (KPMG 2013) it is essential to identify relevant success factors to establish a willingness to adopt such solutions (Garrison et al. 2012; Creeger 2009; Iyer and Henderson 2010).

Requirements For a successful adoption and implementation of Cloud Computing solutions it is inevitable to meet the requirements from the beginning. Therefore, requirements have to be identified and prioritized (Creeger 2009; Garrison et al. 2012; Walterbusch and Teuteberg 2012).

Consequences The adoption of Cloud Computing solutions causes multiple changes in different areas of companies. These consequences of adoption vary in their severity. They have to be considered in an early phase within the adoption process to make appropriate arrangements in a timely manner (Creeger 2009; Cusumano 2010;

Table 1 Applied literature

Journal/ Conference	Reference	Concept focus									
		Definitions	*NIST oriented*	Success factors	Potentials and challenges	Requirements	Consequences	Risks	Decision guidance	Business models	Provider topics
CACM	Armbrust et al. (2010)	■			■						
CACM	Brynjolfsson (2010)									■	
CACM	Creeger (2009)	■		■	■	■	■				
CACM	Cusumano (2010)						■				
CACM	Garrison et al. (2012)	■	■	■	■	■					
CACM	Hayes (2008)				■						
CAIS	Yang & Tate (2012)	■	■								
CIO Mag.	Fogarty (2009)	■			■			■			
HMD	Repschläger et al. (2010)	■			■					■	
HMD	Walterbusch et al. (2012)		■			■				■	
HMD	Pröhl et al. (2012)		■				■				
IEEE Spec.	Katz (2009)										■

Table 2 Basic literature

Journal/ Conference	Reference	Concept focus									
		Definitions	*NIST oriented*	Success factors	Potentials and challenges	Requirements	Consequences	Risks	Decision guidance	Business models	Provider topics
AMCIS 2012	Hoberg et al. (2012)	■	■		■		■				
CC Journal	Linthicum (2009)	■									
ECIS (2010)	Leimeister et al. (2010)	■					■				
HICSS (2011)	Marston et al. (2011)	■	■		■				■		
HICSS (2011)	AlZain et al. (2011)	■	■					■			
HICSS (2012)	Kaisler et al. (2012)	■	■						■		
MISQ Exec.	Iyer et al. (2010)		■	■	■				■		
PACIS (2011)	Son & Lee (2011)	■			■		■		■		
PACIS (2011)	Son et al. (2011)						■				

Pröhl et al. 2012; Hoberg et al. 2012; Leimeister et al. 2010; Son et al. 2011; Son and Lee 2011).

Risks The adoption of Cloud Computing might involve certain risks which have to be kept in mind too (Fogarty 2009; AlZain et al. 2011).

Decision guidance Decision support is an important part in Cloud Computing literature. Especially due to the great variety of application areas it is helpful for companies to receive guidance concerning their decisions (Marston et al. 2011; Kaisler et al. 2012; Iyer and Henderson 2010; Son et al. 2011).

Business models The topics named so far have their impact mainly on the customer side of the Cloud Computing relationship. The topic of business models is aimed at the provider side. New forms of service deployments also carry new opportunities and potentials. Therefore it is necessary to establish new business models (Brynjolfsson et al. 2010; Repschläger et al. 2010; Walterbusch and Teuteberg 2012).

Provider topics Additional topics besides the business model which are mainly interesting for the Cloud Service Providers (CSP) include affordable land, available fiber-optic connectivity, abundant water, and inexpensive electricity. These topics need to be considered too (Katz 2009).

Discussion of Research Topics

This section discusses the main contents of the articles. Table 3 shows the distribution of the articles by topics whereat one article may belong to multiple categories.

In the following subsections the particular topics are detailed on the basis of the analyzed literature.

Definitions

Because of the importance of the NIST definition (Mell and Grance 2011) of Cloud Computing in general a brief summary of this definition is provided in the following. Furthermore the NIST definition provides an overview of the core components of Cloud Computing. After that, additions from both categories are provided.

Mell and Grance (2011) define Cloud Computing as „a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models. In the following the central elements of this definition are described.

Essential characteristics The first characteristic mentioned is *on-demand self-service.* This means, that provision of computing capabilities is done automatically and no active interaction is required. The second characteristic, *broad network access,* implies that services are provided over the network and available for different platforms. *Resource pooling* indicates that multiple consumers share a common pool of services which is allocated dynamically. *Rapid elasticity* means that resources are provisioned and released rapidly or even automatically depending on the

Table 3 Overview of research topics

Focus	Applied literature	Basic literature	Total
Definitions	5 (42 %)	7 (78 %)	12 (57 %)
NIST oriented	4 (33 %)	5 (56 %)	9 (43 %)
Success factors	2 (17 %)	1 (11 %)	3 (14 %)
Potentials and challenges	6 (50 %)	4 (44 %)	10 (48 %)
Requirements	3 (25 %)	0 (0 %)	3 (14 %)
Consequences	3 (25 %)	4 (44 %)	7 (33 %)
Risks	1 (8 %)	1 (11 %)	2 (10 %)
Decision guidance	0 (0 %)	4 (44 %)	4 (19 %)
Business models	3 (25 %)	0 (0 %)	3 (14 %)
Provider topics	1 (8 %)	0 (0 %)	1 (5 %)

demand. The fifth characteristic is *measured service*: The use of resources is managed automatically and can be monitored in a transparent way by the consumer and the provider.

Service models Software as a Service (SaaS) provides applications and software for the user. The user has various configuration possibilities (e.g. through a web browser, or a programming interface) but no control of the underlying infrastructure. With *Platform as a Service (PaaS)* the user has access to a basic infrastructure including an operating system where applications can be run and configured. The third service model, *Infrastructure as a Service (IaaS)*, provides basic hardware and networking resources only which the consumer can use for running operating systems and applications independently.

Deployment models Finally the NIST definition lists four deployment models to describe Cloud Computing. The *private cloud* provides exclusive infrastructure to an organization which is managed either by the organization itself or by an external service provider. The *community cloud* is exclusively allocated for a defined group of users which may belong to different companies. The *public cloud* is a model which provides services to the general public. The last service model mentioned by Mell and Grance is the *hybrid cloud.* It is a combination of two or more of the other models which work independently from each other but are connected to enable data and application portability (Mell and Grance 2011).

From the perspective of applied literature some additional aspects should be considered. In the course of the research these were clustered into four distinct categories: *financial*, *organizational*, *resource based,* and *ecologic* characteristics.

Financial characteristics The adoption of Cloud Computing can help to reduce huge initial capital expenditures (CAPEX) which are often quite hazardous due to lack of demand forecast (Creeger 2009). Cloud Computing transforms those to operational expenditures (OPEX) by introduction of the pay-as-you-go payment model. In this model, customers benefit from demand oriented service charges and reduced risk of expensive oversizing and too narrow resource purchasing (Armbrust et al. 2010). Another aspect mentioned is the assumption that services meeting needs of a company are already available on the market or are going to evolve over time. This allows them to change the procurement strategy and adopt a philosophy of "buy first, build second" (Creeger 2009). Thus, the following characteristics should be considered within a "Big Picture" of Cloud Computing:

- Procurement strategy (buy first, build second) (Creeger 2009)
- Transformation of capital to OPEX (Creeger 2009)
- Payment model (pay-as-you-go) (Armbrust et al. 2010)

Organizational characteristics Depending on the company that adopts Cloud Computing, the implementation of a Cloud Computing solution leads to radical changes of the process structure. IT departments have a great demand to manage this fundamental change. They are no longer responsible for operation and maintenance of IT infrastructure and its components only, but rather for organizational tasks like the selection of CSPs, service level agreements and integration of cloud solutions and corporate systems (Pröhl et al. 2012; Repschläger et al. 2010). Cloud Computing may also work as a catalyst for innovations all across the organization (Brynjolfsson et al. 2010). The following organizational characteristics were consequently regarded as useful to describe Cloud Computing:

- Manage the change of processes and reorientation of the IT organization (Pröhl et al. 2012; Repschläger et al. 2010).
- Catalyst for innovation (Brynjolfsson et al. 2010)

Resource based characteristics IT systems in companies are often oversized because peak demands occur sporadically. But most of the time the demand is rather low. The average server utilization lies between five and twenty percent (Armbrust et al. 2010). The concentration of IT capacity in data centers of the CSPs enables optimization of resource utilization and economies of scale (Cusumano 2010; Repschläger et al. 2010). For this reasons the following characteristic has to be added too:

- Optimized resource utilization (Armbrust et al. 2010; Cusumano 2010; Repschläger et al. 2010)

Ecological characteristics Another aspect considered as relevant within the literature is based on the contribution of energy efficient data centers. Great potential savings through reduced energy consumption motivate CSPs to

Table 4 Characteristics in Cloud Computing definitions

Financial characteristics	Procurement strategy (Creeger 2009)
	Payment model (Armbrust et al. 2010; Son et al. 2011; Hoberg et al. 2012)
	CAPEX to OPEX (Creeger 2009)
Organizational Characteristics	Manage change of processes (Pröhl et al. 2012; Repschläger et al. 2010).
	Innovation catalyst (Brynjolfsson et al. 2010)
	On-demand self-service (Mell and Grance 2011; Creeger 2009; Hoberg et al. 2012)
	Broad network access (Mell and Grance 2011; Hoberg et al. 2012)
	Rapid elasticity (Mell and Grance 2011; Hoberg et al. 2012)
	Measured service (Mell and Grance 2011; Hoberg et al. 2012)
	Additional design principles (Hoberg et al. 2012)
	Market structure (Hoberg et al. 2012)
Resource based characteristics	Resource pooling (Mell and Grance 2011; Hoberg et al. 2012)
	Resource design (Son et al. 2011)
	Resource delivery (Son et al. 2011)
	Optimized resource utilization (Son et al. 2011; Armbrust et al. 2010; Cusumano 2010; Repschläger et al. 2010)
Ecological characteristics	Energy efficiency (Katz 2009)
Service models (XaaS)	Software/application (Mell and Grance 2011; Linthicum 2009; Kaisler et al. 2012; Hoberg et al. 2012)
	Platform (Mell and Grance 2011; Linthicum 2009; Kaisler et al. 2012; Hoberg et al. 2012)
	Infrastructure (Mell and Grance 2011; Kaisler et al. 2012; Hoberg et al. 2012)
	Storage (Linthicum 2009)
	Database (Linthicum 2009)
	Information (Linthicum 2009)
	Process (Linthicum 2009)
	Integration (Linthicum 2009)
	Security (Linthicum 2009)
	Management/Governance (Linthicum 2009)
	Testing (Linthicum 2009)
Deployment models	Private cloud (Mell and Grance 2011; Hoberg et al. 2012)
	Community cloud (Mell and Grance 2011; Hoberg et al. 2012)
	Public cloud (Mell and Grance 2011; Hoberg et al. 2012)
	Hybrid cloud (Mell and Grance 2011; Hoberg et al. 2012)

focus on energy saving technologies (Katz 2009). This is why the following characteristic was added to the list:

- Energy efficiency (Katz 2009)

Within the second category some further aspects that describe Cloud Computing were identified. These are summarized in the following.

Financial Characteristics The payment or pricing model also appears within the academic literature. Son et al. (2011) describe some resource based characteristics including the payment model (pay-per-use, or subscription fee). Hoberg et al. (2012) also define the pricing model as a characteristic and distinguish between pay per use and fixed fees.

Service models Besides the three commonly used service models (SaaS, IaaS, PaaS), academic literature provides further approaches to structure Cloud Computing service models. Linthicum (2009) already defined a classification of ten different service models 3 years before the NIST. Comparing these two models makes a certain similarity evident whereat Linthicum is more detailed than the NIST. Another approach was developed by Kaisler et al. (2012). Their five-layer model is rather similar to the service model view of Linthicum and NIST as well. In summary, the following service models (also called "everything as a service" or XaaS) extend the NIST view on Cloud Computing:

- Storage as a service (storage in the cloud which can be mapped locally) (Linthicum 2009)
- Database as a service (hosted database for shared use) (Linthicum 2009)
- Information as a service (access to all kind of information through defined interfaces) (Linthicum 2009)
- Process as a service (remote-access to resources for generating business processes) (Linthicum 2009)

Table 5 Obstacles and opportunities (Armbrust et al. 2010)

Obstacle	Opportunity
Availability/business continuity	Use multiple CSP
Data Lock-In	Standardize APIs; compatible SW to enable surge or hybrid Cloud Computing
Data confidentiality and auditability	Deploy encryption, VLANs, firewalls
Data transfer bottlenecks	FedExing disks; higher BW switches
Performance unpredictability	Improved VM support; flash memory; gang schedule VMs
Scalable storage	Invent scalable store
Bugs in large distributed systems	Invent debugger that relies on distributed VMs
Scaling quickly	Invent auto-scaler that relies on ML; snapshot for conservation
Reputation fate sharing	Offer reputation-guarding services like those for email
Software licensing	pay-for-use licenses

- Integration as a service (includes the main features of EAI) (Linthicum 2009)
- Security as a service (rudimental security services, identity management) (Linthicum 2009)
- Management/Governance as a service (management of several cloud services) (Linthicum 2009)
- Testing as a service (provision of a test environment) (Linthicum 2009)

Organizational Characteristics Another definition including factors relevant from the organizational perspective is provided by Hoberg et al. (2012). They subsume several factors they term as *design principles*. These contain the five characteristics from the NIST definition and the characteristics virtualization, service and interface description, limited customizability, and security and privacy. Hoberg et al. also identify *market structure* as relevant which includes decentralized market, provider, customer and integrator. Therefore we add:

- Additional design principles (Hoberg et al. 2012)
- Market structure (Hoberg et al. 2012)

Resource based Characteristics Son et al. (Son et al. 2011) describe the following additional resource based characteristics which have not yet been mentioned:

- Resource design (service oriented, definition of standardized offers) (Son et al. 2011)
- Resource delivery (over the internet, high availability for multiple users) (Son et al. 2011)
- Resource usage (flexible use of share service, computing utility, elasticity, scalability) (Son et al. 2011)

Summing up the definitions from applied and basic literature, Cloud Computing includes six main categories as shown in Table 4: financial characteristics, organizational characteristics, resource based characteristics, ecological characteristics, service models, and deployment models.

Potentials and Challenges

Armbrust et al. (2010) identify ten obstacles for Cloud Computing, each of them indicating a potential opportunity (see Table 5).

Iyer and Henderson (2010) also identify several potentials to detail Cloud Computing: *controlled interfaces, location independence, sourcing independence, ubiquitous access, virtual business environment, addressability and traceability, and rapid elasticity*.

Another potential concerns *mobility and collaboration* which are said to be improved by Cloud Computing (Hayes 2008).

Repschläger et al. (2010) describe potentials for the two main actors of a Cloud Computing relationship, the CSP and the recipient of the service. Potentials for the CSP arise from *cost advantages* through efficient resource utilization and economies of scale through large capacities. They achieve customer restraints by building up *lock-in effects*. Recipients benefit in two ways: *cost savings* and *enhanced flexibility*. The mayor challenges are *reliability and trustworthiness* as well as *IT security and compliance issues*.

Marston et al. (2011) also mention the cost advantages as a potential benefit of Cloud Computing. They also include the *immediate access* to the services without upfront capital investments as a potential benefit. This leads to a faster time to market, scalability of services and enabling of new classes of applications.

Success Factors

Three articles deal with the topic of success factors. Garrison et al. (2012) specify three main insights concerning success factors for deployment of Cloud Computing. The author states that a *trusted relationship* between a CSP and the customers is critical for deployment and achievement of mutual benefits. The second insight is that organizations

having successfully adopted Cloud Computing gain competitive advantage by enabling a *concentration on their core competencies*. Finally Garrison concludes that Cloud Computing leads to greater *economies of scale* in the field of IT.

Creeger (2009) discusses *changes of philosophy* as important factors of a successful adoption of Cloud Computing. "Buy first, build second" leads to the consumption of services provided by external organizations instead of operating an own infrastructure. Furthermore he underlines the importance of *familiarize the employees responsible with the IT*. They might be hindering the change process due to fear of losing their employment. The reasons for the deployment of Cloud Computing solutions should be explained to the decision makers as well as to the users. *Any person involved should learn* how to benefit from the cloud solution.

Iyer and Henderson (2010) identify seven potentials of Cloud Computing (cf. previous section). The implementation of each of them needs expenses. By analyzing these costs and the *intended value* of the adoption of Cloud Computing organizations can decide if it is beneficial to them to adopt.

Requirements

Requirements are needed before the process of adoption of certain cloud services is initiated. Walterbusch and Teuteberg (2012) emphasize on the importance of *trust* between CSP and recipient as an essential requirement for the adoption of Cloud Computing. Therefore they recommend bridging the asymmetry of the level of information between the two parties.

As Creeger notes, organizations need *additional expertise to handle Cloud Computing*. They no longer need pure technicians but administrators that can handle the whole environment around the relationship between the CSP and their organization (Creeger 2009).

Consequences

By reviewing literature, Hoberg et al. (2012) reveal six aspects having business impacts. These are *increased scalability*, *reduction of IT infrastructure complexity, increased agility, cost reduction and improved alignment of business and IT*.

Pröhl et al. (2012) highlight the fact that Cloud Computing may cause fundamental *changes concerning IT service management*. It might lead to complete outsourcing of the responsibility for ITSM.

Cusumano (2010) points out that there are *negative consequences for traditional software product companies* and users as well. They will have to shift to cloud services to keep in touch with the market.

Risks

Fogarty (2009) mentions several risks of Cloud Computing. Most *CSPs are not compatible with each other*. For example using data stored at one CSP with an application from another CSP might be problematic. *Privacy* is not controlled by the owner of the data which causes discomfort. Concerning the *service levels* the capabilities of customization are quite limited compared with the opportunities in an in-house data center. Finally he mentions the problem of *interoperability* of highly customized internal applications with the cloud infrastructure.

AlZain et al. (2011) mainly address privacy and security risks that affect single clouds, *namely data integrity, data intrusion, and service availability*. To overcome these risks they propose to migrate to a multi-cloud or intercloud environment.

Decision Guidance

Kaisler et al. (2012) develop a decision framework to assist managers in determining which cloud solution matches their specific requirements. They describe three architectural categories, each of them require five decisions: *Service architecture* contains decisions concerning privacy, economics, standards, management and evolution. *System architecture* includes performance/reliability, virtual machines, distributed virtual storage, distributed virtual machines, and security. Finally, *application architecture* contains partitioning, scaling, integration, development kits and support.

Business Models

Brynjolfsson et al. (2010) compare Cloud Computing with the utility model of electricity. The authors conclude that Cloud Computing cannot be considered as a utility model. As with electricity the technology still has to mature. It is not just the replacement of an old technology with a new one. Instead, it has impact on all surroundings. This is why complete industries will become reshaped.

Repschläger et al. (2010) have chosen a different approach concerning the business models. They derive the business models directly from the service models. So they describe three business models, namely SaaS, PaaS and IaaS.

Provider Topics

Katz (2009) deals with provider topics in his article. He mentions relevant influencing factors for CSPs concerning

the selection of the location to establish a data center to host Cloud Computing solutions like *affordable land, available fiber optic connectivity, abundant water for cooling, and cheap electricity.* Furthermore he mentions the influence of *energy efficiency, zero emission,* and a *minimized environmental impact*.

Conclusion

As the review of existing literature revealed, both scientific communities are discussing the topic of Cloud Computing and the related subjects intensely. Articles deal with the topic of definitions whereat a lot of them refer to the NIST definition. But also some papers intend to investigate into additional perspectives of definitions. The field of potentials and challenges is also already largely covered by both groups. The topics of success factors and requirements still have gaps especially within the academic literature which should be bridged by future research. The review could not identify a paper in the field of decision guidance within the category "applied literature". The same applies to business models from the academic perspective. Provider topics should also be addressed by future research as the coverage is quite low so far for both groups.

The implication of this literature review on Cloud Computing is that there are still gaps that need to be investigated in more detail. Results showed that the widely recognized NIST definition provides a solid basis for the general understanding of cloud computing but is still not sufficient in parts identified by this review.

Research questions for future studies may include novel and additional approaches to define critical success factors and requirements for dissemination and adoption of Cloud Computing. The requirements could be discussed together with decision guidance for the process of adoption. The computation concept based on service models enables novel business models which also should be subject for investigation. As Cloud Computing still has to cope with a growing group of opponents another research direction might cover the field of provider topics to help them establish a trustful image.

The core of every scientific discipline is its own consistent and recognized terminology (Thomas 2005). This is why certain emphasis was given to different definitions of Cloud Computing. But the paper did not intend to extensively examine the literature concerning Cloud Computing, as for example Yang and Tate (2012) did by analyzing 205 papers including technological applications and domains. Instead, it focused on the identification of main concepts and characteristics in the field of Cloud Computing. Nevertheless, the major drawback is the amount of papers analyzed in this review. But the authors believe that the focus on definitions and characteristics of the term justifies the research by providing insights into relevant literature from a broad view.

The conducted review considered basic and applied research literature to broaden the perspective. By doing this, gaps in research were identified concerning this topic. These gaps were provided to encourage further research. With it, it helps to establish an integrated understanding of the abstract concept and it contributes to the formation of a consistent terminology of Cloud Computing.

Acknowledgments Parts of this work emerged from the research project OptiCloud. This project is funded by the European Regional Development fund (EFRE, Regio 13) as well as by the Federal State of Upper Austria.

References

AlZain, M. A., Pardede, E., Soh, B., & Thom, J. A. (2011). Cloud Computing security: From single to multi-clouds. In *Proceedings of the HICSS* (pp. 5490–5499).

Amato, F., Mazzeo, A., Moscato, V., & Picariello, A. (2014). Exploiting Cloud Technologies and context information for recommending touristic paths. In *Intelligent Distributed Computing VII* (pp. 281–287). Springer.

Armbrust, M., Stoica, I., Zaharia, M., Fox, A., Griffith, R., Joseph, A. D., et al. (2010). A view of cloud computing. *Communications of the ACM, 53*, 50–58.

Belfo, F. (2012). People, organizational and technological dimensions of software requirements specification. *Procedia Technology, 5*, 310–318.

Benedettini, O., & Neely, A. (2012). Complexity in services: An interpretative framework. In T. Schoenherr (Ed.), *23rd Annual Conference of the Production and Operations Management Society (POMS)*.

Brooks, S., Wang, X., & Sarker, S. (2010). Unpacking Green IT: A review of the existing literature. In *Proceedings of the AMCIS*.

Brynjolfsson, E., Hofmann, P., & Jordan, J. (2010). Cloud computing and electricity. *Communications of the ACM* (pp.32–34).

Creeger, M. (2009). CTO roundtable. *Communications of the ACM, 52*, 50.

Cusumano, M. (2010). Cloud computing and SaaS as new computing platforms. *Communications of the ACM, 53*, 27–29.

Fogarty, K. (2009). Cloud Computing definitions and solutions. Retrieved February 11, 2013 from http://www.cio.com/article/print/501814.

Garrison, G., Kim, S., & Wakefield, R. L. (2012). Success factors for deploying cloud computing. *Communications of the ACM, 55*, 62.

Hayes, B. (2008). Cloud computing. *Communications of the ACM, 51*, 9–11.

Hoberg, P., Wollersheim, J., & Krcmar, H. (2012). The business perspective on Cloud Computing: A literature review of research on Cloud Computing. In *Proceedings of the AMCIS*.

Iyer, B., & Henderson, J. C. (2010). Preparing for the future—understanding the seven capabilities of Cloud Computing. *MIS Quarterly Executive* (pp. 117–131).

Kaisler, S., Money, W. H., & Cohen, S. J. (2012). A decision framework for Cloud Computing. In *Proceedings of the HICSS* (pp. 1553–1562).

Katz, R. (2009). Tech titans building boom. *IEEE Spectrum* (pp. 40–54).

KPMG. (2013). Cloud Monitor 2013: Cloud Computing in Deutschland—Status quo und Perspektiven.
Leimeister, S., Böhm, M., Riedl, C., & Krcmar, H. (2010). The business perspective of Cloud Computing: Actors, roles and value networks. In *Proceedings of the ECIS*.
Linthicum, D. (2009). Defining the Cloud Computing framework: Refining the concept. Retrieved February 21, 2013, from http://cloudcomputing.sys-con.com/node/811519.
Marston, S., Li, Z., Bandyopadhyay, S., & Ghalsasi, A. (2011). Cloud Computing: The business perspective. In *Proceedings of the HICSS*.
Mell, P., & Grance, T. (2011). The NIST definition of Cloud Computing (NIST Special Publication 800-145).
Opitz, N., Langkau, T. F., Schmidt, N. H., & Kolbe, L. M. (2012). Technology acceptance of Cloud Computing: Empirical evidence from German IT Departments. In *Proceedings of the HICSS* (pp. 1593–1602).
Orlikowski, W. J. (1992). The duality of technology: Rethinking the concept of technology in organizations. *Organization Science, 3*, 398–427.
Picot, A., & Baumann, O. (2009). Die Bedeutung der organisationstheorie für die Entwicklung der Wirtschaftsinformatik. *WIRTSCHAFTSINFORMATIK, 51*, 72–81.
Pröhl, T., Repschläger, J., Erek, K., & Zarnekow, R. (2012). IT-Servicemanagement im Cloud Computing. *HMD—Praxis der Wirtschaftsinformatik* (pp. 6–14).
Repschläger, J., Pannicke, D., & Zarnekow, R. (2010). Cloud Computing: Definitionen, Geschäftsmodelle und Entwicklungspotenziale. *HMD—Praxis der Wirtschaftsinformatik* (pp. 6–15).
Repschläger, J., Wind, S., Zarnekow, R., & Turowski, K. (2012). A reference guide to Cloud Computing dimensions: Infrastructure as a service classification framework. In *Proceedings of the HICSS* (pp. 2178–2188).
Schryen, G. (2010). Preserving knowledge on IS business value. *Business and Information Systems Engineering, 2*, 233–244.
Son, I., & Lee, D. (2011). Assessing a new IT service model: Cloud Computing. In *Proceedings of the PACIS*.
Son, I., Lee, D., Lee, J.-N., & Chang, Y.-B. (2011). Understanding the impact of it service innovation on firm performance: The case of Cloud Computing. In *Proceedings of the PACIS*.
Thomas, O. (2005). Das Modellverständnis in der Wirtschaftsinformatik: Historie, Literaturanalyse und Begriffsexplikation. *Veröffentlichungen des Instituts für Wirtschaftsinformatik* (pp. 184).
Tsaravas, C., & Themistocleous, M. (2011). Cloud Computing and egovernment: A literature review. In *European, Mediterranean & Middle Eastern Conference on Information Systems* (pp. 154–164).
Walterbusch, M., & Teuteberg, F. (2012). Vertrauen im Cloud Computing. *HMD—Praxis der Wirtschaftsinformatik* (pp. 50–59).
Webster, J., & Watson, R. T. (2002). Analyzing the past to prepare for the future: Writing a literature review. *MIS Quarterly* (Vol. 26, pp. xiii–xxiii).
Weinhardt, C., Anandasivam, A., Blau, B., Borissov, N., Meinl, T., Michalk, W., et al. (2009). Cloud Computing: A classification, business models and research directions. *Business and Information Systems Engineering, 1*, 391–399.
Yang, H., & Tate, M. (2012). A descriptive literature review and classification of Cloud Computing Research. *Communications of the Association for Information Systems* (pp. 35–60).

Key Questions

1. What is the current status of research concerning Cloud Computing?
2. What are the core concepts and characteristics of Cloud Computing used within literature?
3. What are the topics that need to be addressed by further research?

Mark Stieninger is working as a researcher at the University of Applied Sciences Upper Austria since 2013. After several professional positions in Account Management and IT Administration he earned his Bachelor's and Master's degree in Electronic Business and Digital Business Management at the Upper Austria University of Applied Sciences and Johannes Kepler University Linz in 2013. His research areas are Cloud Computing and Green IT/IS.

Dietmar Nedbal is a researcher and lecturer at the University of Applied Sciences Upper Austria since 2008. He earned a Master's degree in Business Informatics at Johannes Kepler University Linz in 2000 and was CIO at RIS Software GmbH until 2008. He finalized his PhD in the field of B2B Integration and Enterprise 2.0 in autumn 2013. Dietmar is co-author of over 30 publications at international journals and conference proceedings. His main research areas are Enterprise 2.0, B2B Integration, Green IT/IS, and Cloud Computing.