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WHAT ARE THE MOST IMPORTANT CRITERIA FOR CLOUD SERVICE PROVIDER SELECTION? A DELPHI STUDY

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Research

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Abstract

Selecting an appropriate cloud service provider (CSP) is one of the most important challenges affecting sourcing performance. Although cloud computing (CC) relies on the principle of information technology outsourcing (ITO), it remains unclear if selection criteria for ITO provider hold true. Hence, the purpose of this research is to identify the most important criteria for the selection of cloud service providers (CSP). We do this by conducting a Delphi study which includes 16 cloud service decision makers across different cloud service models, company sizes, and industry types. Our results show consensus on CSP selection criteria and identify functionality, legal compliance, contract, geolocation of servers, and flexibility as top five CSP selection criteria. From a theoretical perspective, we demonstrate that results from ITO research hold true for CC research as differences in delivery model and arrangement between ITO and CC will be considered. Practitioners like CSP and cloud decision makers get guidance from our findings to conduct optimal cloud service investments. This is the first study which provides a comprehensive view on relevant criteria for CSP selection.

Keywords: Cloud Computing; IT Outsourcing; Cloud Service Provider Selection; Selection Criteria; Delphi Study

1 Introduction

The worldwide spending on Cloud Computing (CC) is expected to grow 15.7% to $176 billion in 2015 (Gartner 2015). For 2018, various industry reports predict that the majority of global information technology (IT) spending will be related to CC (Galer 2015). In contrast to in-house IT solutions, CC is by definition “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources […] that can be rapidly provisioned and released […]” (Mell and Grance 2011)[1]. Therefore, CC promises lower cost, increasing productivity and IT elasticity advantages, and enables new business models and values for cloud customers as well as cloud service providers (CSP) (Morgan and Conboy 2013). To benefit from this development, a growing number of companies have entered the CC market by providing distinct cloud services (Kourtesis et al. 2014; Menzel et al. 2015). Prominent examples are Amazon, Google, Microsoft, Rackspace, and GoGrid who are providers of infrastructure as a service (IaaS) and platform as a service (PaaS). SalesForce, Cisco WebEx and DATEV are well-known providers of software as a service (SaaS). Hence, in today’s digital age, CC has become an ubiquitous and important technology paradigm (Gupta et al. 2013).

Overall, from a customer’s point of view, CC can be seen as an evolution and specific form of information technology outsourcing (ITO) and shares basic principles and benefits with ITO (Chen and Wu 2013). CC customers leverage CSP expertise and infrastructure to run a business which in turn relies on the principle of ITO (Chen and Wu 2013). Furthermore, CC and ITO share basic benefits such as cost savings, access to specialized resources, and the enabled flexibility to respond quickly to market changes (Benlian and Hess 2011; Leimeister et al. 2010; Schneider and Sunyaev 2014).

The selection of an appropriate CSP and ITO provider is one of the most important challenges affecting sourcing performance (Chang et al. 2012; Garrison et al. 2012; Garrison et al. 2015; Jain and Thietart 2013). E. g., productivity and performance advantages within an ITO relationship are only possible if the right provider is selected (Chang et al. 2012). Professional skills, capacity of services, capacity of operation, and external evaluation have been identified as the most important criteria influencing ITO provider selection decisions (Chang et al. 2012). Because CC is highly related to ITO, the extensive body of research on ITO provides a valuable basis for investigating CSP selection decisions.

While CC is a technology-enabled arrangement where customers tend to short-term relationships, ITO is an (human) asset specific arrangement where customers tend to long-term relationships (Chen and Wu 2013). Therefore, CC can be better described as a market-based outsourcing arrangement while ITO as a hierarchical outsourcing arrangement (Chen and Wu 2013; Gurbaxani and Whang 1991). Comparing to hierarchical outsourcing arrangements, within market-based arrangements the customer faces operational (transactional) and contractual (writing contracts) costs (Gurbaxani and Whang 1991; Xin and Levina 2008). As such differences between CC and ITO exist, it is unclear if ITO provider selection criteria also hold true for selecting CSP.

Prior qualitative research on CSP selection decisions deductively identified up to 21 criteria affecting selection decisions (Kaisler et al. 2012; Repschlaeger et al. 2012; Repschläger et al. 2011). Quantitative research identified the importance of security and privacy criteria for CSP selection decisions and the relevance of specific criteria for selection decisions within hierarchical groups including IT security and compliance (Gupta et al. 2013; Lübbecke and Lackes 2015; Repschlaeger et al. 2013). Nevertheless, research does not provide a comprehensive view on relevant functional and non-functional CSP selection criteria as experienced by CC decision makers.

From a practical point of view, with the increasing amount of CSP, efficient and accurate provider discovery and selection is a significant challenge for decision makers (Luftman et al. 2015; Sun et al. 2014; Yang and Tate 2012). Cloud decision makers need to consider functional and non-functional criteria

[1] While public cloud services are available from a third party provider via Internet and are very cost effective way to deploy information technology solution, private cloud services are managed within an organization and have a strong resemblance to the traditional on premise service type. Therefore, this article focus on public cloud services.

across a variety of CSP to select the right one (Garg et al. 2013). Since information transaction in market-based relationships is costly (Gurbaxani and Whang 1991), decision makers need to focus on most important criteria (Luftman et al. 2015; Sun et al. 2014; Yang and Tate 2012).

In order to address the lack of research on CSP selection decisions, we conducted an exploratory study of experts' opinions – a Delphi study. Our study compiled the knowledge of 16 experts using a three-phase process to identify, select and rank CSP selection criteria. Using a Delphi study design, we aim to address the following research question: *What are the most important criteria, as identified by experts, for the selection of cloud service providers?* Our study findings not only contribute to extending the understanding of CC and its relationship to ITO, but also provide valuable insights to enable professionals to make optimal cloud service decisions (Garrison et al. 2012; Garrison et al. 2015).

The remainder of the paper is organized as follows. First, we present the theoretical background for our study by describing the current state of research on ITO provider selection and CC as a specific form of ITO. Further, we point out the decision makers' challenges for CSP selection shaped by an increasing amount of CSP. We then explain our methodological approach and describe the three-phase Delphi study applied in our research. In the findings section, we present a list of ranked CSP selection criteria. Finally, we discuss our results from which we derive implications for future research and practice.

2 Research Background

2.1 IT Outsourcing Provider Selection

The selection of an appropriate ITO provider is one of the most important challenges affecting sourcing performance (Chang et al. 2012; Jain and Thietart 2013). ITO is a phenomenon in which a customer transfers property or decision rights using IT infrastructure to a provider's organization (Chen and Wu 2013; Loh and Venkatraman 1992). Previous literature on ITO has looked at determinants of outsourcing success (Agrawal et al. 2006; Jain and Thietart 2013; Lacity et al. 2010) and particularly on ITO selection criteria (Chang et al. 2012; Liang et al. 2015; Michell and Fitzgerald 1997). *Table 1* presents an overview of prior research on ITO provider selection criteria.

ITO Provider Selection criteria	**Description based on Chang et al. (2012)**	**Sources**
Professional capabilities and skills	Current technique and prospective developmental capacity of ITO provider companies.	(Chang et al. 2012; Jain and Thietart 2013; Kourtesis et al. 2014; Liang et al. 2015; Michell and Fitzgerald 1997; Tiwana and Bush 2007)
Capacity of services	ITO provider companies after-sales service, and degree of description of products.	(Chang et al. 2012; Liang et al. 2015; Tiwana and Bush 2007)
Capacity of operation	Internal operations and management, and stability of ITO provider companies	(Chang et al. 2012; Jain and Thietart 2013; Michell and Fitzgerald 1997)
External evaluation	ITO provider companies' knowledge on client's industry and their locations.	(Chang et al. 2012; Michell and Fitzgerald 1997; Tiwana and Bush 2007)

Table 1. IT outsourcing provider selection criteria as reported in IS literature

As described in *Table 1*, prior research identified providers' professional capabilities and skills, capacity of services, capacity of operation, and external evaluation as criteria for ITO provider selection (Chang et al. 2012). Hence, ITO customers select providers who are able to add value to existing in-house capabilities and skills (Jain and Thietart 2013; Liang et al. 2015; Michell and Fitzgerald 1997; Tiwana and Bush 2007). According to Michell and Fitzgerald (1997), the provider should be able to explore new solutions instead of simply reproducing existing ones. Furthermore, ITO customers select providers who offer proper services and operations (Chang et al. 2012; Liang et al. 2015; Tiwana and Bush 2007). Hence, service models, contractual arrangements, and the provider's colocation are vital aspects for provider selection (Jain and Thietart 2013; Michell and Fitzgerald 1997). Finally, ITO decision makers consider external evaluation criteria, such as the provider's reputation or knowledge of the customer's industry, when making provider selection (Chang et al. 2012; Michell and Fitzgerald 1997; Tiwana and Bush 2007). ITO provider selection is therefore well examined and provides a valuable basis for investigating CSP selection decisions.

2.2 Cloud Computing as a Specific Form of IT Outsourcing

According to Chen and Wu (2013), from a customer's point of view CC can be seen as an evolutionary development and specific form of ITO and they share basic principles, benefits, and challenges. First, CC customers leverage the provider's expertise and infrastructure to run a business which in turn relies on the principle of ITO (Chen and Wu 2013). Second, both CC and ITO benefit from cost savings, access to specialized resources, and the enabled flexibility to respond quickly to market changes (Benlian and Hess 2011; Leimeister et al. 2010; Schneider and Sunyaev 2014). Third, CC and ITO customers are challenged to select optimal provider to ensure ex-post sourcing performance (Agrawal et al. 2006; Garrison et al. 2012; Jain and Thietart 2013). Therefore, we argue that the extensive literature on ITO is relevant also for research on the determinant criteria of CC (Chen and Wu 2013; Schneider and Sunyaev 2014).

However, even if CC is an evolutionary development of ITO, different characteristics between ITO and CC exist and therefore CC has to be considered as a specific form of ITO. *Table 2* illustrates characteristics of ITO and CC within certain dimensions: *delivery model, scope, contract, and arrangement*. CC is technology-enabled outsourcing via the internet *(delivery model*), based on standard interfaces and functionalities (*scope*) that are available to all user firms (*delivery model*) (Chen and Wu 2013; Mell and Grance 2011). Traditional outsourcing, on the other hand, often entails the transfer of human and physical assets (*delivery model*) and services are customer-tailored (*scope*) and available to dedicated firms (*delivery model*) (Chen and Wu 2013; Linstone and Turoff 1975; Susarla et al. 2003; Xin and Levina 2008). As a result, traditional outsourcing usually involves long-term contracts while CC involves flexible short-term contracts with consumption-based pricing models (*contract*) (Benlian and Hess 2011; Dongus et al. 2014; Schneider and Sunyaev 2014). Hence, CC arrangements are best described as market-based arrangements, while traditional outsourcing arrangements are best described as hierarchical arrangements (*arrangement*) (Chen and Wu 2013; Gurbaxani and Whang 1991).

Based on these characteristics, CC has to be considered as a specific form of ITO and different outcomes from evolutionary development results (see *Table 2*). Because CC is technology-enabled and available to all customers' firms IT resources are better described as a commodity good and not as a source of competitive advantage anymore (Chae et al. 2014; Chen and Wu 2013). The standardization of interfaces and functionalities enables customers to adopt cloud services without facing up-front investments (Susarla et al. 2003; Xin and Levina 2008). At the same time, CSP are able to rapidly provide and release cloud services for new customers with minimal management effort (Mell and Grance 2011). The contractual mode of cloud services with short-term contracts enables customers to switch between providers more often if not satisfied with the service (Benlian and Hess 2011; Dongus et al. 2014; Schneider and Sunyaev 2014). Finally, within a market-based arrangement, customer faces operational (transactional) and contractual (writing contracts) costs when selecting CSP (Chen and Wu 2013; Gurbaxani and Whang 1991; Xin and Levina 2008). As such differences between CC and ITO exist, it is unclear if ITO provider selection criteria also hold true for selecting CSP.

Dimension	Characteristics of ITO	Characteristics of CC	Outcomes from evolutionary development of CC	Source
Delivery Model	Often entails transfer of human and physical assets available to dedicated customers' firms	Technology-enabled outsourcing via the internet available to all customers' firms	Commoditization of IT resources leads to equalization of competitive advantages regarding used IT.	(Chae et al. 2014; Chen and Wu 2013)
Scope	Customer-tailored services	Standard interfaces and functionalities	No up-front investments for new customers are necessary for both customer and CSP.	(Mell and Grance 2011; Susarla et al. 2003; Xin and Levina 2008)
Contract	Long-term contracts (fixed or time and material pricing models)	Short-term contracts (consumption-based pricing models)	Enable customers to switch between providers more often if necessary.	(Benlian and Hess 2011; Dongus et al. 2014; Schneider and Sunyaev 2014)
Arrangement	Hierarchical arrangement	Market-based arrangement	Customer faces operational (transactional) and contractual (writing and enforcing contracts) costs when selecting CSP.	(Chen and Wu 2013; Gurbaxani and Whang 1991; Xin and Levina 2008)

Table 2. Outcomes from evolutionary development of cloud computing

2.3 Decision Makers' Challenges for Cloud Service Provider Selection

Adopting new technologies, such as cloud services, is a complex phenomenon which includes numerous opportunities and challenges (Luoma and Nyberg 2011). In order to decrease complexity, prior research identified three subsequent problem areas for cloud service adoption: specification, selection, and contract management (Van der Valk and Rozemeijer 2009; Wollersheim and Krcmar 2013). As this research focuses on criteria for CSP selection, we briefly describe the first two problem areas and exclude contract management as this area first becomes important after the selection of a certain provider.

Within the specification and selection area, customers are challenged to identify necessary environmental, organizational, purchase and buying centre characteristics to specify criteria that the cloud service has to satisfy (Wollersheim and Krcmar 2013). Environmental characteristics include legal issues related to certain technologies. Organizational characteristics to be considered include the fit to existing IT architecture and available infrastructure. Depending on the firm's strategy, different risks are acceptable and control mechanisms are needed and will subsequently define purchase characteristics. Finally, buying centre characteristics are defined by buying networks or the composition of the buying centre. Hence, the specification and selection area involves complex criteria decision makers need to consider when selecting CSP.

Prior studies have examined relevant criteria for CSP selection decisions focussing on qualitative, literature based approaches to determine CSP selection criteria (Kaisler et al. 2012; Repschlaeger et al. 2012; Repschläger et al. 2011). Subsequent research selected dedicated items (cost reduction, security and privacy, and reliability) and analysed quantitatively the effects of these items on cloud decisions (Gupta et al. 2013; Lübbecke and Lackes 2015). As an initial result, the researchers identified security and privacy issues as the most important criteria influencing CSP selection decisions. An early approach to analyse different CSP selection criteria quantitatively used an analytic hierarchy process method (Repschlaeger et al. 2013). Because of the complexity of this method, at most seven criteria could be compared concurrently (Repschlaeger et al. 2013). Most studies focused on qualitative and deductive approaches or compared selective criteria which means no comprehensive overview for most important CSP selection criteria as experienced by CC decision makers exists.

The distinctive characteristics of CC and the poor understanding of important CSP selection criteria calls for further research. This research, therefore, extends the ITO literature by considering CC as an evolution and specific form of ITO.

3 Research Approach

To address our research question, we needed input from experts with extensive experience in the cloud computing field and therefore selected the Delphi method. After the Delphi method was developed in the 1950s with the objective of reaching consensus among a panel of experts through an iterative process of controlled feedback (Dalkey and Helmer 1963), IS researchers extensively used such method in the recent years (Chang et al. 2012; Schmidt et al. 2001; Schmidt 1997; Singh et al. 2009). The Delphi method is recommended when "the problem does not lend itself to precise analytical techniques but can benefit from subjective judgments on a collective basis" (Linstone and Turoff 1975). Therefore, the Delphi method provides insights from the collective experience and understanding of an expert panel (Schmidt 1997). Since our study focuses on both identifying most important CSP selection criteria and their relative importance as experienced by experts, the Delphi method was an appropriate choice (Schmidt 1997). The Delphi process stops when a reasonable level of consensus or another pre-defined stop-criterion is achieved (Kendall 1977; Schmidt 1997).

3.1 Panel Selection

We recruited experts with significant work experience in the field of cloud computing in order to obtain valid and robust results. We located our panel of experts, responsible for decision making in regard to CSP selection at their place of employment, at cloud computing workshops and through a special interest group for cloud computing on a social network website. Additionally, experts practicing in this field and known to the researchers through prior work experience, were also included in the panel. All potential participants were asked pre-defined questions regarding their cloud experience and use of cloud deployment and cloud delivery models. In order to ensure a reliable panel, we excluded novice persons (those with less than one-year cloud experience), private and hybrid cloud users, and cloud service users who use cloud services less frequently than once a day. We screened our experts to make sure that as many types of industries as possible, organizations of all sizes and usage of various types of cloud service models were represented in the sample. An overview of all panel selection criteria is consolidated in *Table 3.*

#	Selection criteria	Description
1	CSP decision maker	Experts need to be CSP decision makers.
2	Non-novice person	Experts need more than one-year of cloud experience.
3	Public cloud user	The organization has to use public cloud services.
4	Frequent CS user	Experts need to use cloud service at least once a day.
5	Diversity of used cloud service models	Our panel must include at least three types of cloud service models (IaaS, PaaS, SaaS).
6	Diversity of organizational sizes	Our panel must include organizations of all sizes (Large-sized organization, Medium-sized organization, Small-sized organization).
7	Diversity of industries	Our panel must include a high diversity of industries.
8	Diversity of organizations	Our panel must include a high diversity of organizations.

Table 3. Panel selection criteria

We invited 32 experts fitting to our selection criteria described above, of whom 19 participated (see *Table 4*) in the first round of the study which results in an effective response rate of 59%; no obvious response bias regarding our selection criteria were observed. Our panel included three cloud service models (IaaS, PaaS, SaaS), small-, medium- and large-sized organizations, and different industries (financial services, manufacturing, software development, railway, media, energy, data analytics, public administration, and wholesale). While some of the panellists were responsible for CSP selection within their company, others served as consultants and were frequently challenged with CSP selection for their customers. As some experts are responsible for different cloud service models, experts might be listed several times. Overall, each expert worked for a different company which ensures a diverse perspective on our research topic. As *Table 4* shows, the profile of the panel indicates considerable CSP selection experience for diversity of service models, industries, and company sizes, thus establishing the credibility of the panel.

Cloud service model	Involved company categories	Involved industries	Experts
IaaS	LO (>250), SO (10-49)	Media, Financial services, IT-Consultant, Public administration, Data analytics, IT service, Railway, Manufacturing, Software development	CEO 2, Consultant (Manager), Consultant (Partner 1), Consultant (Partner 2), Consultant (Senior), Project Manager, Business Intelligence Manager, IT-Manager 3, IT-Manager 5, IT-Manager 6, Project Manager, COO 2
PaaS	LO (>250), SO (10-49)	Financial services, IT-Consultant, IT service, Manufacturing, Software development	CEO 2, Consultant (Manager), Consultant (Partner 1), Consultant (Partner 2), Consultant (Senior), IT-Manager 5, IT-Manager 6, COO 2
SaaS	LO (>250), MO (50-250), SO (10-49)	Energy, Manufacturing, Financial services, Communication, IT-Consultant, Software development, Financial services, Railway, Wholesale	IT-Manager 1, CEO 1, COO 1*, Consultant (Manager), Consultant (Partner 1), Consultant (Partner 2), Consultant (Senior), IT-Manager 2*, IT-Manager 4, Project Manager, CEO 3, CEO 4*

* left study after iteration 1 of round 3.
LO = Large-sized organization; MO = Medium-sized organization; SO = Small-sized organization

Table 4. Panellists' overview

3.2 Data Collection and Analysis Method

To investigate the relative importance of CSP selection criteria, we followed a modified version of the Delphi method as proposed by Schmidt (1997). Data was not only collected via brainstorming but also via semi-structured interviews which allowed us to develop a deep understanding of the identified criteria and reasoning behind the participants' individual rankings. Similar to Schmidt et al. (2001) our study design consists of four stages: the preparation stage and three subsequent Delphi rounds (see *Figure 1*). We started our first round in May 2015 and the Delphi study finished in October 2015. Activities during the preparation stage included planning of the study and establishment of the expert panel using a pre-questionnaire as described above.

In round 1, brainstorming and semi-structured interviews with experts were arranged and conducted in order to identify as many CSP selection criteria as possible. While brainstorming enabled us to get a high quantity of possible relevant selection criteria, the semi-structured interviews provided additional information and selection criteria which were not mentioned during brainstorming. After interviewing the experts, the gathered information was transcribed, analysed and synthesised. To aggregate the findings across all interviews, we adapted the method of Strauss and Corbin (1990) and used open and axial coding to identify all relevant criteria. To ensure consistent coding, two researchers independently read and coded all interview transcripts line-by-line using phrases from the transcripts that described CSP selection criteria (open coding) and discussed any conflicting results. This open coding process resulted in a list of 69 codes and 360 phrases. The resulting discussions and the rich body of information within the transcripts provided us with the necessary background information for the subsequent axial coding. After completing the axial coding, we reached a final list of 31 un-ranked CSP selection criteria.

During round 2, we pared the consolidated list of CSP selection criteria into a more manageable set for the ranking phase. Following the suggestion by Schmidt (1997), we presented the experts with a randomised list of the 31 un-ranked CSP selection criteria from round 1 and asked each expert to select (not rank) the most important criteria (at least 10, at most 20) for CSP selection. We provided a brief definition for each selection criterion in order to assure that all experts had the same understanding of each. All 19 experts provided responses in this round 2. After the responses were consolidated, a cut-off value has to be defined which yields to a list of 12 to 15 items for the subsequent ranking phase (Singh et al. 2009). Using this process, we chose a cut-off value of 60% and identified a pared list that included 13 most important CSP selection criteria.

An overview of our overall research process is illustrated in *Figure 1*.

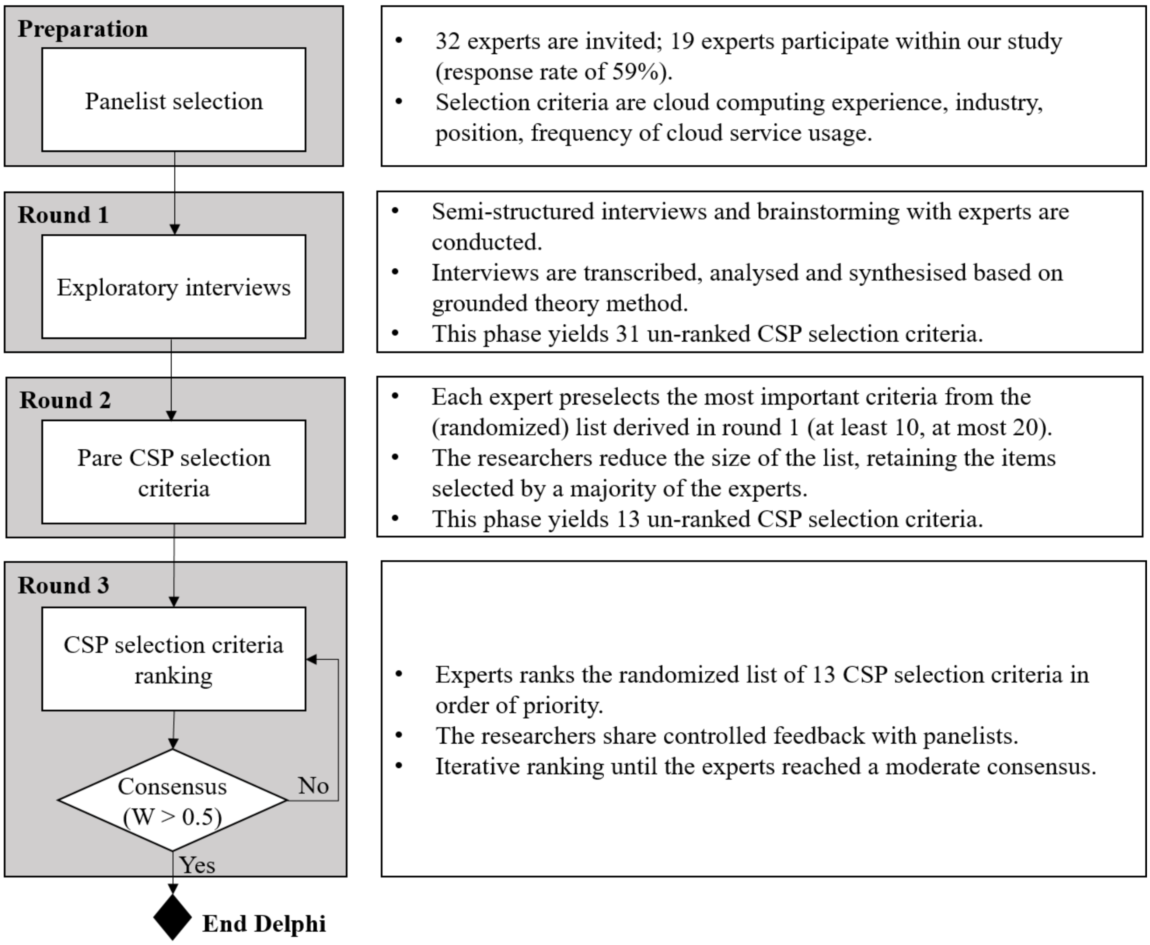

Figure 1. Research process based on Schmidt (1997)

The pared list is transferred to round 3 of the study for ranking. We send the manageable list of 13 CSP selection criteria from the selection round 2 in randomized order to each of our experts and asked them to rank the CSP selection criteria in order of priority. We also asked the experts to explain their reasoning for the chosen ranking. This information would be shared with the experts in subsequent iterations. To measure the degree of consensus among our experts, we followed the approach of Schmidt (1997) and used Kendall's coefficient of concordance (W). Kendall's W is frequently used in Delphi studies and is applied to indicate whether a consensus among the panellists has been reached and the relative strength of the consensus (Schmidt 1997). When Kendall's W is greater than 0.7, strong consensus has been reached, values between 0.5 and 0.7 indicate moderate consensus and values less than 0.5 indicate there is little consensus among panellists (Schmidt 1997). 19 experts participated in the first iteration of ranking in round 3 which yielded a Kendall's W value of 0.22 indicating relatively weak consensus.

Following Schmidt (1997) we decided to continue the ranking process until the coefficient of concordance indicated a moderate consensus. Therefore, we conducted two further iterations within round 3. This time, we provided the following additional information to each expert as controlled feedback: (I) the average rank of each criterion, (II) the ranking given by that expert for each criterion at the prior iteration of ranking, and (III) the percentage of experts who ranked that criterion within the top-50%. As a fourth controlled feedback (IV), we provided a summary of all comments made by the experts for each criterion collected within the prior iteration. Similar to Singh et al. (2009), we believed that this additional information would help the experts to consider their own ranking in light of the group's ranking thus providing them the opportunity to adjust their ranking where it made sense to them to do so. 16 experts participated in the second iteration, yielding a Kendall's W of 0.32. The Kendall's W was 0.69 in our third iteration in which 16 experts participated suggesting that a moderate level of consensus had been reached. According to the rankings made by the experts during iteration three, Kendall's W almost doubled. We believe this result may be due to the fact that the experts were able to reflect their own ranking in light of the panel's ranking by considering the controlled feedback of two iterations. This additional information most likely helped the experts to reach a group consensus.

4 Results

Results of our Delphi study are described next. As mentioned, round 1 (exploratory interviews) yielded to 31 un-ranked CSP selection criteria which have been pared to a manageable number of 13 criteria in round 2 (pare) by majority ranking. Results of round 2 are listed and briefly described in *Table 5*.

CSP selection criteria	**Description provided by panel**
Certification	A CSP is certified by an independent authority in accordance with established requirements or standards.
Contract	The provider offers understandable contractual arrangements including a clear cost structure (e.g. consumption-based pricing model).
Control	A CSP provides remote access tools to provide proactive control of data, functionalities and processes (e.g. customization).
Deployment model	A clearly defined deployment model in terms of ownership, control of architectural design, and degree of available customization exists (e.g. private cloud, hybrid cloud, community cloud, public cloud).
Flexibility	A customer can independently adjust the obtained capabilities and the adjustments are carried out automatically within a short period of time and with transparent costs.
Functionality	The set of functions or capabilities (e.g. availability, usability, security, performance requirements) associated with the cloud solution match the demand of the customer.
Geolocation of servers	Geographical location of providers' servers is suitable in terms of data protection legislation and user latency.
Integration	Configuration of the service enables its smooth integration into the IT landscape of the business.
Legal compliance	Due to its geographical location, policies, etc., a CSP complies with legal and regulatory requirements of the customer.
Monitoring	A manual or automated IT monitoring and management technique which provides transparency of cloud service quality.

Support	A CSP possesses a responsive service support, which provides all operative processes necessary for the handling of service interruptions and for implementation of changes.
Test of solution	A CSP enables convenient trial periods of a service.
Transparency of activities	Transparency of security, data privacy, data access, cloud architecture, service level competencies etc.

Table 5. List of 13 un-ranked CSP selection criteria

Within the subsequent round 3 (ranking) the CSP selection criteria were ranked with regard to their relative importance. *Table 6* presents the 13 CSP selection criteria most often identified by the experts, their average rank, the Kendall's W value for each ranking iteration (round 3), and the final ranking of the selection criteria.

CSP selection criteria	**Iteration 1 average rank**	**Iteration 2 average rank**	**Iteration 3 average rank**	**Final rank**
Functionality	2.95	2.6	1.56	1
Legal compliance	4.79	4.53	2.56	2
Contract	6.42	5.20	3.94	3
Geolocation of servers	5.42	5.27	4.25	4
Flexibility	6.11	6.40	5.75	5
Integration	7.26	7.40	6.88	6
Transparency of activities	7.21	7.07	7.44	7
Certification	8.21	7.20	8.19	8
Monitoring	8.42	8.27	8.75	9
Support	7.89	8.20	9.00	10
Control	8.21	8.67	9.25	11
Deployment model	8.79	9.67	11.56	12
Test of solution	9.32	10.53	11.88	13
Kendall's W*	**0.22**	**0.32**	**0.69**	

* Kendall's W > 0.7 → strong consensus among panellists
0.5 ≤ Kendall's W ≤ 0.7 → moderate consensus among panellists
Kendall's W < 0.5 → little consensus among panellists

Table 6. Intermediate and final ranking of the most important criteria for selecting a cloud service provider

As mentioned, iteration 3 yielded a Kendall's W of 0.69 which indicates that our pre-defined stop-criterion of a moderate consensus was achieved. Since our panel of experts was highly diverse in regard to cloud service model, size of company, and type of industry represented, we conclude that a reasonable degree of confidence in the ranking is reached (Schmidt 1997).

5 Discussion

The conduction of this research was motivated by a poor understanding of the validity of existing ITO provider selection criteria within the context of CC. In order to enhance understanding of this issue, we conducted a Delphi study to identify criteria of importance to experts when selecting CSP. The study yielded the identification and ranking by importance of 13 CSP selection criteria (see *Table 6*).

5.1 Relation between Selection Criteria of Cloud Service Provider and IT Outsourcing Provider

The 13 important criteria for selecting cloud service providers, can be used to make optimal CC investment decisions. Because CC can be seen as an evolution and specific form of ITO, as listed in *Table 7*, we are able to conceptually and directly compare our results to the ITO provider selection criteria reported by Chang et al. (2012). As a structure for our discussion, we use the identified ITO provider selection criteria “capacity of professional skills”, “capacity of operation”, “capacity of service”, and “external evaluation” from Chang et al. (2012).

Chang et al. (2012) defined capacity of professional skills as a current technique and prospective developmental capacity of ITO companies. According to this definition, capacity of professional skills can be connected conceptually to *functionality*, *flexibility*, and *integration* (see *Table 7*) (Lankton et al. 2014). For example, while an ITO provider can perform tasks well, provide flexible problem solving, and make good decisions for future developments, a cloud service cannot perform all these tasks. A cloud service can only perform functions or provide and integrate flexible features which the user requires to accomplish a particular task (Lankton et al. 2014). *Functionality*, *flexibility*, and *integration* are important CSP selection criteria as a customer buys and integrates a certain service to solve problems in a flexible way (Mell and Grance 2011).

ITO provider selection criteria	**Evolution and specific form of CSP selection criteria**	**Conceptual or direct link between ITO and CC**
Capacity of professional skills	Functionality	Lankton et al. (2014)
Capacity of operation	Legal compliance	Ang and Cummings (1997)
Capacity of operation	Contract	Tiwana and Bush (2007)
Capacity of operation	Geolocation of servers	Han and Lee (2012)
Capacity of professional skills	Flexibility	Mell and Grance (2011)
Capacity of professional skills	Integration	Mell and Grance (2011)
External evaluation	Transparency of activities	Meiseberg (2015)
External evaluation	Certification	Sunyaev and Schneider (2013)
External evaluation	Monitoring	Meiseberg (2015)
Capacity of services	Support	Han and Lee (2012)
Capacity of operation	Control	Han and Lee (2012)
Capacity of services	Deployment model	Mell and Grance (2011)
Capacity of services	Test of solution	Chang et al. (2012)

Table 7. Evolution and specific form of CSP selection criteria based on Chang et al. (2012)

Capacity of operation can be related to *legal compliance*, *contract*, *geolocation of servers*, and *control*. For example, ITO customers tend to use formal and informal controls such as contractual arrangements, frequent status meetings, or operation-check visits on the ITO provider site (Tiwana and Bush 2007). Since CSP provide their services over the internet, frequent personal status meetings and visits on the CSP site are not always possible. Instead, a CSP can be indirectly controlled by considering the *legal compliance* of the CSP and the *geolocation of servers* (Ang and Cummings 1997; Han and Lee 2012). In order to consider specific requirements regarding service costs or service descriptions, contractual arrangements and provided control mechanisms are relevant criteria for CSP selection (Han and Lee 2012; Tiwana and Bush 2007).

Capacity of services can be directly related to a *support* and *deployment model* and conceptually related to *test of solution*. End-user support as well as the available service model (for ownership) are important for both selection of ITO and cloud service providers (Chang et al. 2012; Mell and Grance 2011). *Test of solutions* are additional services which help to persuade potential customers to use CSP. Since capacity of services describes service related issues (Chang et al. 2012), a conceptual connection to *test of solution* is appropriate.

Finally, external evaluation can be related directly to *transparency of activities*, *certification*, and *monitoring*. For example, ITO customers tend to trust any suggestions and/or recommendations coming from known business partners when selecting ITO providers (Chang et al. 2012). Because *transparency of activities*, *certifications*, and *monitoring* are instruments to establish trust (Meiseberg 2015; Sunyaev and Schneider 2013), these identified CSP selection criteria are also applicable as ITO provider selection criteria.

Our results for CSP selection criteria also represent ITO provider selection criteria for a technology-enabled and market-based outsourcing arrangement (see *Table 7*). According to our findings, the rich body of ITO knowledge is still valid within the context of CC, and CC can be seen as an evolution and specific form of ITO.

5.2 Limitations, Implications and Future Research

As with any study, the results of the current study must be interpreted in the context of the limitations and constraints which attend its generalisability, expert selection, and abstraction level of CSP selection criteria. First, the final study results are based on the participation of 16 experts and thus, may not be generalisable to a larger population or prescriptive in nature. Being able to analyse results from a larger group of CC decision makers from other firms or countries, or for other cloud delivery models (such as private cloud) would be advantageous for future studies. Second, our experts were not chosen randomly and we did not attempt to control for the criticality (in terms of data sensibility) for used cloud services. Hence, future research could address this issue by providing a larger, randomized sample and control for criticality of used cloud services. Third, we considered CSP selection criteria on a high abstraction level. To provide further insights, future research may use our results as a research agenda for investigating CSP selection criteria on a lower abstraction level. Therefore, researchers may focus on functionality aspects e.g. considering customers' functional preferences for different cloud delivery models, on legal compliance e.g. privacy issues, on contract related aspects e.g. different pay-per-use models, or on impact of geolocation of servers on CSP selection within future investigations.

However, to the best of our knowledge, this is the first study to apply a comprehensive scope of experts from multiple industries, of different organizational sizes, and using different cloud service models to identify most important criteria for CSP selection. The results obtained in our study extend criteria mentioned in previous literature for CSP selection and provide a better understanding about their relative importance (Garrison et al. 2012; Garrison et al. 2015; Schneider and Sunyaev 2014). In that vein, contrary to the suggestion of Schneider and Sunyaev (2014), we identified consensus regarding the importance of relevant criteria across different service models. We explain our findings by considering the abstraction level of relevant CSP selection criteria. Since we aimed to also consider non-functional criteria, we combined functional criteria on a high abstraction level and simultaneously consider further non-functional criteria on a high abstraction level. Therefore, on a high abstraction level, the preferences of our experts resulted in consensus. Our interview analysis suggests that functional selection criteria of SaaS solutions may considerably differ from functional selection criteria of IaaS or PaaS solutions when considering different industries or application areas. Hence, we suggest that future research in the CC context should focus on organizational or environmental characteristics to examine differences within functionality aspects.

Our results indicate that inter-organizational control mechanisms within CC context are vital. In traditional ITO, relational controls are in use to complement formal controls like service-level-agreements (SLA) (Gopal and Koka 2012). Particularly, this is important when high task uncertainty exists (Rustagi et al. 2008). CC faces continuously high uncertainty because cloud services are delivered over the internet from an external CSP which means inherently low controllability (KPMG 2015). In order to complement formal controls, CC decision makers need a greater amount of relational control mechanisms, in comparison to ITO decision makers, as the importance of capacity of operations increases for conceptually related CSP selection criteria (Chang et al. 2012; Gopal and Koka 2012).

Since CC is a technology-enabled and market-based outsourcing arrangement via the internet, particularly IS based control mechanism are needed to assure organizational performance and organizational integrity (Chen and Wu 2013; Schermann et al. 2012). IS based control mechanisms enable organizations to detect or even prevent failures, and to assure outcomes (Wiesche et al. 2012). Therefore, we call for further research to examine inter-organizational IS based control mechanisms to reduce market uncertainty.

Overall, our results support findings from previous ITO studies regarding provider selection criteria. Nevertheless, since diverging developments between CC and ITO exist, researchers should re-examine ITO findings within the context of CC in order to identify new developments.

This study presents valuable insights for practitioners. The list of 13 un-ranked CSP selection criteria validated by 19 experts clearly delineates aspects that should be taken into consideration when making CC investment decisions from both the CSP and customer viewpoint. Furthermore, the ranked list of 13 CSP selection criteria provides a compact list containing the most important criteria in the opinion of our experts. This list could enable practitioners to focus on most important information with the greatest influence on optimal CC investment decisions. CSP, or possibly certification authorities, may use this list to provide most important information to cloud customers. Decision makers can use the list to direct their limited resources toward addressing the most important CSP selection criteria.

6 Conclusion

In this study, we investigate the most important criteria, as identified by experts, for the selection of CSP. To answer our research question, we conducted an exploratory Delphi study on experts' opinion. We identified 13 CSP selection criteria and ranked their importance. We further show that our results for CSP selection criteria represent ITO provider selection criteria for a technology-enabled and market-based outsourcing arrangement.

Our main contribution is threefold. First, our results support prior findings that CC can be seen as an evolution and specific form of ITO and the rich body of ITO knowledge should be leveraged within the context of CC. Second, our results serve as a research agenda for future investigations on CSP selection decisions. Third, we contribute to practice by providing a comprehensive overview of most important CSP selection criteria when making CC investment decisions from both the CSP and customer viewpoint.

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References

Agrawal, M., Kishore, R., and Rao, H. R. 2006. "Market Reactions to E-Business Outsourcing Announcements: An Event Study," *Information & Management* (43:7), pp. 861-873.

Ang, S., and Cummings, L. L. 1997. "Strategic Response to Institutional Influences on Information Systems Outsourcing," *Organization Science* (8:3), pp. 235-256.

Benlian, A., and Hess, T. 2011. "Opportunities and Risks of Software-as-a-Service: Findings from a Survey of It Executives," *Decision Support Systems* (52:1), pp. 232-246.

Chae, H.-C., Koh, C. E., and Prybutok, V. R. 2014. "Information Technology Capability and Firm Performance: Contradictory Findings and Their Possible Causes," *Management Information Systems Quarterly* (38:1), pp. 305-326.

Chang, S.-I., Yen, D. C., Ng, C. S.-P., and Chang, W.-T. 2012. "An Analysis of It/Is Outsourcing Provider Selection for Small-and Medium-Sized Enterprises in Taiwan," *Information & Management* (49:5), pp. 199-209.

Chen, P.-y., and Wu, S.-y. 2013. "The Impact and Implications of on-Demand Services on Market Structure," *Information Systems Research* (24:3), pp. 750-767.

Dalkey, N., and Helmer, O. 1963. "An Experimental Application of the Delphi Method to the Use of Experts," *Management science* (9:3), pp. 458-467.

Dongus, K., Yetton, P., Schermann, M., and Krcmar, H. 2014. "Transaction Cost Economics and Industry Maturity in It Outsourcing: A Meta-Analysis of Contract Type Choice," *Proceedings of the European Conference on Information Systems (ECIS) 2014*, Tel Aviv, Israel.

Galer, S. 2015. "Idc Releases Top Ten 2016 It Market Predictions." Retrieved 22.11.2015, 2015, from http://www.digitalistmag.com/technologies/2015/11/13/idc-releases-top-ten-2016-it-market-predictions-03746307

Garg, S. K., Versteeg, S., and Buyya, R. 2013. "A Framework for Ranking of Cloud Computing Services," *Future Generation Computer Systems* (29:4), pp. 1012-1023.

Garrison, G., Kim, S., and Wakefield, R. L. 2012. "Success Factors for Deploying Cloud Computing," *Communications of the ACM* (55:9), pp. 62-68.

Garrison, G., Wakefield, R. L., and Kim, S. 2015. "The Effects of It Capabilities and Delivery Model on Cloud Computing Success and Firm Performance for Cloud Supported Processes and Operations," *International Journal of Information Management* (35:4), pp. 377-393.

Gartner. 2015. "Forecast Analysis: Public Cloud Services, Worldwide, 1q15 Update." Retrieved 18.11.2015, 2015, from https://www.gartner.com/doc/3077621/forecast-analysis-public-cloud-services

Gopal, A., and Koka, B. R. 2012. "The Asymmetric Benefits of Relational Flexibility: Evidence from Software Development Outsourcing," *MIS Quarterly* (36:2), pp. 553-576.

Gupta, P., Seetharaman, A., and Raj, J. R. 2013. "The Usage and Adoption of Cloud Computing by Small and Medium Businesses," *International Journal of Information Management* (33:5), pp. 861-874.

Gurbaxani, V., and Whang, S. 1991. "The Impact of Information Systems on Organizations and Markets," *Communications of the ACM* (34:1), pp. 59-73.

Han, J.-S., and Lee, S.-Y. T. 2012. "Impact of Vendor Selection on Firms' It Outsourcing: The Korea Experience," *Journal of Global Information Management* (20:2), pp. 25-43.

Jain, A., and Thietart, R.-A. 2013. "Knowledge Based Transactions and Decision Framing in Information Technology Outsourcing," *The Journal of Strategic Information Systems* (22:4), pp. 315-327.

Kaisler, S., Money, W. H., and Cohen, S. J. 2012. "A Decision Framework for Cloud Computing," *Hawaii International Conference on System Science (HICSS), 2012* Maui, USA: IEEE, pp. 1553-1562.

Kendall, J. W. 1977. "Variations of Delphi," *Technological forecasting and social change* (11:1), pp. 75-85.

Kourtesis, D., Bratanis, K., Friesen, A., Verginadis, Y., Simons, A. J., Rossini, A., Schwichtenberg, A., and Gouvas, P. 2014. "Brokerage for Quality Assurance and Optimisation of Cloud Services: An Analysis of Key Requirements," *Service-Oriented Computing – ICSOC 2013 Workshops*: Springer, pp. 150-162.

KPMG, A. 2015. "Cloud Monitor 2015. Cloud-Computing in Deutschland – Status Quo Und Perspektiven," KPMG AG, Bitkom.

Lacity, M. C., Khan, S., Yan, A., and Willcocks, L. P. 2010. "A Review of the It Outsourcing Empirical Literature and Future Research Directions," *Journal of Information technology* (25:4), pp. 395-433.

Lankton, N., McKnight, D. H., and Thatcher, J. B. 2014. "Incorporating Trust-in-Technology into Expectation Disconfirmation Theory," *The Journal of Strategic Information Systems* (23:2), pp. 128-145.

Leimeister, S., Böhm, M., Riedl, C., and Krcmar, H. 2010. "The Business Perspective of Cloud Computing: Actors, Roles and Value Networks," *Proceedings of the European Conference on Information Systems (ECIS) 2010*, Pretoria, South Africa.

Liang, H., Wang, J.-J., Xue, Y., and Cui, X. 2015. "It Outsourcing Research from 1992 to 2013: A Literature Review Based on Main Path Analysis," *Information & Management*).

Linstone, H. A., and Turoff, M. 1975. *The Delphi Method: Techniques and Applications*. Boston, USA: Addison-Wesley Publishing.

Loh, L., and Venkatraman, N. 1992. "Diffusion of Information Technology Outsourcing: Influence Sources and the Kodak Effect," *Information Systems Research* (3:4), pp. 334-358.

Lübbecke, P., and Lackes, R. 2015. "Drivers and Inhibitors for the Adoption of Public Cloud Services– an Empirical Study," in: *Twenty-first Americas Conference on Information Systems*. Puerto Rico.

Luftman, J. D., Barry, Dwivedi, R., Santana, M., Zadeh, H. S., and Rigoni, E. 2015. "Influential It Management Trends: An International Study," *Journal of Information Technology* (30:3), pp. 293-305.

Luoma, E., and Nyberg, T. 2011. "Four Scenarios for Adoption of Cloud Computing in China," *Proceedings of the European Conference on Information Systems (ECIS) 2011*, Helsinki, Finland.

Meiseberg, B. 2015. "Linkages among Trust, Monitoring & Performance in Interfirm Relationships: A Cross-National Study," *Academy of Management Proceedings*, Vancouver, Canada.

Mell, P., and Grance, T. 2011. "The Nist Definition of Cloud Computing," National Institute of Standards and Technology.

Menzel, M., Ranjan, R., Wang, L., Khan, S. U., and Chen, J. 2015. "Cloudgenius: A Hybrid Decision Support Method for Automating the Migration of Web Application Clusters to Public Clouds," *IEEE Transactions on Computers* (64:5), pp. 1336-1348.

Michell, V., and Fitzgerald, G. 1997. "The It Outsourcing Market-Place: Vendors and Their Selection," *Journal of Information Technology* (12:3), pp. 223-237.

Morgan, L., and Conboy, K. 2013. "Factors Affecting the Adoption of Cloud Computing: An Exploratory Study," *Proceedings of the European Conference on Information Systems (ECIS) 2013*, Utrecht, Netherlands.

Repschlaeger, J., Wind, S., Zarnekow, R., and Turowski, K. 2013. "Decision Model for Selecting a Cloud Provider: A Study of Service Model Decision Priorities," *Proceedings of the Nineteenth Americas Conference on Information Systems*, Illinois, USA.

Repschlaeger, J., Zarnekow, R., Wind, S., and Turowski, K. 2012. "Cloud Requirement Framework: Requirements and Evaluation Criteria to Adopt Cloud Solutions," *Proceedings of the European Conference on Information Systems (ECIS) 2012*, Barcelona, Spain, p. 42.

Repschläger, J., Wind, S., Zarnekow, R., and Turowski, K. 2011. "Developing a Cloud Provider Selection Model," *Enterprise Modelling and Information Systems Architectures*, Hamburg, Germany, pp. 163-176.

Rustagi, S., King, W. R., and Kirsch, L. J. 2008. "Predictors of Formal Control Usage in It Outsourcing Partnerships," *Information Systems Research* (19:2), pp. 126-143.

Schermann, M., Wiesche, M., and Krcmar, H. 2012. "The Role of Information Systems in Supporting Exploitative and Exploratory Management Control Activities," *Journal of Management Accounting Research* (24:1), pp. 31-59.

Schmidt, R., Lyytinen, K., and Mark Keil, P. C. 2001. "Identifying Software Project Risks: An International Delphi Study," *Journal of management information systems* (17:4), pp. 5-36.

Schmidt, R. C. 1997. "Managing Delphi Surveys Using Nonparametric Statistical Techniques," *Decision Sciences* (28:3), pp. 763-774.

Schneider, S., and Sunyaev, A. 2014. "Determinant Factors of Cloud-Sourcing Decisions: Reflecting on the It Outsourcing Literature in the Era of Cloud Computing," *Journal of Information Technology*), pp. 1-31.

Singh, R., Keil, M., and Kasi, V. 2009. "Identifying and Overcoming the Challenges of Implementing a Project Management Office," *European Journal of Information Systems* (18:5), pp. 409-427.

Strauss, A. L., and Corbin, J. M. 1990. *Basics of Qualitative Research*. Newbury Park, USA: Sage

Sun, L., Dong, H., Hussain, F. K., Hussain, O. K., and Chang, E. 2014. "Cloud Service Selection: State-of-the-Art and Future Research Directions," *Journal of Network and Computer Applications* (45), pp. 134-150.

Sunyaev, A., and Schneider, S. 2013. "Cloud Services Certification," *Communications of the ACM* (56:2), pp. 33-36.

Susarla, A., Barua, A., and Whinston, A. B. 2003. "Understanding the Service Component of Application Service Provision: Empirical Analysis of Satisfaction with Asp Services," *Management Information Systems Quarterly* (27:1), pp. 91-123.

Tiwana, A., and Bush, A. A. 2007. "A Comparison of Transaction Cost, Agency, and Knowledge-Based Predictors of It Outsourcing Decisions: A Us-Japan Cross-Cultural Field Study," *Journal of Management Information Systems* (24:1), pp. 259-300.

Van der Valk, W., and Rozemeijer, F. 2009. "Buying Business Services: Towards a Structured Service Purchasing Process," *Journal of Services Marketing* (23:1), pp. 3-10.

Wiesche, M., Bodner, J., and Schermann, M. 2012. "Antecedents of It-Enabled Organizational Control Mechanisms," *European Conference on Information Systems*, Barcelona.

Wollersheim, J., and Krcmar, H. 2013. "Purchasing Processes for Cloud Services-an Exploratory Study of Process Influencing Factors," *22nd Annual IPSERA Conference*, Nantes, France, pp. 1285-1295.

Xin, M., and Levina, N. 2008. "Software-as-a-Service Model: Elaborating Client-Side Adoption Factors," *Proceedings of the 29th International Conference on Information Systems (ICIS) 2008*, Paris, France.

Yang, H., and Tate, M. 2012. "A Descriptive Literature Review and Classification of Cloud Computing Research," *Communications of the Association for Information Systems* (31:2), pp. 35-60.