# INTEGRATION OF CLOUD SERVICES CRITERIA IN THE SELECTION PROCESS OF IT SOLUTIONS IN TECHNICAL WHOLESALE[1]

*Dr.-Ing. Andreas Pescholl*

Head of Information and Communication System and Marketing
Haustechnik Handels-GmbH, Treuen
e-mails: a.pescholl@haustechnik-team.com
Germany

**Abstract:** More and more companies in technical wholesale rely on IT services from the cloud. This development must also be reflected in the basic selection procedures for IT products and services. In this article, this is shown by means of decision-making processes and criteria for evaluating offers for operational application systems as well as for IT platforms and providers. Cloud computing is becoming increasingly important as evidenced by the growing market for IT infrastructure, development platform and software services. For companies, this opens up new opportunities to meet their IT needs. The central evaluation criterion here is the economic benefit that results from the use of cloud offerings in comparison to the acquisition and operation of company-owned IT. This development must also be reflected in the basic selection procedures for IT products and services. For a comprehensive view, both quantitative and qualitative factors are to be included, suggesting an extended cost-benefit analysis for enterprise cloud computing. In this paper, this will be illustrated by decision processes and criteria for the evaluation of offers for operational application systems as well as for IT platforms and providers.

**Key words:** Selection processes, system evaluation, SaaS, PaaS

## 1. INTRODUCTION

Cloud computing is playing an increasingly important role in enterprise IT. Typical reasons for this are an increased degree of automation for the management of IT infrastructures in the industry. Due to the growing importance of cloud offerings, the question arises as to whether and how existing selection processes need to be adapted for IT solutions.

This paper explores how established approaches to selecting IT systems and infrastructures can take into account new requirements for cloud services and how these can be integrated into the standard procedures used. To this end, first experiences from the industry of the technical wholesale trade over the evaluation of software as a service (SaaS),

[1] The paper is renewed and extended version of the report presented on the International Conference on Information Technologies (InfoTech-2017), 20-21 Sept 2017, Bulgaria.

Platform as a service (PaaS) and Infrastructure as a service (IaaS) are discussed. The selected experiences, despite the not reliable scientific, are further quantitatively evaluated in subsequent ones. Despite the scientifically not reliably secured experiences, these seem interesting enough to be summarized here. The experience gained provides valuable starting points for further analysis of the industry and for the improvement of the selection process with consideration of cloud services.

Section 3 gives a general overview of the experiences in fallow. Basic considerations that can lead to the use of SaaS are shown in section 4. Section 5 presents changed criteria for evaluating operational applications. Section 6 extends this discussion for IT platforms. Section 7 summarizes the experience gained.

## 2. POSSIBILIES OF USING CLOUD COMPUTING

Cloud Computing stands for the use of IT resources over the Internet, which are accounted for according to demand [22], [4]. A distinction is made between infrastructure-as-a-service such as computing power and storage space, platforms for the development of IT services (platform as a service) and applications (software as a service). For companies, cloud computing opens up new opportunities to meet their IT needs. The many business models in Clouds and the underlying Dynamic Usage Model [7] make the use of cloud computing in enterprises diverse. In addition to the scenario of obtaining any information technology (IT) from the cloud, a combination with existing IT resources is just as conceivable as a successive use of infrastructure-as-a-service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). The fundamental question is which form of cloud deployment - whether complementary or substitutive to the acquisition and operation of in-house IT - entails the long-term most economically advantageous situation. The core construct that needs to be highlighted is therefore the benefit (economic benefit) that can be generated through the use of cloud computing in the enterprise. For companies with (newly added) IT needs, the existing IT capacity and the (new) IT needs to be covered from an economic point of view result in three basic ways to cover this: (1) purely through cloud resources (substitutive), (2) purely through the acquisition and operation of proprietary systems, or (3) through a hybrid of cloud and corporate environment (hybrid model or complementary deployment) [18]. For companies considering the use of cloud computing, scenarios (1) to (3) give rise to company-specific valuation questions. The purpose of the paper is to help companies analyze the added value of cloud computing versus the acquisition and operation of proprietary IT and, if necessary, draw conclusions about the appropriate mix of in-house systems and cloud resources. The analysis is individual for each company or case of need. With a high demand for computing power and fluctuating capacity requirements, cloud offerings are an efficient alternative by dynamically adapting billing to actual requirements. These include, in particular, the automotive and mechanical engineering, wholesale, finance, pharmaceuticals and media sectors, and generally small and medium-sized businesses Companies or start-ups that have not specialized in IT [3], [24]. Common goals of deploying cloud computing include cost and time benefits [19], increased operational and strategic flexibility, and the benefits of resource virtualization [20] to improve enterprise IT performance. By sourcing IT resources from the cloud, cost savings can be realized [1], [3], both in terms of running costs and eliminating initial investment costs. Effects on the IT cost structure are also to be expected, since the use of cloud services results in a shift from fixed to variable costs. The extent and contribution of these benefits to the overall benefits of

IT resources used by companies should be reviewed on a case-by-case basis. For this reason, approaches must be formulated that enable a cost-effectiveness analysis of cloud computing in business use and support the comparison to the acquisition and operation of company-owned systems.

## 2. CHANGES IN SYSTEM EVALUATION AND SELECTION

In addition to traditional approaches to the economics of IT purchases, there are considerations as to how cloud computing can be economically evaluated compared to the acquisition and operation of proprietary IT. Costs and benefits represent the primary cost-effectiveness factors of IT solutions [5] and thus also the core of economic considerations. Direct benefits arise from cost advantages and are the easiest to determine. Existing cloud-specific approaches focus on the cost aspect and primarily review the cost advantage of using a cloud solution to purchase and operate on-premises systems. In a make-or-buy approach to cloud computing [2], the focus is on costs.

It is assumed that, in certain company-specific starting situations, the external procurement of IT via the cloud has a cost advantage over the in-house generation of IT services (acquisition and operation of company-owned IT systems). This model allows a computational assessment of the benefits of using a cloud. A further differentiated framework for the company-specific comparison of cloud offers with a company-owned IT variant offers a TCO framework [17]. The basis of this purely cost-oriented approach is the breakdown of IT costs according to the Total Cost of Ownership (TCO). The result of this comparison of Cloud Model and a comparison model, which relates to in-house IT, is an absolute cost advantage over the entire useful life of the considered IT (in-house or via a cloud provider). Since costs as directly and indirectly quantifiable factors represent only one, albeit important, sub-aspect of economic considerations and also incorporate qualitative aspects, an extension of the pure cost analysis to qualitative benefit effects is suggested, in order to depict the economic effects of cloud offers in business use to compare company alternatives. This includes the evaluation of indirectly monetarily measurable or intangible (not monetarily quantifiable) benefit contributions from cloud computing. However, as these have a significant impact on the overall economic situation and development of a company in the long term, integration is important. Worth mentioning here are qualitative factors with sometimes significant strategic importance such. Flexibility by the nature of available IT resources, high availability performance (business continuity, disaster recovery) [20] or user satisfaction. Possible is a combination of cost-focused approaches with qualitative methods of economic analysis. Furthermore, considerations can be made as to how profitability and efficiency considerations can be integrated as flexibly as possible in the cloud case; depending on which target group in the company needs economic value for the evaluation of cloud offers or can provide them as quickly and comprehensively as possible.

Since a pure cost analysis is to be regarded as too one-sided, on the other hand a purely qualitative procedure contradicts the rationality principle of economy, which implies the use of quantitative and value-based reference variables (so-called hard factors), a combined cost-benefit assessment approach is presented, which should be possible includes many hard factors, but at the same time integrates the no less important soft (qualitative) factors. This approach is common in practice when the subject of valuation has many different dimensions, as is the case with cloud services [23]. The main framework of the approach is the utility value analysis, since it can be adapted to specific companies or cases and represents an easy-

to-use instrument through the subjective approach of the evaluation [13]. As with the investment calculations, this is not a mathematical, but a qualitative procedure, in which firstly target criteria are determined, on the basis of which alternatives are to be evaluated, as well as weighting factors, which reflect the significance of the criteria. The (subjective) evaluation of the alternatives then takes place via the allocation of points (weighted: partial benefit values), the comparison over the sum of the weighted point values (total benefit value) [14], [11]. However, as the main method is complemented by a detailed cost comparison of cloud and proprietary IT alternatives and, if possible, by capital values or profitability measures.

Many companies in the technical wholesale trade follow typical standard procedures when choosing suitable IT solutions. The comparison of functional and non-functional requirements for IT infrastructure components or information systems is usually based on similar patterns (see e.g. [6], [12]): After the project preparation phase and the actual analysis, a target concept is set up based on the Business requirements based. Then, after the system evaluation, the best provider will be selected in several steps: market view and preselection based on requirements, system tests including detailed analysis, subsequent negotiations and completion. Subsequent considerations focus on the process of system evaluation and selection. The results of the previous phases project preparation, as-is analysis and target conception are taken as input for the phase of system evaluation. For example, through a comparison of the actual analysis and the target concept, the scope of action is revealed, which can be described by functional and non-functional requirements for the new IT solution. The requirements identified in this way then flow into the system evaluation as criteria for assessing new systems [6].

*Table 1. Cloud-specific extension of the procedure in a system evaluation*

| ***Basic evaluation of cloud solutions*** | ***market analysis*** | ***preselection*** | ***system test*** | ***rating*** | ***selection*** |
|---|---|---|---|---|---|
| | | | | | |
| | *New cloud-specific criteria* | *New cloud-specific criteria* | *New cloud-specific criteria* | *New cloud-specific criteria* | *New cloud-specific criteria* |
| ***Cloud-specific phase of system evaluation*** | *Previous phases of system evaluation* | | | | |

As shown in the following sections, cloud offerings (see, e.g., [21]) modify the existing practice of system evaluation. Companies usually clarify before the phases market review, pre-selection, system test, detailed analysis and selection recommendation, whether and to what extent a cloud approach such as SaaS, PaaS or IaaS for the proposed solution even comes into question. Accordingly, an additional phase for the fundamental assessment of a possible use of cloud computing is preceded by the previous procedure. In addition, in the subsequent, customary phases of the selection process, cloud-specific criteria are also used

for the assessment. Table 1 illustrates these changes, which are detailed in the following sections.

## 4. BASIC REVIEWS OF SAAS OFERS

It is worth noting that only a few companies evaluate cloud offerings and classic on-premise solutions on an equal footing. Rather, it is usually decided beforehand whether cloud solutions should be considered at all. Corresponding criteria are described here for the SaaS area.

Basic cloud policies are often based on external and internal compliance and security requirements, e.g. on national laws that restrict the storage of sensitive data in the cloud. However, interviews with companies also show that a blanket rejection of cloud solutions due to such requirements is often questioned in a differentiated way. On closer inspection, hybrid cloud approaches (see, e.g., [1], [3]) are often feasible and useful. For example, if storage of billing information in the cloud is prohibited, companies may be able to store it in-house and still, e.g. in the processes of a SaaS solution for CRM use. Even token-based approaches often make it possible to deal with strict specifications for data storage. This data is anonymized and provided for identification with a generated unique token. The anonymized data can then be transferred to the cloud and used there. The tokens remain in in-house on-premise systems and can thus be used to identify the data (see also the Compliant Data Replication Pattern in [8]). Also considered are non-functional requirements, which are usually not a problem for on-premise solutions. For example, some states require financial data to be auditable at the physical level. This sometimes presents a significant barrier to SaaS solutions because large vendors usually do not have access to their data centers.

Fundamental decisions for or against Cloud are often based on external and internal compliance and security requirements - e.g. on national laws that limit the storage of sensitive data in the cloud. Experience from the company’s shows that a general rejection of cloud solutions is often questioned differently based on such requirements. On closer examination, hybrid cloud approaches (see, for example, [9]) are often also possible and useful. If, for example, the storage of invoice data in the cloud is not allowed, companies can store the data within the enterprise and, in the processes of a SaaS solution for CRM. Non-functional requirements are also included as criteria, which are usually not a problem for on-premise solutions. In this context, it is intended to refer to the requirement of individual national directives that financial data must be auditable on the physical level. For SaaS solutions, this often entails a significant hurdle because the large vendors normally do not have access to their data centers.

In addition, completely new aspects are important in the basic decision for or against the cloud. One example of this is the risk of loss of image, as a result of the familiarity with foreign access. But also questions about how to integrate cloud applications into the existing IT landscape is not always easy to solve. It often seems more sensible to clarify the degree of integration at the beginning of the selection process. Because the more the targeted cloud solution is to be connected to different systems via interfaces, the higher is generally the hurdle for a SaaS offer. Finally, the architect's perspective also plays a role that cloud solutions can contribute to higher standardization. For this reason, some companies are deliberately using cloud solutions as a means to implement strategic consolidation measures more quickly and with greater acceptance [10].

## 5. NEW AND CHANGED ASSESSMENT CRITERIA

When a SaaS solution is in the main, companies are looking at vendors in the next phase on the basis of the usual criteria: compliance with business requirements, functional bandwidth, usability, consensus with architecture principles, and more. However, some of these points are new for cloud applications questions:

- Is a fast implementation by SaaS an advantage for the companies? The short time to rollout is often seen as an argument for cloud solutions.
- Do we get a complete solution? The companies consider it important to evaluate a holistic solution.
- How innovative is the provider? For end users, SaaS solutions are often attractive because they have high usability and provide innovative functionalities quickly.
- How can internal stakeholders be convinced of the solution? In the case of several companies, the user ability that is attractive to the user has been rated higher.
- Do we need the adjustments and extensions offered? When companies compare SaaS offerings with functional requirements, it is often the case that they are in contradiction to standardization efforts or a high degree of flexibility, which is contrary to the actual goal of the SaaS solution.

In practice, it is often the case that companies are only considering the respective market leader for a SaaS product. This was based on the assumption that other vendors will hardly meet important security or compliance requirements if these are not met by the leading vendors. In addition, companies are usually not willing to become pilot customers of smaller SaaS service providers, in particular because the long-term marketability of these providers has not yet been proven.

## 6. DECISION-MAKING CRITERIA FOR PAAS

If companies want to use PaaS as an IT platform, there is a fundamental difference to the selection of SaaS. In a first phase of the analysis (see Table 1), the companies basically decide whether to use PaaS. The subsequent steps in the selection process then often focus on evaluating different PaaS offers.

The pursued goals for the introduction of a PaaS can be varied. For example, their use promises to help build a flexibly scalable platform that can better support new IT services and significantly accelerate their market launch. In particular, modern DevOps principles such as continuous delivery and integration can be optimally implemented. Important considerations and the selection criteria derived from this, when the companies initially think about using PaaS, are as follows [16], [19]:

- How to increase the degree of automation in software development, for example, dynamically scalable environments in real-time? With PaaS, application environments in the form of preconfigured application containers, such as Java EE application servers, can be automatically deployed together with the operating system environment.
- How can system integration be improved? The communication between applications is carried out in a PaaS via middleware components - as a rule, messaging systems (see Message Oriented Middleware in [15]). Compared to installations in often different infrastructural environments, environment-specific configurations do not

exist within one PaaS. Modular, loosely coupled services are created that can consume each other. To the outside, these services can be integrated using the principles of a Service-Oriented Architecture to maintain loose coupling.

- How can data retention be optimized through cloud approaches? This requires a careful evaluation: using data services within a virtual container, database states can be automatically scaled horizontally. However, this leads to a paradigm shift in the case of classical database-centric application architectures in which database conditions are traditionally held centrally in relational database management systems (see Stateless Component and Stateful Component in [15], [5]).

If PaaS presents itself as a promising possibility, initial experience in the selection by company's shows that a fundamental decision for or against the introduction of corresponding cloud services often depends on organizational circumstances. Stronger than the selection of a platform technology, adjustments to the way of working and a cross-cutting cooperation in the introduction of a PaaS are the focus of the discussion. Differentiating factors are less the product features of the platform technology and the supplied default-frameworks, but rather the existing framework conditions within one's own organization. In this context, the following questions arise:

- Are internal structures and interfaces to IT infrastructure components sufficient for complete automation? The implementation of a PaaS requires the complete automation of the deployment mechanisms of the complete platform. This also applies in particular to integration with existing billing and management software.
- Are existing virtualization approaches a sufficient foundation for further dynamization? As a rule, the path to dynamization leads to the successive virtualization of the infrastructure, which has mostly developed historically.
- Are there appropriate security standards that can be applied to dynamically scalable infrastructures? Safety standards are still often geared to static infrastructure. There are also few experiences with virtual decoupling mechanisms of a PaaS.
- The issue of whether or not the included application frameworks play a role is often classified as a downstream issue.

If a first decision has been made for the introduction of a PaaS, detailed questions will be taken into account in subsequent phases of the selection process. Examples for this are:

- What lifecycle services are available? In order to increase the degree of industrialization and automation in a cloud stack, the hardware and software components required for each other are needed. This also applies in particular to lifecycle aspects.
- How can optimal integration of hardware and software components be ensured? Often it is not enough to build on existing virtualization approaches. On the contrary, there is the danger that additional PaaS components tend to increase the complexity of the overall landscape. It is also being separately virtualized in many companies in the development and production area.
- What are the advantages of open source platforms? Open source solutions are usually based on open standards. However, it is to be assumed that modifications or additions are necessary. In particular, interfaces for own authentication mechanisms and self-service procedures have to be implemented.

- What distinguishes commercial products? In particular, the interoperability of existing APIs is one of the essential factors.

Companies are increasingly finding that PaaS is not an issue for a simple, comparative platform selection. In order to reduce complexity, the first step is to clarify the possibilities and goals of the existing organization.

## 7. CONCLUSION

Cloud services are changing the selection process for IT solutions. This is the conclusion of the present snapshot in the industry of the technical wholesale trade. It turns out that the typical pattern for evaluating IT applications and platforms is preceded by a phase in which you basically decide whether cloud services are eligible or not. Subsequent decision steps will then contain partly amended evaluation criteria, which address the most diverse aspects of cloud offerings.

This paper presents an approach that integrates both hard and soft factors and can be customized to meet specific needs. However, it has to be noted that the evaluation process for determining the profitability of different cloud offerings or combinations with in-house IT is a complex and time-consuming process; not least because the breakdown of IT costs into indirect and direct costs through potential estimation inaccuracies and risk mitigation techniques, especially in the calculation of cloud costs, has bottlenecks. As it was only hinted at in the procedure with the selection of a cloud service, beside the economicalness of the employment of cloud computing in enterprise IT security and legal aspects play a central role. Also, the fear of cloud customer companies against loss of control over their data and dependency on the cloud provider (lock-in) can be pure economic benefits, albeit significant, not compensate. Since these points are essential, it makes sense to carry out a risk analysis and early exclusion of unsuitable cloud services or service providers in the run-up to a profitability analysis. In addition, security and legal criteria can be included in the Advanced Benefit Analysis as a target criteria when data is cloud-aware, but different security and service levels are different across different cloud providers or solutions. The profitability analysis is thus never alone and cost-benefit criteria with regard to cloud computing are always to be embedded in a company-specific overall catalog of requirements. The presented approach serves as a rough framework and lives from the company-specific adaptation. The procedure can therefore not be generalized. Advantages can be seen in the fact that even if there is insufficient numerical basis a useful statement on the suitability and efficiency of a use of cloud computing can be made, as far as a detailed target criteria catalog - optimally derived from the company-specific IT KPI system for controlling IT efficiency - formulated and the utility value analysis is used as a basis.

A further analysis of the hardening and detailing of the first observations made here appears to be useful. Both for application companies and IT service providers is an understanding of the constantly changing process processes and criteria of IT solutions.

## REFERENCES

[1] Andrikopoulos, V.; Fehling, C.; Leymann, F.: *Designing for CAP - The Effects of Design Decisions on the CAP Properties of Cloud-native Applications,* Proceedings of the 2nd International Conference on Cloud Computing and Service Science, CLOSER, 2012; pp. 365-374.

[2] Simon, A.; Rischbeck, T.; Erl, T.: *Modern ESB Architecture for SOA*, Pearson Education Schweiz, 2010.

[3] Bernard, A.: *Is Converged Infrastructure the Future of the Data Center?*, CIO, 2013, http://www.cio.com/article/730423/Is_Converged_Infrastructure_the_Future_of_the_ Data_Center, retrieved on 16.04.2014.

[4] BITKOM (Hrsg.): *Cloud Computing - Evolution in technology, revolution in business - BITKOM guide.* Federal Association for Information Technology, Telecommunications and New Media e. V., Berlin, 2009.

[5] Brugger, R.: *The IT Business Case: Record and analyze costs - recognize and quantify benefits.* Springer publishing company, Berlin, 2009.

[6] Becker, J.; Winkelmann, A.; Vering, O.: *Software selection and introduction in industry and trade*, Springer publishing company, Heidelberg, 2007; pp. 61-108.

[7] Doeffinger, D.; Lutz, F.; Hammermann, D.: *Dynamic Services for SAP® Applications.* In: Jacob, O. (Hrsg.): *ERP Value: Significant advantages with ERP systems*. Springer publishing company, Berlin/Heidelberg, 2008; pp. 103-115.

[8] ENISA (Ed.): *Cloud Computing. Benefits, risks and recommendations for information security.* European Network and Information Security Agency, 2009.

[9] Fehling, C. et al.: *Cloud Computing Patterns: Fundamentals to Design, Build, and Manage Cloud Applications*, Springer publishing company, Wien 2014.

[10] Gilbert, S.; Lynch, N.: *Brewer´s conjecture and the feasibility of consistent, available, partition-tolerant web services,* ACM SIGACT News 33, 2002; S. 51-59

[11] Gadatsch, A.; Mayer, E.: Masterkurs *IT-Controlling: Fundamentals and practice - IT costs and performance calculation - contribution margin and activity costing - target costing.* 3. Edition. Vieweg and Teubner publishing company, Wiesbaden, 2006.

[12] Gronau, N.: *Enterprise Resource Planning*, Oldenbourg Science Publishing, München, 2010.

[13] Hirschmeier, M.: *Profitability analysis for IT investments.* Publisher for Science and Culture Stein & Brokamp KG, Berlin, 2005.

[14] Hoffmeister, W.: *Investment calculation and utility analysis*. Kohlhammer publishing company, Stuttgart/Berlin/Köln, 2000.

[15] Humble, J; Farley, D.: Continous *Delivery: reliable software releases through build, test, and deployment automation,* Addison-Wesley, Boston, 2011.

[16] Kavis, M.: *Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS),* John Wiley & Sons, Hoboken, 2014.

[17] Klems, M; Nimis, J; Tai, S.: *Do Clouds Compute? A Framework for Estimating the Value of Cloud Computing.* FZI Research Center Computer Science Karlsruhe. Karlsruhe: University of Karlsruhe. 2008. http://www.cca08.org/papers/Poster12-MarkusKlems.pdf; retrieved on 22. Januar 2010.

[18] Lamberth, S.: *Criteria and Economic Considerations for the Use of Cloud Computing in Enterprises*, Fraunhofer Institute for Industrial Engineering IAO, Stuttgart, 2010.

[19] Reese, G.: *Cloud Application Architectures.* O'Reilly Media, Inc., Sebastopol, 2009.

[20] Thorns, F.: *The virtualization book. Concepts, techniques and solutions.* 2nd Edition. C & L Computer and Literature Publisher, Böblingen, 2009.

[21] Vossen, G.; Haselmann, G.; Hoeren, T.: *Cloud computing for businesses*, dpunkt. publishing company, Heidelberg, 2012.

[22] Vaquero, L., Rodero-Merio, L., Caceres, J., Lindner, M.: *A Break in the Clouds: Towards a Cloud Definition.* ACM SIGCOMM Computer Communications Review, Vol. 39, No. 1, January 2009, pp. 50-55.

[23] Weisbecker, A.; Falkner, J; Strauß, O.: *Fraunhofer Enterprise Grids: Grid Check.* Fraunhofer IRB publishing company, Stuttgart, 2008.

[24] *EU research project 4CaaSt to create an enhanced PaaS cloud platform*, http://www.4caast.eu/, retrieved on 25.04.2014.

***Information about the author:***

**Andreas Pescholl** – Dr.-Ing. Andreas Pescholl doctorate at the Institute of Technical and Business Information Systems at the Otto-von-Guericke University of Magdeburg and is Chief Information Officer and Chief Marketing Officer of the building Services trade-GmbH of Treuen, Germany. He is engaged in the business process modeling and re-engineering in the technical wholesale.

**Manuscript received on 11 December 2017**