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Sebastian Schlauderer

Sven Overhage

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# Selecting Cloud Service Providers - Towards a Framework of Assessment Criteria and Requirements

Sebastian Schlauderer and Sven Overhage

Chair of Industrial Information Systems, University of Bamberg, Bamberg, Germany  
{sebastian.schlauderer, sven.overhage}@uni-bamberg.de

**Abstract.** The on-demand usage of enterprise software services from the cloud rapidly evolves towards a viable IT outsourcing option. Although the successful use of software services considerably depends on the ability of the consumers to assess the various offerings and select the ones best suited, literature provides little support for the evaluation of software services and their providers. In this manuscript, we address the question of how to support the evaluation of software service providers. Building upon a design science research approach and a literature survey, we propose an assessment framework that assembles relevant criteria for the evaluation of software service providers. We examine the practical relevance of the assembled criteria using the results of an empirical study, in which we surveyed 28 experts on the subject matter. The results indicate that the framework is effective in supporting the assessment of service providers.

**Keywords:** Software as a service, provider evaluation, assessment criteria

## 1 Introduction

With the persisting trend to offer software as a service, ever more complex enterprise software functionality becomes available in the cloud. The on-demand usage of enterprise software services (ESS) accordingly provides a viable IT outsourcing option today [1]. Studies show that using complex enterprise software such as customer relationship management (CRM) systems as a service from the cloud can indeed lead to reduced costs, a shorter time to market, and an increased flexibility [1, 2]. It is therefore expected that the market for ESS will continue its rapid growth.

The successful adoption of ESS considerably depends on the ability of the consumers to differentiate between the various service offerings and select the ones best suited, however. As the market for ESS is diverse, many offerings naturally do not, or only partially, meet the consumers' expectations [3, 4]. At the same time, the decision to adopt a specific ESS is difficult to reverse since a lacking interoperability between services from different providers often leads to a so-called vendor lock-in. Literature therefore emphasizes the development of competencies to evaluate and select appropriate ESS as an important challenge for IT departments [4-7].

Nevertheless, the evaluation of software service offerings is not sufficiently supported in literature yet. Instead, research regarding the selection and adoption of ESS

is still primarily focused on identifying basic mechanisms such as the drivers for the adoption of cloud computing, the types of service implementation, or the different adoption dimensions [8-10]. In comparison, there seem to exist only few research endeavors that address the assessment of software service offerings. In particular, some approaches have been proposed to compare a consumer's software requirements with the functional and non-functional characteristics of the provided cloud software [11, 12]. These approaches bear similarities with well-established approaches to assess and select traditional standard software packages that are used on the premises.

To evaluate the suitability of software service offerings, it is not sufficient to only look at the provided software, however. As software services are co-produced by consumers and providers, it is mandatory to also inspect the service providers and their characteristics. Studies indicate, for instance, that the reputation of a service provider might even be more important for consumers than financial aspects such as the costs for using a service [13]. Yet, research about relevant provider characteristics and consumer preferences is still rare [3]. It hence remains unclear how software service providers can be systematically evaluated and which criteria ought to be assessed.

To contribute to the closure of this literature gap, we propose a new assessment framework that assembles relevant criteria for the evaluation of software service providers and organizes them into a coherent structure. Building upon a design science research approach [14, 15] and the results of a literature survey, we address the following research questions: *How can software service providers be systematically evaluated? Which criteria ought to be assessed when evaluating a software service provider?* We examine the practical relevance of the developed framework using the results of an empirical study, in which we surveyed 28 experts on the subject matter.

The remaining manuscript is organized according to Gregor's and Hevner's guidelines for publishing the results of design science research endeavors [16]: next, we discuss related work to highlight the literature gap. We then describe our research approach in section 3. In section 4, we present the developed assessment framework and elaborate on its criteria for the evaluation of software service providers. We then discuss the results of our study to evaluate the assessment framework in section 5. In section 6, we discuss the findings, implications, and limitations of our research.

## **2 Related Work**

To compile relevant literature and confirm the research gap, we conducted a systematic literature review based on the recommendations of Webster and Watson [17]. Following our research questions, we were interested in identifying literature that addresses the adoption of software services in general as well as literature that addresses the assessment and selection of enterprise software and ESS offerings in particular. To explore a wide range of publications, we queried multiple literature databases, among them the AIS Electronic Library, IEEE Xplore, ACM Digital Library, EBSCOHost, or Google Scholar. We inspected the titles and abstracts of the manuscripts that matched our keyword-based searches to sort out irrelevant articles. The remaining articles were evaluated in detail and selected based on their full texts. Additional-

ly, we conducted backward and forward searches starting from the literature sections of the selected articles to identify further manuscripts [17]. Using a narrative review method, we then qualitatively interpreted the articles we had found [18].

The results of our literature review indicate that research regarding software as a service initially concentrated on technological issues such as the cloud computing concept, implementation architectures, and technologies [10]. A literature study revealed that, until 2012, only 14 percent of the examined research articles targeted business-related issues [10]. To fully leverage the opportunities that are associated with software as a service, research has to also investigate business-related aspects, however [13, 19]. Such research is particularly focusing on the adoption of software services [10]. Using theoretical lenses like the transaction cost theory, the diffusion of innovation theory, or the resource dependency theory, various studies have investigated which factors affect the perception of software services and if they contribute to a successful adoption in practice [9, 20-24]. Nevertheless, only a few research endeavors seem to have examined the evaluation and selection of software services so far.

In part, the evaluation and selection of software services can be supported with traditional approaches that have been designed to assess third-party software packages (such as CRM systems), which are shipped and installed on the consumers' premises [25, 26]. Such approaches allow consumers to systematically compare their requirements with the functional and non-functional properties of the available software products. In particular, they support examining the business functionality, the programming interfaces, and the quality characteristics of third-party software products [27]. On this basis, it becomes possible to identify and select the software product (e.g. the CRM system) that best fulfills the consumer's software requirements. Most approaches that were so far proposed to support the selection of software services bear significant similarities to such traditional assessment approaches. Overhage and Schlauderer [11], Zardari and Bahsoon [28], and Menychtas et al. [29] for instance have proposed approaches to evaluate software services according to the functional requirements of the consumer. Martens et al. [12] and Garg et al. [30] have developed approaches to select software services based on the non-functional requirements of the consumer.

To evaluate the suitability of a software service, it is not sufficient to only inspect the characteristics of the provided software, however. Other than traditional software packages, which are used self-responsibly by the consumer, software services are co-produced by the consumer and the provider. In particular, the service provider is responsible for ensuring the continuous operation and availability of the provided software (e.g. the CRM system). Next to the characteristics of the software, the characteristics of the service provider therefore become an important factor when selecting a software service. For instance, the location of the provider's data center and the implemented privacy policy often form important criteria when selecting software services [31]. Other studies have shown that the reputation of a provider and the use of standards might even be more important when selecting a software service than financial aspects such as the costs [13]. It is hence necessary to develop approaches for the selection of software services that also take into account the service provider [3].

Despite the necessity to also assess the service providers, little research has investigated which provider characteristics are of relevance when searching for suitable

software services. While there exist manifold indications of potentially relevant provider characteristics in literature, we found only two research endeavors trying to define relevant criteria for the assessment of software service providers [3, 32]. So far, however, only abstract assessment criteria [32] or provider requirements from the viewpoint of a specific consumer group [3] have been suggested. To fill the existing literature gap, we aim at developing a consolidated framework with generic and concrete requirements that can be evaluated to assess the suitability of service providers.

### 3 Research Approach

To develop a framework with criteria and requirements to evaluate software service providers, we followed the design science paradigm. This paradigm provides guidelines to ensure the rigorous, scientific construction of novel artifacts [14]. In order to enhance the traceability of our research endeavor, we adhered to the design cycle, a structured, iterative procedure model (see Fig. 1). The employed design cycle is based on the work of Takeda et al. [33]. It contains a sequence of dedicated design research steps. After the evaluation of the designed artifact has been completed, it supports the beginning of a new iteration to refine the solution concept and the design artifact. This procedure is meant to be repeated until a satisfactory evaluation result is achieved.

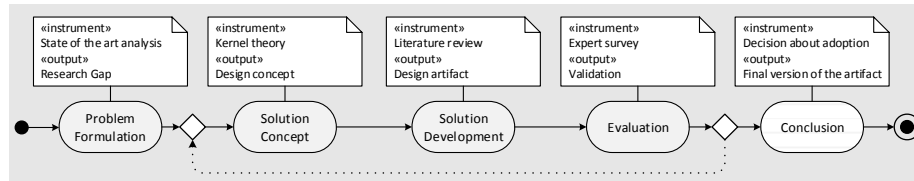


Fig. 1. Design science research cycle [33]

Currently, we have completed the first iteration of the design cycle. During the problem formulation step, we conducted an analysis of the current state of the art in order to concretize the research problem. We analyzed related work and classified the articles according to their objectives. The result of this step was the identified research gap as described in the last section. Thereafter, we designed the structure of the framework as a solution concept. As recommended in literature, we based the design of our framework upon a kernel artifact. Kernel artifacts shall provide a theoretical foundation for the design of new artifacts. They inform the design activity with applicable and well-established knowledge [15]. As kernel artifact, we used the ISO 9126 standard [34], a generic framework that supports the assessment of the quality of software artifacts. To this end, it is hierarchically structured into assessment criteria, properties, and concrete metrics. We took over this structure when designing the solution concept in order to support an assessment of the provider quality in a similar manner.

During the solution development step, we then populated the framework with specific criteria, properties and requirements. To achieve this goal, we conducted a literature review and examined articles on the evaluation and selection of cloud services. In addition, we surveyed articles that identify and discuss risks in cloud computing to

find additional requirements for service providers. We systematically categorized the gathered requirements and structured them according to the solution concept.

Finally, we empirically evaluated the framework by surveying experts on the subject matter. As the framework design was in an early stage, we concentrated on verifying that the identified assessment criteria and requirements are indeed found to be relevant. In addition, we wanted to get an indication if all the criteria are perceived as equally important or if they are found to be of differing significance. Based on the results, we plan to further refine the framework in future iterations of the design cycle.

## **4 Assessment Framework**

During a broad literature review on the subject matter, we identified 39 different requirements R1-R39 that can in principle be used to evaluate the suitability of a cloud service provider (see Table 1). To increase the understandability of the resulting framework, we thematically grouped the identified requirements according to the provider characteristics that they address. Borrowing from the structure of the ISO 9126 framework [34], we introduced a hierarchy of three levels that consists of assessment criteria (general evaluation topics; level 0), assessment properties (provider characteristics; level 1), and measurable items (concrete requirements; level 2).

To derive the thematic grouping, we transcribed the definitions of the requirements that were provided in literature and analyzed them in three steps [35, 36]. First, we used open coding to identify the provider characteristics that they refer to. Second, we grouped requirements with the same or a similar code into segments to identify provider characteristics that were repeatedly referred to (e.g. the requirements “security of data centers” and “security of the network” both refer to the security architecture). In so doing, we identified 15 different provider characteristics as assessment properties. We then analyzed the provider characteristics and grouped thematically related characteristics to obtain general evaluation topics as assessment criteria. Altogether, we could derive five thematically different assessment criteria characterizing the suitability of a cloud service provider: the service contract, the provider’s trustworthiness, the technology, the IT security, and the implemented service management (Table 1).

### **4.1 Service contract**

The requirements with respect to the service contract characterize the ability of consumers to contractually stipulate a desired service behavior. An important aspect is the provided service quality, which can be specified in terms of the availability and efficiency of the service [12, 30]. The ISO 9126 standard offers several metrics for that purpose [34]. Often, however, software quality specifications do not form a part of the legal contract. Service consumers should therefore mandate that a specification of the desired service availability (R1), the aspired availability of the customer data (R2), and the wanted service efficiency (R3) are included into the service contract.

As a second element, literature emphasizes the costs that result from using a service [30, 37]. The software as a service paradigm paves the road for new, usage-de-

pendent pricing models. Ideally, a service provider should hence offer a flexible pricing model based on the actual service usage (R5). In this case, however, the service provider should provide detailed pricing information that specifies the arising costs in relation to the usage. This information should also be part of the service contract (R4).

**Table 1.** Assessment criteria and requirements

Crit.	Property	Requirement	Frequency
Service contract	Performance obligations	R1. Service availability	F
		R2. Data availability	S
		R3. Service efficiency	F
	Cost analysis	R4. Detailed pricing information	F
		R5. Flexible pricing model	F
	Contract violation and settlement	R6. Sanctions in case of contract violation	M
		R7. Phase-out procedures after contract termination	S
		R8. Return of customer data after contract completion	S
Trustworthiness	Transparency	R9. Data center locations	F
		R10. Subcontractors (and their locations)	S
		R11. Financial stability of provider	S
		R12. Ownership structure and rights	S
	Personnel policy	R13. Control of access to customer data	F
		R14. Letters of adherence	S
		R15. Employment of trained personnel	S
	Rights of control	R16. Possibility to conduct on-site inspections	M
		R17. Possibility to conduct on-site audits	M
	Certification	R18. Third-party certificate	F
R19. Certified sub-contractors		M	
R20. Publication of audit results		S	
Technology	Compatibility	R21. Service portability	F
		R22. Data portability	F
		R23. Interoperability	F
	Elasticity	R24. On-demand scalability	F
	Modularity	R25. Tailor-made solution	M
Accessibility	R26. Browser / access medium compatibility	M	
IT security	Security architecture	R27. Data center security	F
		R28. Network security	F
		R29. Server security	M
		R30. Platform security	M
	Data security	R31. Access control	F
		R32. Multi-client capability	S
		R33. Data encryption	F
		R34. Data backup and restore	M
		R35. Secure data erasure	S
	Sv. mgmt.	Service controlling	R36. Information security management
R37. Business continuity management			S
R38. Security incident management			M
Measurement		R39. Continuous monitoring of service quality	F

Legend: F: frequent (>10 occurrences); M: medium (5-10 occurrences); S: sporadic (<5 occurrences)

Third, a comprehensive description of the service behavior also has to account for scenarios in which the contract has been broken or terminated [38, 39]. To achieve this goal, the service contract should contain sanctions for contract violations (R6). It should also be possible to specify phase-out and handover activities that need to be executed after a contract has been terminated (R7), e.g. in the case of a bankruptcy of the provider. Finally, it should be possible to define any procedures that are needed to return the stored data to the service consumer upon completion of the contract (R8).

## 4.2 Trustworthiness

The requirements of the trustworthiness category characterize the provider's ability to reliably execute an offered service. A crucial feature of the provider in this context is transparency vis-à-vis to the customers [13, 30, 39]. To achieve transparency, service providers should communicate the data center locations (R9) and the involved sub-contractors and their locations (R10). Furthermore, providers should publish information about their financial stability (R11), and the ownership structure (R12). To increase the trustworthiness, a service provider moreover ought to implement a restrictive personnel policy [40]. Such a personnel policy should specifically encompass the implementation of control mechanisms to limit the access to customer data (R13), the formulation and enforcement of letters of adherence (R14), and the exclusive deployment of trained personnel (R15).

According to the results of our literature review, an important measure to increase the trustworthiness furthermore is the granting of control rights to service consumers [30]. To this end, a service provider should allow his/her customers to conduct on-site inspections (R16) and on-site audits (R17). In addition, service providers can acquire third-party certificates that attest the implementation of technical and organizational measures to ensure the IT security, data security, service quality etc. [30]. Service consumers should mandate the presentation of such certificates (R18). They should also demand that all involved sub-contractors are certified (R19). Depending on the application scenario, service consumers could also require providers to publish details of the audits, which were conducted during the certification process (R20).

## 4.3 Technology

The requirements belonging to the technology category characterize the provider's IT platform. As a crucial platform characteristic, literature emphasizes the compatibility, i.e. the portability and interoperability of the platform [13, 41]. The platform compatibility is of strategic importance for service consumers as the use of non-compatible platforms makes them dependent on the provider and can cause a vendor lock-in. Ideally it should be possible to migrate entire cloud services to other providers (R21). At least, however, it ought to be possible to migrate the stored data, e.g. due to the use of standardized data formats (R22). It also ought to be possible to connect the provided service to those of other providers, e.g. by making use of standard interfaces (R23).

As another platform feature, the elasticity of the IT platform is discussed in literature. This feature is a prerequisite to offer rapidly scalable software services [13, 24].



While consumers usually do not have a direct influence on the providers' IT platform, they should at least demand that the infrastructure is scalable on demand (R24).

Finally, literature emphasizes the modularity and accessibility as desirable properties of cloud service platforms. Modular platforms contain multiple small-grained services that can flexibly be combined according to the consumer's preferences [41]. Service consumers should accordingly demand that the service provider is able to deliver tailor-made cloud solutions (R25). In addition, they should mandate that the service is accessible from the desired access media (R26). The accessibility of a service is an important factor that significantly influences its usability in practice [30].

#### **4.4 IT security**

The requirements summarized under the IT security category describe the measures of the provider to protect the data of service consumers. Hosting data under foreign control is a critical issue that requires stringent security policies to be implemented by the service providers. On the one hand, providers ought to implement a security architecture [40, 41]. As part of this activity, they have to take measures to ensure the security of the data centers (R27), the security of the communication network (R28), the security of the servers (R29), and the security of the provided software platforms (R30).

On the other hand, providers should define and implement a data security policy [30, 42]. Such a policy is multi-dimensional in nature. In particular, service providers have to limit and control access to customer data (R31). They furthermore ought to implement multi-client capabilities to keep data of different customers separate (R32). In order to guarantee data integrity and privacy, service providers should also employ encryption technologies (R33). Finally, service providers ought to make use of techniques to backup and restore data (R34) and to securely erase data on demand (R35).

#### **4.5 Service management**

The requirements contained in the service management category describe the provider's management activities to ensure the continuity of his/her services during runtime. In general, such management activities should account for the controlling and monitoring of the offered services as well as for the performance measurement [2, 30]. In particular, providers ought to implement dedicated activities to ensure the information security (R36), to ensure the business continuity in exceptional situations (R37), and to handle any occurring security incidents (R38). Furthermore, service providers ought to continuously monitor the quality of their services (R39).

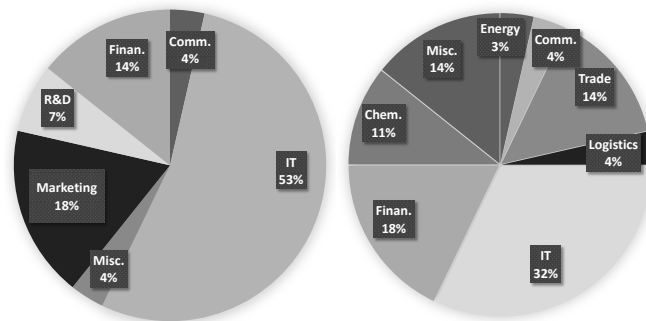
#### **4.6 Synopsis**

Table 1 summarizes the requirements that we gathered during our literature review and subsequently consolidated into the presented framework. Note that we are unable to provide a complete list of literature references for each requirement due to the existing space limitations. However, we augmented Table 1 with an indicator that documents for each requirement the number of manuscripts mentioning it in literature.

The framework provides a generic library of assessment criteria and requirements that can be used to conduct a comprehensive evaluation of service providers. It hence goes beyond other approaches that only introduce abstract assessment criteria [32] or list requirements of specific consumer groups [3]. While the long-term goal behind the design of our framework is to provide a unified, complete source of assessment criteria and requirements, we expect their relevance to vary depending on the type of software service. In future iterations, we will therefore also focus on providing guidelines for using (parts of) the framework in different application scenarios.

## 5 Evaluation

To evaluate if the identified criteria and requirements are relevant in practice, we conducted an online survey with experts on the subject matter. The participants of the survey were selected by searching social (career) networks. We decided to only contact persons who had specified to be involved with cloud computing. Moreover, we decided to focus on employees of small and medium enterprises (SMEs), as ESS are expected to be of particular interest for such companies [20, 24]. The survey was formulated in German language and contained 16 questions regarding the demographics of the participants, e.g. their age, their position, or how many employees their company had. In addition, we asked the participants to assess the relevance of each requirement using a Likert scale from 1 (not relevant at all) to 5 (very relevant).

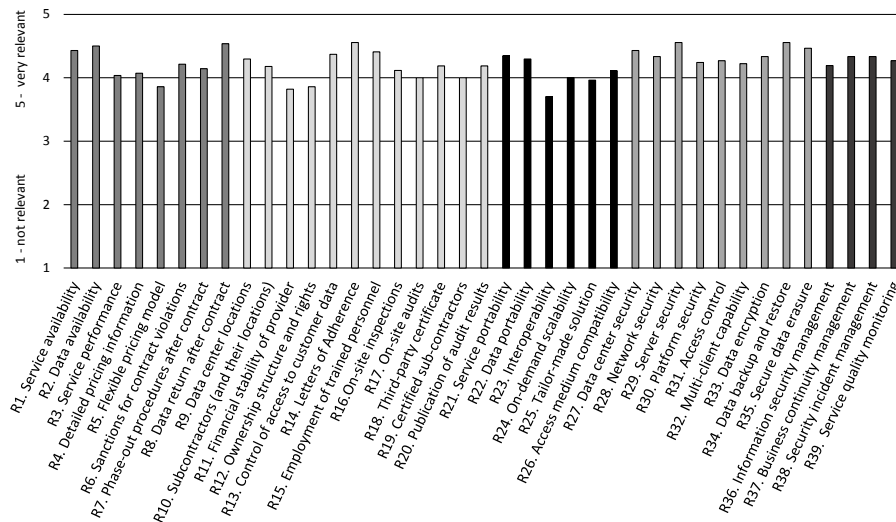


**Fig. 2.** Work departments (left) and industry sectors (right) of survey participants

We started the survey in May 2014 and subsequently received 34 completed answers. For the following analysis, we had to exclude the data of five participants because they did not answer the majority of questions. One participant specified that his answers were given referring to a company-internal, private cloud solution. As such solutions have different requirements, e.g. regarding the data security, we decided to also exclude his answers, leaving us with a total of 28 responses. The majority of participants (68%) was younger than forty years and ranked themselves as (potential) cloud service consumers (61%). Additionally, 14% of the participants stated that they were both, consumers as well as providers. Most of the participants were employees (43%) or executive employees (50%), while only 7% stated that they were managers.

Most participants worked in IT departments. Some of them worked in marketing, financial, or research & development. The companies of the experts were diverse, yet most companies belonged to the IT, financial or trade industry sectors. Fig. 2 depicts the departments the participants worked in (left) and the industry sectors of the companies (right). The results of the survey are summarized in Fig. 3, which depicts the mean assessment value for each requirement, as well as in Table 2, which contains the summary statistics. Since the average value for the requirements was constantly above value 3, the participants overall perceived all requirements to be relevant. Altogether, the survey results confirm the practical relevance of the proposed framework, since the total average over all requirements was moreover found to be 4.22.

Nevertheless, the results vary to some extent. Regarding the service contract criterion, the service availability (R1) and the data availability (R2) were perceived to be particularly relevant. Surprisingly, however, the experts found the return of customer data upon the completion of the contract (R8) to be the most important requirement of a service contract. Obviously, it was especially important to the participants that the customer data remains in their property after contract termination. Losing confidential customer data to a cloud computing provider hence is deemed to be a severe risk. Another interesting result is that the participants did not regard flexible pricing models (R5) to be of particular high relevance. While this requirement was still perceived to be somewhat relevant, its support compared to other requirements was rather low. The remaining requirements of the service contract criterion, i.e. service efficiency (R3), detailed pricing information (R4), sanctions in case of contract violations (R6), and procedures after the termination of the contract (R7) received an average support.



**Fig. 3.** Perceived relevance of provider requirements (criteria indicated in different colors)

The criterion trustworthiness was altogether ranked as relevant. Especially the three requirements regarding the personnel policy were ranked as highly relevant. For the

participants, it was particularly important that the cloud provider controls the employees' access to the customer data (R13), that they sign letters of adherence with their employees (R14), and that providers employ trained personnel only (R15). Signing letters of adherence with the employees was even ranked to be among the top three requirements overall. The location of the data centers (R9) and that of the subcontractors (R10) was also perceived to be very important. Surprisingly, the financial stability of cloud providers (R11) as well as information about ownership structures (R12) were ranked below average. The participants apparently felt that if they fixed details like the return of customer data after contract termination, detailed information about the providers' financial and organizational situation are less important.

**Table 2.** Summary statistics for the identified requirements

Variable	N	Summary statistics				
		Min.	Max.	Median	Mean	Std.dev.
R1. Service availability	27	1,00	5,00	5,00	4,43	1,03
R2. Data availability	27	1,00	5,00	5,00	4,50	1,07
R3. Service performance	25	1,00	5,00	4,00	4,04	1,14
R4. Detailed pricing information	26	1,00	5,00	4,50	4,07	1,21
R5. Flexible pricing model	27	1,00	5,00	4,00	3,86	1,18
R6. Sanctions in case of contract violation	27	1,00	5,00	5,00	4,21	1,10
R7. Phase-out procedures after contract	27	2,00	5,00	4,00	4,14	0,80
R8. Return of customer data after contract	28	1,00	5,00	5,00	4,54	1,00
R9. Data center locations	28	1,00	5,00	5,00	4,30	1,07
R10. Subcontractors (and their locations)	28	1,00	5,00	4,50	4,18	1,09
R11. Financial stability of provider	28	1,00	5,00	4,00	3,82	1,12
R12. Ownership structure and rights	28	1,00	5,00	4,00	3,86	1,18
R13. Control of access to customer data	28	1,00	5,00	5,00	4,37	1,04
R14. Letters of Adherence	28	1,00	5,00	5,00	4,56	1,01
R15. Employment of trained personnel	28	2,00	5,00	5,00	4,41	0,93
R16. Possibility to conduct on-site inspections	28	1,00	5,00	4,50	4,12	1,21
R17. Possibility to conduct on-site audits	28	1,00	5,00	4,00	4,00	1,12
R18. Third-party certificate	27	1,00	5,00	5,00	4,19	1,24
R19. Certified sub-contractors	28	1,00	5,00	4,00	4,00	1,24
R20. Publication of audit results	28	1,00	5,00	5,00	4,19	1,11
R21. Service portability	28	2,00	5,00	5,00	4,35	0,85
R22. Data portability	27	1,00	5,00	5,00	4,30	0,99
R23. Interoperability	27	2,00	5,00	4,00	3,70	1,14
R24. On-demand scalability	27	2,00	5,00	4,00	4,00	1,04
R25. Tailor-made solution	26	2,00	5,00	4,00	3,96	1,09
R26. Browser / access medium compatibility	28	1,00	5,00	4,00	4,11	1,12
R27. Data center security	27	1,00	5,00	5,00	4,43	1,14
R28. Network security	27	1,00	5,00	5,00	4,33	1,14
R29. Server security	27	1,00	5,00	5,00	4,56	0,85
R30. Platform security	26	1,00	5,00	5,00	4,24	1,20
R31. Access control	27	1,00	5,00	4,50	4,27	0,96
R32. Multi-client capability	27	2,00	5,00	5,00	4,22	1,01
R33. Data encryption	27	1,00	5,00	5,00	4,33	1,14
R34. Data backup and restore	27	1,00	5,00	5,00	4,56	1,12
R35. Secure data erasure	27	1,00	5,00	5,00	4,46	1,14
R36. Information security management	26	2,00	5,00	4,50	4,19	1,02
R37. Business continuity management	27	1,00	5,00	5,00	4,33	1,18
R38. Security incident management	27	1,00	5,00	5,00	4,33	1,07
R39. Continuous monitoring of service quality	26	1,00	5,00	5,00	4,27	1,15

Another interesting result is that third-party certificates (R18) and certified sub-contractors (R19) were both ranked below average. Seemingly, some participants did not see a benefit in such certifications. However, the participants were rather discordant about this issue as these two requirements had the highest standard deviations overall. A possible explanation might be that a certification is not necessary for smaller solutions, while it could indeed provide benefits for more complex cloud solutions. This means that depending on the application scenario, the relevance of the requirements could still be high. Moreover, the possibility to conduct on-site inspections (R16) or on-site audits (R17) was ranked slightly below average. It seems that not all participants are willing to take the required effort to conduct on-site investigations. Accordingly, the participants ranked the publication of audit results (R20) to be more important than the possibility to conduct such audits themselves.

Regarding the technology criterion, the perceived relevance of the requirements varies more. On the one side, service portability (R21) and data portability (R22) were ranked above average. On the other side, on-demand scalability (R24) and tailor-made solutions (R25) were ranked below average, even though they are generally viewed to be among the great advantages of cloud computing. The participants also ranked the interoperability (R23), i.e. a seamless integration of services from different cloud providers, to be rather unimportant. In fact, this requirement had the overall lowest support. An explanation might be that they did not consider this to be a realistic goal. Access medium compatibility (R26) was ranked slightly below average. It seems the participants felt that this feature would be nice to have, but not of crucial importance.

The IT security criterion had the highest support overall, with all requirements having a mean value above average. The server security (R29) was not only ranked to be one of the two the most important requirements overall, it also had one of the lowest standard deviations. The experts consistently perceived this requirement to be a top priority. Yet, all requirements concerning the security were ranked as very relevant by the participants. Particularly, data center security (R27), network security (R28), secure data erasures (R35), platform security (R30) as well as data encryption techniques (R33) were deemed to be highly relevant factors. Furthermore, data backups and restores (R34) were ranked to be very important and, together with R29, had the overall highest support. The requirements access control (R31) and multi-client capability (R32) furthermore received a support that was still slightly above average.

Regarding the management criterion, the support of the requirements was consistent. All requirements had high support and the mean value was on par with the overall average. The participants hence perceived it to be equally important that cloud providers offer a security (R36), continuity (R37), and incident management (R38). They also found the continuous monitoring of the service quality (R39) to be relevant.

With all requirements of the framework having an average value above three, none of the requirements was ranked to be not important. However, the support of the requirements varies strongly. Especially the security criterion was perceived to be highly relevant. The results of the study hence confirm related studies, where security is pronounced to be a top priority challenge in cloud computing scenarios [43]. In a more detailed future analysis, the correlations between the requirements as well as the relations between demographic data and requirements should be further investigated.

## 6 Conclusions

So far, literature provides little advice on how to systematically evaluate software service providers. To help closing this literature gap, we have presented a framework for the assessment of software service providers. It contains a library of criteria and requirements that can be used to evaluate and compare various characteristics of cloud service providers when searching for a suitable ESS offering. The results of the conducted expert survey indicate that the proposed assessment criteria and the requirements are effective in supporting the assessment of software service providers and can help enterprises to identify a suitable ESS offering.

The results of our research endeavor have implications for academia and practice alike. With the provided assessment criteria and requirements, we help to operationalize the process of identifying and selecting suitable ESS. For practice, the results of our research hence contribute to building the skills that are needed to efficiently use ESS [4]. Compared to the arbitrarily chosen criteria that are sometimes proposed in analyst reports [39], the developed framework provides a more refined and theoretically justified basis for the evaluation of service providers. The framework primarily targets the potential consumers of software services who can use the evaluation criteria as a blueprint to define their own assessment processes. However, the framework can also be beneficial for service providers who might use the criteria as a diagnostic tool during a self-assessment in order to reveal room for improvements.

Regarding academia, the proposed assessment framework and its criteria help to create theories that explain the procurement of ESS from the cloud. The procurement of ESS differs significantly from the procurement of traditional software packages. While the software requirements of the enterprise have to be matched against the functional and non-functional characteristics of the available software offerings in both scenarios, the characteristics of the providers are equally crucial when procuring software as a cloud service. The proposed framework gives information about the characteristics of service providers that might have to be taken into account during the procurement process. It might accordingly present a starting point to formulate more comprehensive theories of the cloud procurement process and to improve existing approaches that support the assessment and selection of software services.

We designed the assessment framework to be generic and readily applicable. The results of our empirical evaluation indicate, however, that the importance of the requirements and assessment criteria might vary depending on the application domain of the software and the type of the consumers. In future iterations of our research project, we will therefore examine more closely from both a theoretical and an empirical viewpoint, which requirements are more or less relevant in certain scenarios and how they might be weighted in comparison to each other. As we currently only have completed an initial design cycle of our research project, we will also need to continue searching for requirements and assessment criteria that might have remained undiscovered so far. Despite these obvious limitations, however, the manuscript provides new findings about the consumer preferences in enterprise cloud computing – a research topic that needs to be better explored in order to unleash the full potential of this new trend.

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