CLOUD COMPUTING BENEFIT FRAMEWORK

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ABSTRACT

Cloud computing has been a much marketed term in the recent past. While there definitely are benefits, nebulosity still surrounds the topic and economic benefits to corporations are especially unclear. This work suggests a model offering an overview of cloud computing benefits as a basis for further benefit analysis by consolidating existing sources on the topic. To create the model, an approach suggested by Müller et al. [21] in the field of Service-Oriented Architecture is transferred to the field of cloud computing.

Keywords: Cloud computing, Cloud computing benefits, Economic potential, Cloud computing framework

INTRODUCTION

In 2011 it seemed like every new IT service announced was „in the cloud". Service providers made promises of diverse benefits such as cost savings, flexibility and higher automation. The economic benefits of these services to consumers are immediately clear – mostly because services like online storage or music streaming are free of charge. But the economic benefits to corporations are less obvious. Vendors' and service providers' promises of agility and lower costs are contrasted by doubts about security. Cloud computing seen in isolation, is not a new, innovative stand-alone technology. Rather, cloud computing builds on and combines existing technologies from the fields of high performance computing, cluster computing, virtualization, service-oriented architecture (SOA) amongst others. Naturally, streams of research from these fields converge on the topic of cloud computing. Thus, cloud computing research is often written from a technology focused perspective where cloud computing is compared to the "incumbent" technology and benefits are evaluated on this basis. The objective of this research is to identify, structure and rank corporate

cloud computing benefits and to explore whether the approach Müller et al. [21] used to explain the economic potential of SOA is transferable to other areas of Information Systems (IS) research. In order to achieve this objective, an initial model is developed and decomposed into value chains as basis for data analysis. The findings of the analysis are presented and consolidated into a conceptual model of corporate cloud computing benefits.

After initial discussion on the definition of the term cloud computing, the definition of the National Institute of Standards and Technology (NIST) has emerged as the de facto accepted standard definition and is therefore used in this paper [26]. Mell and Grance define cloud computing as a "[…]model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" [19].

The cloud computing model is further structured into widely used service models (Infrastructure, Platform and Software as a Service), deployment models (private, community, public and hybrid cloud) and five essential characteristics. These five essential characteristics are *on-*

demand self-service, broad network access, resource pooling, rapid elasticity and *measured service*.

RESEARCH APPROACH

In their paper "Understanding the Economic Potential of Service-Oriented Architecture" Müller et al. [21] created an economic potential model by exploring the connection between the design principles of SOA and the benefit categories of Shang and Seddon [25]. In order to establish this connection, Müller et al. used the approach of gradual decomposition [24], which has been repeatedly and successfully applied in Information Systems (IS) benefit research [22]. For the decomposition itself, the resource-based view of the firm was selected as theoretical foundation [2]-[3], [7], [18].

This research follows a similar approach, transferred to the topic of cloud computing. The aforementioned approach by Müller et al. not only offers the opportunity to consolidate existing research on a topic into a single model, but achieves this on the basis of a sound theoretical footing. Consequently, it is a matter of particular interest if this approach can be successfully transferred to another field of IS research. In this specific case, the objective is to verify if this approach is suitable to establish and explain a connection between the defining characteristics of cloud computing and resulting IS benefits.

According to Gregor [8], this type of research can be classified as a "theory for explaining". While case studies would be a valid research approach to explain the benefits occurring in real world cloud computing implementations, due to the novelty of cloud computing, only a limited number of case studies are available. Thus, while case study based research would have been the preferred approach, available scientific research and white papers were chosen as the basis for the research instead. The intended use of the resulting framework is to guide investment decisions on cloud computing by giving an overview of the possible benefits. Besides this qualitative benefit analysis, future research could develop methods for quantitative benefit analysis based on this framework.

In the context of enterprise systems, but also other areas of IS research, the benefit framework of Shang and Seddon has established itself in the IS research community in the last years [13]-[15], [21]. While the five essential characteristics of a cloud computing solution serve as the starting point of the proposed benefit model, the IT benefit categories of Shang and Seddon are supposed to act as end points of the value chains.

The 5 categories of IT benefits described by Shang and Seddon are: *operational, managerial, strategic, IT infrastructure* and *organizational benefits* [25].

Assigning the benefits of cloud computing into these categories provides a perspective on the potentially involved stakeholders in management. If the main focus of a company, when introducing cloud computing, is for example on IT infrastructure benefits, the business case needs to be sold differently, in contrast to the focus being on strategic benefits.

In order to identify the benefits generated by cloud computing, the method of content analysis was chosen to make replicable and valid inferences from primary publications on cloud computing and its benefits [17]. Available scientific research on the topic of cloud computing was studied to identify a preliminary, unstructured list of benefits, as elements of the model. With these findings and insights from the work as an IT consultant an initial framework was constructed. The outcome is a set of 10 main cloud computing benefit categories. Combined with the defining characteristics of cloud computing and the benefit categories of Shang and Seddon described above, a three-tiered structure of cloud computing benefits is created (Figure 1).

The benefit of each of the 10 main categories stems, technologically speaking, from one or more of the 5 defining characteristics and can be associated with one of the 5 IS benefit categories. This results in value chains, linking for example "on-demand self-service" with "low start-up costs for new projects" and "strategic benefits".
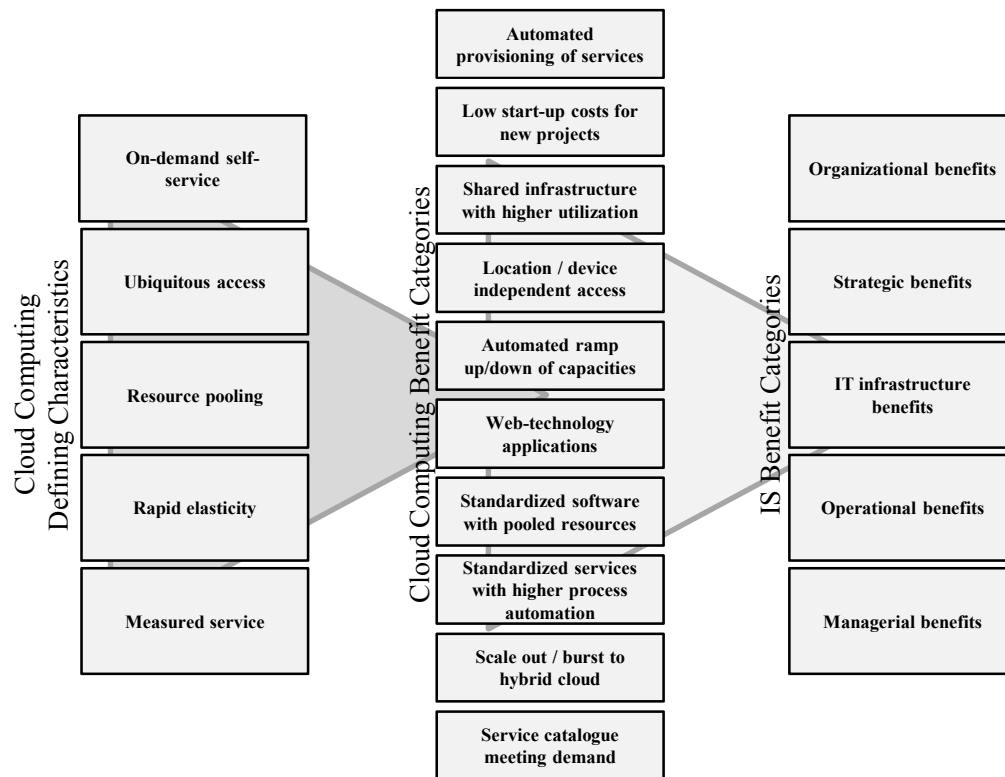
Figure 1: Structure of Cloud Computing Benefit Framework

Similar to Müller et al., the categories of cloud benefits were decomposed into an IS capability, a connection and a benefit sub-dimension layer in order to increase the explanatory power of the framework and investigate the causal relationship between the attributes of cloud computing and its benefits. This decomposition is a result of trying to illuminate and bridge the gap between the defining characteristics and the IS benefit categories from both sides. Müller et al. [21], p. 153] argue that the introduction of a new IS technology changes the way IT departments operate, by improving existing or adding new capabilities. A benefit sub-dimension was also used by Shang and Seddon, specific to the technology in focus, in their case Enterprise Resource Planning (ERP) systems. In order to connect these two layers, Müller et al. [21], p. 159] developed the concept of a connection layer built on "application scenarios" to allow for causal relationships between capabilities and benefits.

Following this approach, a new or improved IS capability was identified on the IS capability layer for each benefit category as part of the initial review of related literature. In addition, the resulting benefit was specified on the benefit sub-dimension layer. Finally, the connection layer establishes the logical connection between IS capability and benefit of the respective category. Table 1 summarizes the results of the decomposition.

Table 1: Decomposition of Benefit Categories

#	Benefit Category	IS Capability Layer	Connection Layer	Benefit Sub-dimension Layer
1	Automated provisioning of services	Automated (server) provisioning	Faster service provisioning	Faster project implementation/time-to-market/time-to-value
2	Low start-up costs for new projects	Provision of infrastructure at low initial investment cost for new projects (CAPEX vs. OPEX)	"Prototyping" of new business applications	IT supported innovation
3	Shared infrastructure with higher utilization	Operation of a shared / flexible infrastructure	Higher HW utilization	Lower technology TCO
4	Location / device independent access	Provision of secure location / device independent access	Disaster Recovery capabilities	Improved disaster recovery
5	Automated ramp up/down of capacities	"Instant" automated ramp up/down of capacities	Quicker reaction to changes in demand	Reduction of lost business / productivity
6	Web-technology applications	Operation of web-enabled applications (on Inter-/Intranet)	Data available for collaborative work	Ease of user collaboration
7	Standardized software with pooled resources	Standardization of software versions across pooled resources	Simplified software installation, maintenance and management	Reduced effort for software installation, maintenance and management
8	Standardized services with higher process automation	Provision of highly standardized services (vs. Individualization)	Increased process automation	Focus on tasks of higher value
9	Scale out / burst to hybrid cloud	Capability to automatically /easily integrate external resources on demand	On-demand (emergency) integration of external resources (hybrid cloud)	Shifted risk of overutilization and failure
10	Service catalogue meeting demand	Accurate forecast of IT demand (demand transparency)	Flexible service catalogue	Demand matching standard services

This list of logical value chains served as basis for the coding scheme to be used for the coding of selected scientific publications and publicly available white papers [23]. The wording of the items was in some cases refined, for instance if the initial denomination turned out to be overly specific.

Accordingly, the level of individual document was chosen as sampling unit. The search for "cloud computing" and "benefits" unfortunately did not return many suitable results. Of these results many had to be discarded after a brief review as they focused on the technological aspects of cloud computing and did not include any references to business benefits of cloud computing. Of the papers discussing benefits of cloud computing, the related literature and references were also reviewed. Regrettably, only the unsatisfactory number of 20 scientific papers could be deemed adequate for analysis. These scientific papers were published between January 2009 and September 2012.

The white papers used were retrieved via Internet search in November 2011 and published between February 2009 and October 2011. The companies sponsoring or publishing these white papers include amongst others Accenture, Amazon, Cisco, Colt, CSC, EMC², Forrester, Google, Hewlett-Packard, IBM, IDC, Intel, Microsoft, NetApp, Oracle, Rackspace, Red Hat, SAP, Symantec, Verizon and Xerox. 53 white papers were selected for the analysis. It was assumed that this number of white papers would yield theoretical saturation regarding the benefits of cloud computing, meaning that additional white papers would increase the count of already mentioned benefits, but add no new significant benefits to the model.

After a test coding of a sub set of the documents, all documents were then (re-)read and manually coded using the software MaxQDA. In the case of a reoccurring

benefit not in the original model after test coding the documents were recoded after adding a new code to the code book. To establish construct validity, codings were double checked via automated document full-text search.

7 white papers with only product specific benefits and no mentions of general cloud computing benefits were excluded from the analysis. The list of analyzed research and white papers is available from the author upon request.

FINDINGS

Caveats

The analysis of the papers resulted in some caveats: First of all, some of the papers do not clearly articulate benefit chains, or the logical relationship between the elements of a chain constructed by the author of this paper, but rather named single benefits. If elements from the IS capability layer and the benefit sub-dimension of a chain were present in a paper, this was evaluated as the chain being present.

Secondly, even without an in-depth literature analysis, it can be argued that a benefit of cloud computing cannot be clearly attributed to just one of the five essential characteristics of cloud computing. "Automated provisioning of services" depends on "on-demand self-service" (as the trigger of the automated processes) as well as "resource pooling" (because in a business setting, the services would be commissioned from pooled resources, not from a stock of spare servers). This results in a less elegant model and also chimes with the other ambiguities surrounding the topic of cloud computing.

However, experimentation with different constellations than the NIST definition of characteristics does not produce clearer results. Therefore, since the NIST definition seems to be prevailing, it was still used as point of origin for the model.

Thirdly, there was hardly any verbatim mention of the benefit categories of Shang and Seddon in any of the articles and white papers. This is not unexpected, but necessitates a logical assignment of cloud computing benefits to IS benefit categories. This assignment can certainly be disputed, even if the assignment choice seemed unambiguous in the majority of cases.

The same holds true for the 5 defining cloud characteristics of the NIST definition of cloud computing.

While there were verbatim mentions, they were in the context of the definition itself. Logical inferences between the definition of cloud computing and its benefits were not made by any of the analyzed paper's authors. Again, a logical assignment of the 10 benefit categories to the 5 defining characteristics was necessary.

Discussion of Elements

In how many documents each of the elements of Table 1 was mentioned is shown in Table 2, split by research (R) and white papers (W).

Out of the 10 identified benefit categories 2 emerged as barely mentioned, namely "scale out / burst to hybrid cloud" and "service catalogue meeting demand".

It can be argued that scale out to hybrid cloud is a mix of private and public cloud, which inherits not only some of the benefits of both concepts, but also some of the downsides. If, on the other hand, security is a primary concern, companies will tend towards a private cloud solution. If scalability is the major goal of a corporation, it will tend towards a public cloud implementation. Scenarios, where an interconnected public and private cloud are the right solution, seem to be less popular. The business benefit of this architecture lies in the shifted risk of overutilization according to Buyya et al. [[4]]. The implications of cloud computing on the IT services offered and service catalogue management seem to be disregarded as a side effect. Of all analyzed sources, only EMC², HP and IBM [[6]], [[9]]-[[11]] recognize the impact cloud computing has on strategic service management. The underlying automation forces a standardization of services and a reduction of individualized services in the service portfolio. This in turn calls for a match of service demand and the offered services.

Of the remaining 8 categories, "automated provisioning of services" was mentioned the most often (61 times, see Table 1). The time it takes to provision a server for a project is a major pain point for many CIOs. Cloud computing, through its automation, alleviates this problem, reducing the time it takes to provision a server from – in some cases – weeks to minutes. Ultimately, this time saved results in a faster project implementation and improved time-to-value.

This argumentation seemed more important to companies, as it was, relatively seen, mentioned more often in white papers then in peer reviewed research.

Table 2: Count of Mentions for Research (R) and White Papers (W)

#	Benefit Category	IS Capability Layer	Connection Layer	Benefit Sub-dimension Layer
1	Automated provisioning of services [R14|W54]	Automated (server) provisioning [R3|W13]	Faster service provisioning [R5|W24]	Faster project implementation/time-to-market/time-to-value [R6|W17]
2	Low start-up costs for new projects [R20|W43]	Provision of infrastructure at low initial investment cost for new projects (CAPEX vs. OPEX) [R10|W16]	"Prototyping" of new business applications [R4|W7]	IT supported innovation [R6|W20]
3	Shared infrastructure with higher utilization [R18|W47]	Operation of a shared / flexible infrastructure [R2|W4]	Higher HW utilization [R3|W13]	Lower technology TCO [R13|W30]
4	Location / device independent access [R11|W28]	Provision of secure location / device independent access [R9|W17]	Disaster Recovery capabilities [R1|W6]	Improved disaster recovery [R1|W5]
5	Automated ramp up/down of capacities [R24|W36]	"Instant" automated ramp up/down of capacities [R9|W3]	Quicker reaction to changes in demand[R14|W33]	Reduction of lost business / productivity [R1|W0]
6	Standardized software with pooled resources [R12|W23]	Standardization of software versions across pooled resources [R1|W2]	Simplified software installation, maintenance and management [R3|W9]	Reduced effort for software installation, maintenance and management [R8|W12]
7	Web-technology applications [R7|W19]	Operation of web-enabled applications (on inter-/intranet) [R3|W5]	Data available for collaborative work [R3|W5]	Ease of user collaboration [R1|W9]
8	Standardized services with higher process automation [R7|W24]	Provision of highly standardized services (vs. Individualization) [R0|W6]	Increased process automation [R2|W4]	Focus on tasks of higher value [R5|W14]
9	Scale out / burst to hybrid cloud [R3|W3]	Capability to automatically /easily integrate external resources on demand [R0|W3]	On-demand (emergency) integration of external resources (hybrid cloud) [R1|W0]	Shifted risk of overutilization and failure [R2|W0]
10	Service catalogue meeting demand [R1|W4]	Accurate forecast of IT demand (demand transparency) [R1|W0]	Flexible service catalogue [R0|W1]	Demand matching standard services [R0|W3]

"Shared infrastructure with higher utilization" (R18/W47) and "Low start-up costs for new projects" (R20/W43) were mentioned nearly as many times. This does not come as a surprise, as the theme of "doing more with less", has been on many CIO agendas in a tough economic environment. "Doing more" is represented by the benefit of "IT supported innovation" (R6/W20; as part of the "Low start-up costs for new projects" benefit chain). Cloud computing enables increased innovation by removing the need for dedicated hardware, thus reducing the infrastructure costs for new projects (R10/W16). In consequence organizational barriers for experimentation with new IT solutions are effectively lowered (R4/W7). "With less" refers to the potential of cloud computing lowering not only the startup costs for new projects, but also the total cost of ownership (TCO) of IT solutions. Through the operation of an infrastructure shared between applications and projects, instead of being dedicated to them, overall hardware utilization can be increased. As a result, less hardware is needed in total, reducing direct costs as well as indirect costs such as labor and licensing costs.

In the current economic climate, the monetary benefit of cost reductions (R13/W30) seems to be of much higher importance than the technological benefit of higher utilization (R3/W13).

The other argument often brought forward to promote cloud computing is scalability (also referred to as

agility). While the ability to quickly react to changes in demand has been one of the most mentioned items in the analysis (R14/W33), the benefits of this scalability are explained only infrequently. Ultimately, scalability allows IT architects to design systems around average load instead of peak loads without the fear of lost business or productivity caused by unresponsive systems. In addition, growth and shrinkage of system use throughout its lifecycle does not have to be predicted (as accurately) in advance. However, this argument for the need of scalability was made just once [28]. In contrast to "automated provisioning of services" this benefit category was of higher importance to researchers than to practitioners (R24/W36), even being the most mentioned amongst the peer reviewed sources.

Another benefit, where the argumentation for the benefit chain is not very strong is „standardized services with higher process automation". Even if the benefit of "focus on tasks of higher value" is mentioned quite a few times (R5/W14), it cannot be clearly attributed to just one of the capabilities of cloud computing. While the provision of highly standardized services (R0/W6) certainly enables increased process automation (R2/W4), other factors, such as reduced efforts for software installation, maintenance and management (R8/W12) also free up resources to focus on different tasks of higher strategic importance. This is not the only logical connection to the benefit chain "standardized software with pooled resources". As the name already implies, both chains revolve around the topic of standardization; a standardization of the software portfolio (R1/W2) is a prerequisite for the standardization of services. A reduced hardware, software and service portfolio simplifies the installation, maintenance and management of software (R3/W9). The last item with a significant amount of mentions is „web-technology applications" (R7/W19). In general, the use of open, platform independent web standards seems to be welcomed (R3/W5). The use of these technologies simplifies collaborative work (R1/W9) by making data generally available (R3/W5). However, these benefits are also not unique to cloud computing which might explain the low amount of mentions.

The focus on total cost of ownership and scalability as key benefits of cloud computing is also visible when looking on the distribution of the sum of elements across the three layers. It could be expected that the connection layer as an intermediate construct would gather the fewest mentions across all value chains. Yet, because of the strong effect of scalability, it actually has more elements mentioned (R36/W102) than the IS capability layer (R38/W69). The benefit sub-dimension layer still comes out on top (R43/W110).

Discussion of Links and Chains

If two or more elements of the same benefit category were found in a document, this was evaluated as a link being present (Table 3). An inference on the strength of the link itself cannot be made from this approach. Analyzing the links found on a per document basis showed that many documents were focusing either on the technical or business spectrum of a chain. However, overall there is not a huge disparity between the number of links from the IS capability layer to the connection layer (46) and the number of links from the connection layer to the benefit sub-dimension layer (44). Links directly from the IS capability layer to the benefit sub-dimension layer were substantially less (14).

Naturally, benefit categories with few mentions also display fewer links. Again, this mainly affects the categories "service catalogue meeting demand" and "scale out / burst to hybrid cloud" for which no links could be found. If links between the IS capability layer of a benefit category and the benefit sub-dimension were found in a paper, this was counted as a complete chain. Unfortunately, only a disappointing number of complete chains were found in the documents (19).

More than a third (7) of the complete chains are in the category of "low start-up costs for new projects". While "automated provisioning of services" has most mentions and links, it only has the second most complete chains (4). Two chains were found for "shared infrastructure with higher utilization" as well as "web-technology applications"; 3 for "location/device independent access".

Adding the direct links between the IS capability layer and the benefit sub-dimension layer to the number of complete chains does not alter the results significantly: "low start-up costs for new projects" still appears to be most solid logical chain, followed by "automated provisioning of services".

Table 3: Overview of Links and Chains

#	Benefit Category	IS Capability Layer	→	Connection Layer	→	Benefit Sub-dimension Layer	IS capability to Benefits Sub-dimension	Complete Chain
1	Automated provisioning of services	Automated (server) provisioning	10	Faster service provisioning	11	Faster project implementation/time-to-market/time-to-value	3	4
2	Low start-up costs for new projects	Provision of infrastructure at low initial investment cost for new projects	8	"Prototyping" of new business applications	8	IT supported innovation	7	7
3	Shared infrastructure with higher utilization	Operation of a shared / flexible infrastructure	4	Higher HW utilization	12	Lower technology TCO	1	2
4	Location / device independent access	Provision of secure location / device independent access	5	Disaster Recovery capabilities	3	Improved disaster recovery	2	3
5	Automated ramp up/down of capacities	"Instant" automated ramp up/down of capacities	9	Quicker reaction to changes in demand	0	Reduction of lost business / productivity	0	0
6	Standardized software with pooled resources	Standardization of software versions across pooled resources	3	Simplified software installation, maintenance and management	5	Reduced effort for software installation, maintenance and management	1	1
7	Web-technology applications	Operation of web-enabled applications (on inter-/intranet)	3	Data available for collaborative work	4	Ease of user collaboration	0	2
8	Standardized services with higher process automation	Provision of highly standardized services (vs. Individualization)	4	Increased process automation	1	Focus on tasks of higher value	0	0
9	Scale out / burst to hybrid cloud	Capability to automatically /easily integrate external resources on demand	0	On-demand (emergency) integration of external resources (hybrid cloud)	0	Shifted risk of overutilization and failure	0	0
10	Service catalogue meeting demand	Accurate forecast of IT demand (demand transparency)	0	Flexible service catalogue	0	Demand matching standard services	0	0

Conceptual Model

Combining the framework structure with the data and removing the two categories with less than 20 mentions results in the following model (Figure 2). The model is sorted by number of mentions, links and chains. The benefit categories are omitted from the model and just their elements on the 3 layers are shown. Each element on the IS capability layer was connected to the best matching essential characteristic. In addition, each element on the benefit sub-dimension layer was connected to the appropriate benefit category. 8 cloud computing value chains result from these connections.

Based on the findings from the model, the following propositions can be derived:

Proposition 1: Strategic benefits are deemed most important

At first glance it looks like strategic benefits are deemed most important or at least most marketed. Three factors are mainly responsible for this: automated (faster) service provisioning, low start-up costs for new projects, as well as IT supported innovation.

Proposition 2: Infrastructure benefits are mainly achieved through cost savings

Cost is not only a major factor regarding new projects but also regarding operational costs. Cloud computing promises to lower TCO by increasing average utilization, thereby reducing hardware as well as administrative costs.

Proposition 3: Scalability is the main operational benefit

Scalability is the most mentioned benefit. In times where the competitive environment is perceived to be more dynamic, scalability promises to reduce the risks of uncertainty.

Proposition 4: Cloud Computing does not result in managerial benefits

Cloud computing itself does not improve resource management, decision making or planning capabilities of an organization.

Comparison to related literature

Compared to similar studies of the same nature in other fields of IS research, the maturity of available data sources leaves a lot to be desired.

Firstly, due to a lack of case studies of real world implementations, fewer well-reasoned value chains are documented in the literature. This can be attributed to cloud computing being a relatively new technical phenomenon, where the majority of implementations are currently taking place or yet to come. Naturally, the publication of case studies succeeds implementations, which is why an improvement in this area is more likely than not.

Secondly, in addition to the lack of case studies, there is also a shortage of scientific research on the topic of cloud computing (at least for this type of study and at the time of writing). Having supplemental research of course solidifies the theoretical foundation of any research. Especially in the case of the development of a framework this would have been highly desirable.

Thirdly, also the number of available white papers was unsurprisingly lower compared to more mature technologies. Nonetheless, white paper availability appears to be sufficient, especially when compared to peer-reviewed research.

Comparable studies also based on the framework of Shang & Seddon [13]-[14], [21], [27] were able to resort to several case studies in their respective fields of research (SOA, ERP and enterprise application integration) as theoretical foundation of their models. This adds a certain level of refinement to a model, which is currently not possible in the field of cloud computing research. Nevertheless, once case studies become available, modifying the model to account for new information will ultimately yield the same model maturity.

The works of Themistocleous [27], Karimi et al. [13] as well as Khoumbati et al. [14] have a much wider focus than just benefits. Their frameworks also include factors like costs, barriers to adoption along with external and internal pressures in order to explain the factors influencing the success of IS adoption. This difference in scope results in less emphasis on benefits. However, cloud computing research has not yet evolved to the point where a framework to explain the success of adoption is feasible. This work is a first step towards the creation of such a framework by shedding some light on the aspect of cloud computing benefits.

The study of Müller et al. has admittedly inspired the design of this research. The concept of explaining how an IS technology generates benefits by decomposing the value chains between defining characteristics of the technology and the ultimate benefit category is as elegant as it is easy to understand. Through this lower level of abstraction (compared to the aforementioned studies) the framework is not only of value to a community of researchers, but also to practitioners.
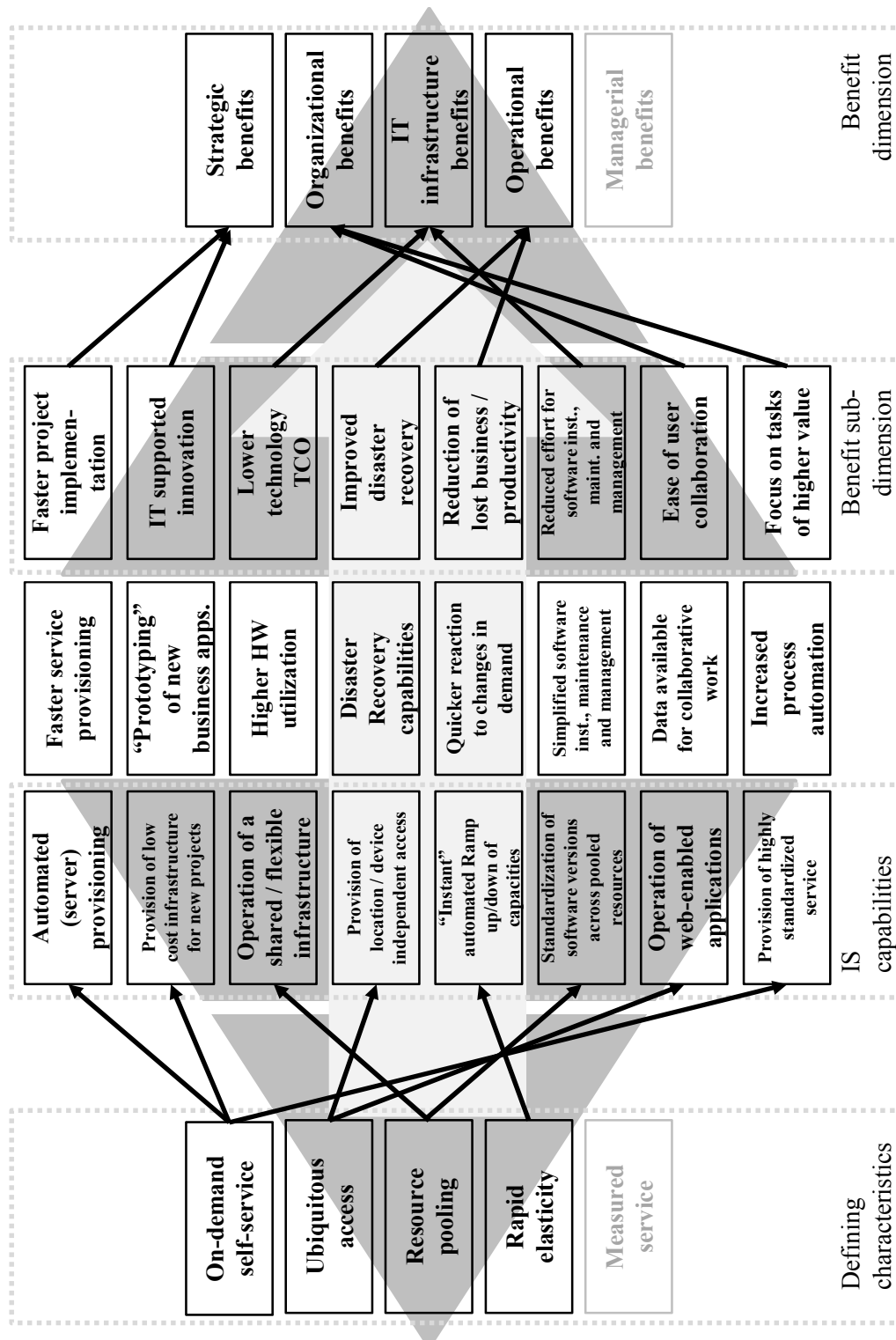
Figure 2: Cloud Computing Benefit Conceptual Model

While the work of Müller at al. is also based on secondary data, their available data set was much richer. It consisted of 164 case descriptions with a much higher percentage of scientific sources. It is questionable though, if the higher number of cause and effect chains found by them can only be attributed to the data set. The research subject probably also plays a role. It could be argued, that at the respective time of writing SOA as an architectural paradigm was better understood than cloud computing is. Also SOA was surrounded by much less ambiguity than cloud computing is. Additionally, SOA being an architectural paradigm arguably has a larger impact on an IT landscape than cloud computing which in comparison is "only" a new approach to highly virtualized and automated service provisioning. Müller et al. also found more elements on the connection and benefit sub-dimension layer, indicating that SOA offers more differentiated or individualized benefits compared to cloud computing. Then again, the result is also an absence of a few dominant chains. This gives the model less universal validity, making the potential use by practitioners more complex.

Nevertheless, the approach by Müller et al. seems to be well suited to explain the economic potential of IS technologies, as long as the respective technology has defining characteristics or principles to which benefits can be attributed. Sufficient sources, preferably case studies, are also a prerequisite for this approach. Fewer principles as well as universal benefits result in a clearer model with less items and connections, increasing the applicability by practitioners. If the benefits are very company specific or the respective IS technology has several defining principles, the resulting model could be quite cluttered.

Limitations

Even if this is one of the first studies trying to provide a framework for cloud computing benefits, it should not be evaluated without taking its limitations into consideration. The most profound of the limitations is the reliance on secondary data. On the one hand, data was gathered for different purposes, on the other hand data quality may be an issue. Thus, ensuring the external validity of the elements within the chains of the model becomes a challenging task. This challenge can be overcome by immersing oneself with the materials and the topic at hand [12].

Additionally, the majority of this data consist of company publications which have not been peer reviewed. Thus, data quality could be scrutinized. However, it can be argued that the publishing companies are concerned with their reputation and would therefore not publish false

information. Moreover, it can be assumed that the authors would also not omit benefits or mention non-existent benefits, again out of concern for their reputation [21].

The over- or understatement of benefits which might certainly be present in some of the studied white papers has no relevance for this study, as benefits have not been weighted. Evidently, there is also the issue of rater bias as only the author analyzed the source material. However, as the valuation performed is bivalent (a benefit is mentioned or it is not mentioned) the influence of rater bias on the results is negligible. Additional full text search should have identified any overlooked text segments.

Undeniably, a certain marketing hype currently surrounds the topic of cloud computing. If the promoted benefits really materialize in the majority of implementations is currently hard to fathom. Hence the results of this study should be compared to case studies of cloud computing implementations once available.

CONCLUSIONS

Contributions to Research

Bardhan et al. have proposed cloud computing as a field of research worth pursuing within the emerging research stream of "services science, management, and engineering" especially with regard to the value IT services generate, since it is one of the outcomes of the effects of hardware commoditization [1].

The proposed model fills a void of explanatory frameworks on cloud computing benefits. By systematically capturing cloud computing benefits, the model helps to explain how cloud computing implementations may generate value.

This paper also shows that it is possible to apply the approach of Müller et al. on other IS technologies, given a clear definition and sufficient sources on their benefits.

Opportunities for Future Research

The model proposed by the author offers several opportunities for future research. It would certainly be interesting to use the model during the cost-benefit discussion of a planned cloud computing implementation in an enterprise. The information gained through real world case studies could be used to revise and improve the model. Once actual benefit expectations have been captured, the model could be used for an ex-post analysis of cloud computing benefits by assigning key performance indicators (KPIs) to the individual items of the model. A list of exemplary KPIs is proposed in Table 4. Based on these

KPIs a framework for quantitative analysis of cloud computing implementation projects could be created.

Furthermore, it would be of interest to see how the focus of the model shifts by industry, size and other company characteristics [16]. Bardhan et al. have already recognized the need for this type of research by proposing the following research direction: "Additional service science research should be done to explore the value of cloud computing in specific industry settings"[1].

Table 4: Exemplary KPIs

#	Benefit Category	Exemplary KPIs
1	Automated provisioning of services	Percentage of servers automatically provisioned; average provisioning time
2	Low start-up costs for new projects	One-off cost of one standard logical server instance; number of new applications tested p.a.
3	Shared infrastructure with higher utilization	Average hardware utilization; TCO of one standard logical server instance
4	Location / device independent access	Number of applications accessible via VPN/network; cost of disaster recovery measures
5	Automated ramp up/down of capacities	Revenues (earnings) of additional business through ramp up of capacities
6	Standardized software with pooled resources	Number of software packages * respective versions * installations; effort for software installation and maintenance; TCO of software
7	Web-technology applications	Number of web-enabled applications with collaboration features (e.g. shared data)
8	Standardized services with higher process automation	Number of automated processes; number and cost of standardized services vs. non-standard services
9	Scale out / burst to hybrid cloud	Number of "hybrid cloud enabled" applications; cost of risk mitigation
10	Service catalogue meeting demand	Updates to service catalogue; number of requests for non-catalogue items; user satisfaction

Managerial Implications

As with all investments, a careful cost-benefit analysis should also be conducted for any cloud computing implementation. This framework illuminates the benefit side of the analysis. While costs have to be estimated using established techniques, this framework provides a list of potential benefits. Admittedly, quantifying these benefits is still a daunting task. Unfortunately, this calculation cannot be generalized and depends on the particular circumstances.

In times where IT is seen by some as just a commodity cost factor [5], placing cloud computing as a strategic initiative might be hard to argue for, as it pushes the commoditization of IT even further. Even if strategic benefits dominate according to this study, which is based on the publications of researchers and cloud computing vendors, it might be easier to promote a cloud computing project focusing on the potential cost savings.

Despite the quite complicated evaluation of benefits, this framework gives an overview of the potential benefits achievable with cloud computing. How these benefits are evaluated is up to the individual decision maker.

REFERENCES

[1] Bardhan, I., Demirkan, H., Kannan, P.K., Kauffman, R.J., and Sougstad, R. "An interdisciplinary perspective on IT services management and services science," *Journal of Management Information Systems*, Volume 26, Number 4, Spring 2010, pp. 13-64.

[2] Barney, J.B. "Resource-based theories of competitive advantage: a ten-year retrospective on the resource-based view," *Journal of Management*, Volume 27, Number 6, 2001, pp. 643-650.

[3] Bharadwaj, A.S. A resource-based perspective on information technology capability and firm performance: an empirical investigation. MIS Quarterly, Volume 24, Number 1, 2000, pp. 169-196.

[4] Buyya, R., Yeo, C.S., Venugopal, S., Broberg, J., Brandic, I. "Cloud computing and emerging IT plat-

forms: Vision, hype, and reality for delivering computing as the 5th utility," *Future Generation Computer Systems*, Volume 25, Number 6, 2009, pp. 599-616.

[5]   Carr, N.G. "IT doesn't matter," *Harvard Business Review*, Volume 81, Number 5, 2003, pp. 41-49.

[6]   EMC², "Private Cloud Means Business: Costs Down and Agility Up", http://www.idgconnect.com/download/4337/private-cloud-means-business-costs-down-agility-up?source=connect, November 2011.

[7]   Grant, R.M. "The resource-based theory of competitive advantage," *California Management Review*, Volume 33, Number 3, 1991, pp. 114-135.

[8]   Gregor, S. "The nature of theory in information systems," *MIS Quarterly*, Volume 30, Number 3, 2006, pp. 611-642.

[9]   Hewlett-Packard Development Company, "Five myths of cloud computing," http://www.idgconnect.com/download/7035/five-myths-cloud-computing?source=connect, November 2011.

[10] Hewlett-Packard Development Company, "START small, grow tall: why cloud now," http://www.idgconnect.com/download/7036/start-grow-tall-cloud?source=connect, November 2011.

[11] IBM, "Cloud Computing Payback," http://www.idgconnect.com/download/6379/cloud-computing-payback?flag=true&source=connect, November 2011.

[12] Kaplan, B. and Duchon, D. "Combining qualitative and quantitative methods in information systems research: a case study," *MIS Quarterly*, Volume 12, Number 4, 1988, pp. 571-586.

[13] Karimi, J., Somers, T.M., and Bhattacherjee, A. "The impact of ERP implementation on business process outcomes: a factor-based study," *Journal of Management Information Systems*, Volume 24, Number 1, 2007, pp. 101-127.

[14] Khoumbati, K., Themistocleous, M., and Irani, Z. "Evaluating the adoption of enterprise application integration in health-care organizations," *Journal of Management Information Systems*, Volume 22, Number 4, 2006, pp. 69-108.

[15] King, S.F., Burgess, T.F. "Beyond critical success factors: A dynamic model of enterprise system innovation," *International Journal of Information Management*, Volume 26, Number 1, 2006, pp. 59-69.

[16] Kohli, R. and Grover, V. "Business value of IT: an essay on expanding research directions to keep up with the times," *Journal of the Association for Information Systems*, Volume 9, Number 1, 2008, pp. 23-39.

[17] Krippendorf, K. "Reliability in Content Analysis: Some Common Misconceptions and Recommendations," *Human Communication Research*, Volume 30, Number 3, 2004, pp. 411-433.

[18] Mata, F.J., Fuerst, W.L., and Barney, J.B. "Information technology and sustained competitive advantage: a resource-based analysis," *MIS Quarterly*, Volume 19, Number 4, 1995, pp. 487-505.

[19] Mell, P., Grance, T. "The NIST Definition of Cloud Computing," National Institute of Standards and Technology, NIST Special Publication 800-145, 2011.

[20] Misra, S. and Mondal A. "Identification of a company's suitability for the adoption of cloud computing and modelling its corresponding Return on Investment," *Mathematical and Computer Modelling,* Volume 53, Number 3, 2011, pp. 504-521.

[21] Müller, B., Viering, G., Legner, C., Riempp, G. "Understanding the Economic Potential of Service-Oriented Architecture," *Journal of Management Information Systems*, Volume 26, Number 4, 2010, pp. 147-182.

[22] Peppard, J., Weill, P., and Daniel, E. "Managing the realization of business benefits from IT investments," *MIS Quarterly Executive*, Volume 6, Number 1, 2007, pp. 1-11.

[23] Romano, N.C., Donovan, C., Hsinchun, C., and Nunamaker, J.F. "A methodology for ana-lyzing web-based qualitative data," *Journal of Management Information Systems*, Volume 19, Number 4, 2003, pp. 213-246.

[24] Saaty, T.L. *The Analytic Hierarchy Process*, McGraw-Hill, New York, New York, 1980.

[25] Shang, S. and Seddon, P.B. "Assessing and managing the benefits of enterprise systems: the business manager's perspective," *Information Systems Journal*, Volume 12, Number 4, 2002, pp. 271-299.

[26] Sriram, I and Khajeh-Hosseini, A "Research Agenda in Cloud Technologies," LSCITS Technical Report, 2010.

[27] Themistocleous, M. "Justifying the decisions for EAI implementations: a validated proposition of influential factors," *Journal of Enterprise Information Management*, Volume 17, Number 2, 2004, pp. 85-104.

[28] Xia, T., Li, Z., Yu, N. "Research on Cloud Computing Based on Deep Analysis to Typical Platforms," in M.G. Jaatun, M.G., Zhao, G., Rong C. (eds.) *Cloud Computing*, Springer, Heidelberg, 2009, pp. 601–608.

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