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Managing Heterogeneity in IT Service Management: Towards a Research Agenda

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Abstract

Cloud computing changes the way of delivering and consuming IT services. Due to increasing modularization and standardization, it is possible to deliver highly scalable and flexible cloud-based IT services at a superior price point. Therefore, cloud computing supports the process of IT industrialization to a high extent. Furthermore, the industrialization of IT entails a trend towards cloud-based value chains or service value network. Thus, most of the IT service providers have to handle heterogeneous IT landscapes and their service value networks including all upstream suppliers.

This paper provides an overview on recent research concerning these particular topics by conducting a literature review on heterogeneous IT landscapes and IT service management. The review showed that there is a large body of knowledge for each of the research domains (IT service management, cloud computing, heterogeneous IT landscapes). However, there is little research that integrates these domains. Hence, research on IT service management and cloud computing is still limited and no research could be found concerning heterogeneity in IT service management in the context of cloud computing.

Based on the discovered research gaps a research agenda is proposed and a first draft for a framework structuring research on heterogeneity in IT service management is presented. Two conceptual models are presented to measure and visualize heterogeneity in IT service management. Also the drivers of heterogeneity in IT landscapes are summarized. Both models offer a basic approach for future research.

Keywords: *IT service management, ITSM, ITIL, heterogeneous IT landscape, cloud computing, heterogeneity, literature review*

INTRODUCTION

For many years, developing and provisioning IT services was a task restricted to IT departments. At the same time the business functions of the IT department's enterprise were the only IT customers. Thus, the IT landscapes and processes were solely aligned to the business needs of the respective enterprise. With the advent of outsourcing, this one-to-one service model began to change and complexity in managing IT grew constantly (Böhm, Leimeister, Riedl, & Krcmar, 2009). During the last five years, cloud computing arose as a new sourcing paradigm and brought along with it an acceleration and expansion of this process.

With cloud computing the way of generating and delivering IT services changed substantially (Böhm, Herzog, Riedl, Leimeister, & Krcmar, 2010; Heininger, Wittges, & Krcmar, 2012; Hoberg, Wollersheim, Böhm, & Krcmar, 2012). More specifically, cloud computing enables the establishment of a new provisioning model for IT and IT services (Böhm et al., 2009; Heininger et al., 2012). Furthermore, rapidly changing, complex and competitive business environments call for highly scalable and flexible IT services. However, in this context it should also be taken into consideration that IT services are intangible, perishable, and heterogeneous (Kim & Nam, 2009).

While cloud computing changes the way of delivering and consuming IT services, innovation in managing those IT services is still required. IT departments are facing the challenge to manage heterogeneous IT landscapes and distributed service generation. Thus provisioning IT services means to orchestrate several vendors and consequently leads to supply chain management problems in the field of IT service management (Ferguson & Hadar, 2011). The management of in-house development and provisioning of IT services becomes less important and the use of service supply chains increases (Erbes, Motahari-Nezhad, & Graupner, 2012). According to a survey of 153 German IT decision-makers carried out by IDC (2013), cloud services are becoming increasingly important and the integration of those services into existing on premise landscapes is a critical task, requiring different capabilities.

Also over the past decades with the growing business relevance of IT, a paradigm shift from developing and operating IT systems towards developing and providing IT services has taken place. By becoming an in-house IT service provider, IT departments had to manage the change towards IT service orientation, IT process orientation, and IT architecture orientation (Böhmann & Krcmar, 2004). In order to reach these targets, IT departments strengthened their IT service management teams and began to align their processes and organization along common IT service management standards. Thus, IT service management has become an important topic and many IT departments started complex restructuring projects to re-organize their IT processes by adopting best practice collections like the *Information Technology Infrastructure Library* (ITIL). A survey conducted in 2008 on U.S. systems and network managers has shown that 45 percent have already used IT service management and 15 percent were planning to do so. 66 percent of those who already had used IT service management at that time resorted to ITIL (Conger, Winniford, & Erickson-Harris, 2008). A second survey conducted in 2013 with 742 IT service management experts from 49 countries/regions also shows that ITIL is the most widely adopted framework (itSMF International, 2013).

However, both surveys reveal that the adoption of IT service management is still in progress and as described below, there are still open research questions on this matter. Increasing heterogeneity due to cloud computing and the impact on IT service management or methods to manage heterogeneous IT service landscapes have not been researched at all. Hence, by

contributing to related research and conducting a literature review on heterogeneity in IT service management, this paper proposes a research agenda and a first conceptual approach for a framework of heterogeneity in IT service management. This might be useful to gain an insight into this emerging field of research and offers a basic approach for the future research.

RELATED WORK

IT Service Management in a Cloud Environment

IT service management stands for a process to plan and to control the quality and quantity of provided IT services considering the objectives of business processes, customer orientation and cost optimization (Kopperger, Kunsmann, & Weisbecker, 2009, p. 129) and can be defined as "*[...] a set of specialized organizational capabilities for providing value to customers in the form of services*" (OGC, 2007, p. 15). A literature review by Heininger (2012) concludes that there is only little work done on the impact of cloud computing and complex value-creation networks on the proven ITSM standards (e.g. ITIL). The main findings are that there is no holistic view on IT service management in a cloud environment to date, process roles are the most researched objects, and ITIL is still missing cloud specific topics (Heininger et al., 2012). Despite that, ITSM is acknowledged as an important element to handle responsibility and complexity in cloud computing value networks (Bohn, Messina, Liu, Tong, & Mao, 2011; Hamm & Yampolskiy, 2008; Sreekumar & Prabhakara, 2011).

Another literature review conducted on topics and applied theories in IT service management by Pröhl, Erek, Limbach, and Zarnekow (2013) provides a research agenda to handle the identified areas of future research in IT service management as depicted in **Figure 1**.

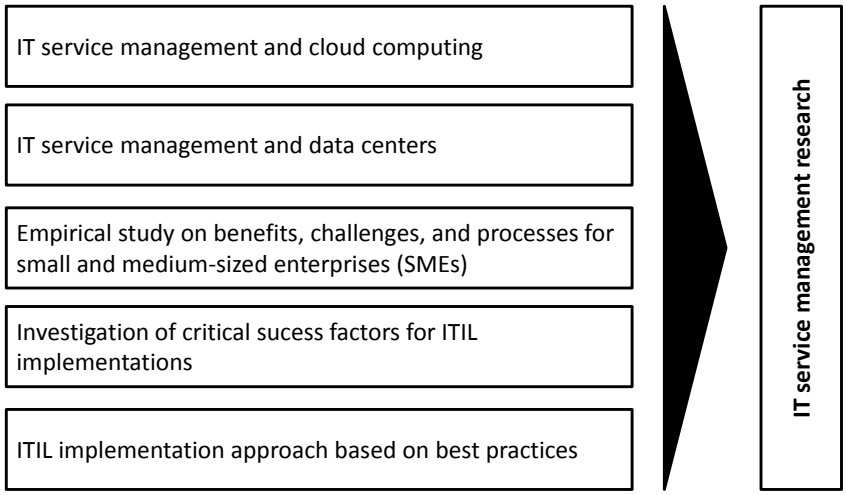

Figure 1: Research agenda for IT service management
Source: based on Pröhl et al. (2013)

Both literature reviews point out a huge amount of publications concerning IT service management. They also agree in the findings that further research should concentrate on IT service management and cloud computing. This might include developing a next generation ITIL containing critical success factors for ITIL implementations especially in the context of cloud computing (Heininger et al., 2012; Pröhl et al., 2013).

Business Perspective on Cloud Computing

A literature review by Hoberg, Wollersheim, and Krcmar (2012) analyzed the business perspective on cloud computing. They found that research on structures, processes and employee qualification to manage cloud services from a cloud customer's perspective still was at a very early stage during the time of their writing. The authors developed a large set of cloud computing characteristics arranged in the following five categories: design principles, service models, deployment models, market structures, and pricing models (Hoberg, Wollersheim, & Krcmar, 2012).

The main contribution of the literature review are several research gaps, pointing out for example that research regarding the customer-perspective of cloud computing is still limited. Also the authors mention that researchers might focus their work on developing instruments, for example taxonomies and typologies to increase transparency in the cloud service market. Next, research on factors influencing the adoption of cloud services and investigating its business impact, is not very prevalent as well.

Actors within the Cloud Computing Ecosystem

By analyzing a dataset of 2628 cloud services, Böhm, Koleva, Leimeister, Riedl, and Krcmar (2010) discovered eight generic actors and arranged them into a generic value network of cloud computing using the e³value method (cf. Gordijn & Akkermans, 2002). Their generic value network is shown in **Figure 2**. This network presents a business perspective on cloud computing and constitutes the ecosystem that has developed around cloud computing.

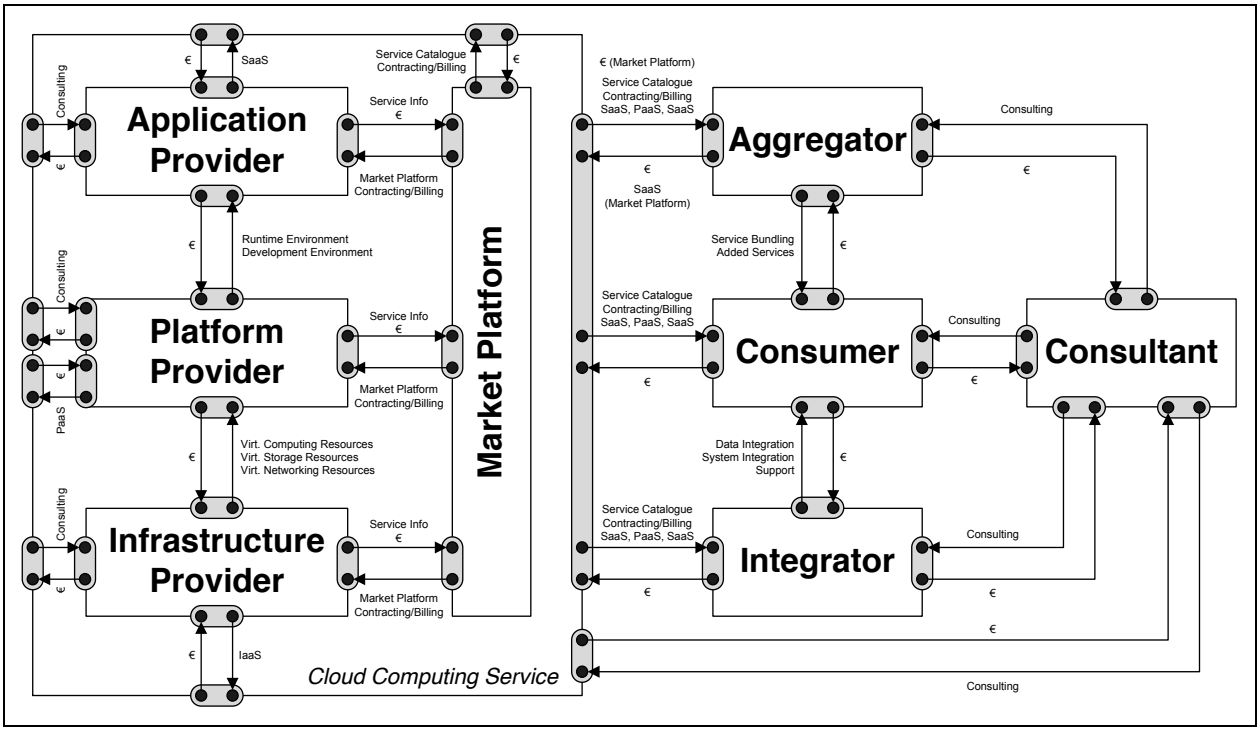

Figure 2: A generic value network of cloud computing
Source: based on Böhm, Koleva, et al. (2010)

The most common value chain approach was presented by Porter (1991), accounting the collaborations between different companies by creating an extended value chain, termed value system. Thus a value system represents a linear interconnected system of autonomous value chains. Based on this, a value network is a "*set of relatively autonomous units that can be managed independently, but operate together in a framework of common principles and service level agreements (SLAs)*" (Peppard & Rylander, 2006). In terms of a division of labour respectively distributed service generation, the roles application, platform and infrastructure provider represent the basic IT functions. These include developing software, providing a runtime environment and the provisioning and operation of hardware and network infrastructure. These products are delivered as a service and offered by using internet-based market platforms. Alongside with this, the opportunity to aggregate these services to service bundles arises. Aggregators combine existing services created by several providers to a new service offered to a diverse range of customers. Integrators focus on integrating cloud services into the existing IT landscape including technical, data, process, and governance issues (Böhm, Koleva, et al., 2010). Both, aggregators and integrators have to address the challenges caused by heterogeneity to offer their value-added service to the consumer.

Besides this classification of roles, the *National Institute of Standards and Technology* (NIST) also developed a conceptual model concentrating on the role and interactions of cloud computing actors (Bohn et al., 2011). In contrast to the generic value network of cloud computing presented by Böhm, Koleva, et al. (2010), Bohn et al. (2011) distinguish between five major actors who perform unique and specific cloud computing activities, namely cloud service provider, cloud broker, cloud auditor, cloud carrier, and cloud service consumer.

Bleizeffer et al. (2011) propose three core cloud user roles – creator, provider and consumer – supplemented with several sub-roles. Some of these sub-roles such as Service Manager are well known in the domain of IT service management.

To summarize the above, there are several views on the sphere of cloud computing with different focus and perspectives, but they all show increasing complexity and heterogeneity induced by cloud computing. Therefore IT service management faces the challenge of exploiting the growing heterogeneity IT landscapes and there is a strong need for models, methods, tools, and best practices for mastering heterogeneity in IT service management.

HETEROGENEITY IN IT SERVICE MANAGEMENT

Schematic View of Supplier-Customer Relationships in Cloud Computing

Cloud computing enables modularization, standardization and concentration on core competencies in the IT industry (Böhm, Herzog, et al., 2010; Heininger et al., 2012; Lindner, McDonald, McLarnon, & Robinson, 2011). Future development paths of IT industrialization supported by cloud computing might be concluded by analyzing the developments of other industries with similar characteristics for example the automotive industry (Böhm, Herzog, et al., 2010). For example, the outsourcing of complete IT service modules towards upstream suppliers in automotive supply chains, its diverse network and the issue of transparency in supply chains may nowadays also be found in cloud computing value networks (Böhm, Herzog, et al., 2010).

Figure 3 shows a schematic overview of supplier-customer relationships in a cloud computing value network. It demonstrates the rising complexity of a heterogeneous IT landscape and further depicts the increasing responsibilities of each individual actor.

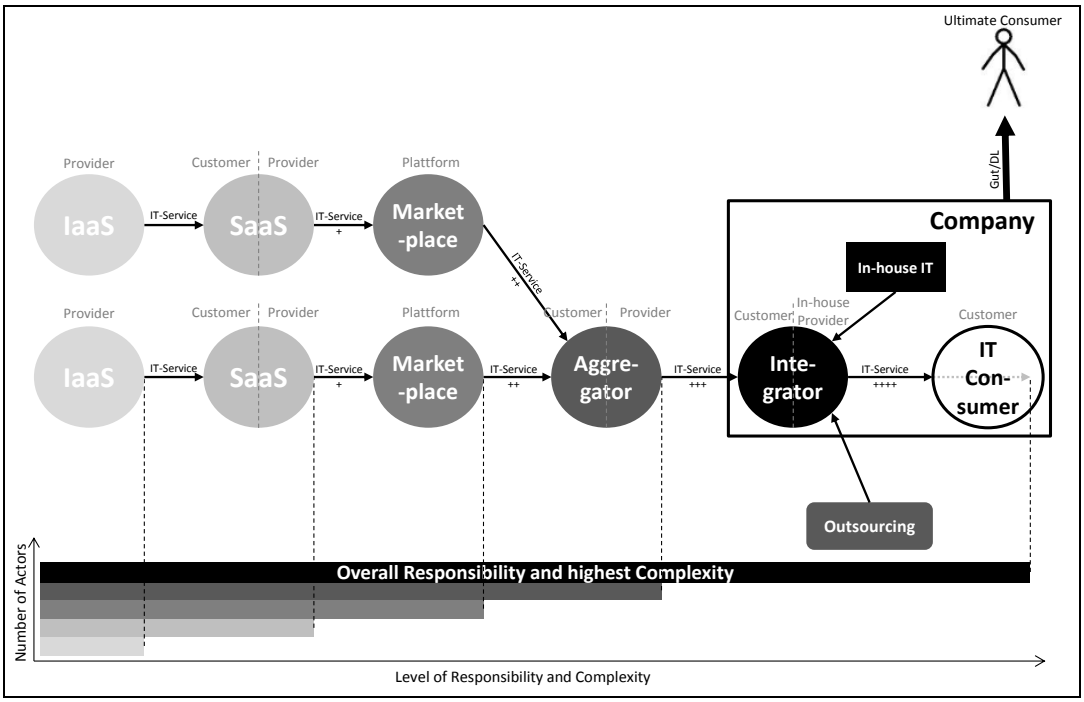

Figure 3: Complexity of a heterogeneous IT landscape in a schematic view
Source: based on Heininger (2013)

For example, the in-house IT service provider or integrator according to Böhm, Herzog, et al. (2010) is responsible for IT services across the whole IT value network including the final service delivery to the end consumer (Böhm, Herzog, et al., 2010). Other IT service providers may combine cloud services with other forms of outsourcing and traditional in-house IT service provisioning. These customer-supplier relationships result in heterogeneous IT landscapes (Knittl & Lauchner, 2010). Before the era of cloud computing, the IT service provider has been responsible for in-house service delivery and with regard to outsourcing as principal. In IT value networks, the IT service provider becomes a customer due to outsourced services additionally. However, the responsibility for the complete service delivery must still be guaranteed by the IT service provider, especially with regard to performance, availability and security levels provided by the offered services. Moreover, the prospect of automated data centers which require automated service processes further exacerbate the situation and pose a challenge to IT service providers. Against this background several types of heterogeneity become relevant (cf. Erbes et al., 2012; Janiesch, Fischer, Matzner, & Müller, 2011; Pansa, Walter, Scheibenberger, & Abeck, 2010; Richter & Schaaf, 2011):

- heterogeneity of software and hardware vendors respectively service vendors,
- heterogeneity of IT services,
- heterogeneity of IT service management processes,
- heterogeneity of IT service data,
- heterogeneity of IT service attributes (e.g. availability, security),
- heterogeneity of IT service generation,
- heterogeneity of IT service provisioning,
- heterogeneity of IT service management tools,
- and so on …

State-of-the-Art on IT Service Management and Heterogeneity

In order to research IT service management in heterogeneous IT landscapes a literature review was conducted, following the guidelines of Webster and Watson (2002). The main research question of this study was: *which aspects of IT service management and heterogeneity in IT landscapes are researched and published to date?* We searched for literature in the ACM Digital Library, EBSCOhost (Business Source Complete), IEEEXplore, AISeL, and Google scholar using the search terms as listed in **Figure 4**. The search was conducted within title, abstract and keywords. This was complemented by a backward and forward search. The search was performed by two researchers to enforce reliability and completeness. As the term cloud computing was not used before October 2007[1], the literature review was limited to publications published in the year 2008 or later.

	ITSM	IT service management	ITIL	ISO/IEC 20000	IT landscape	IT environment	IT value network	heterogeneous	cloud
ITSM					59 / 5				
IT Service Management					173 / 6				
ITIL					167 / 2				
ISO/IEC 20000					12 / 0				
IT landscape	1 / 1	6 / 0	10 / 0	1 / 0				115 / 4	
IT environment	4 / 0	20 / 1	26 / 0	1 / 0				113 / 3	
IT value network	1 / 0	3 / 0	5 / 0	0 / 0				63 / 0	
heterogeneous	11 / 2	40 / 1	39 / 0	2 / 0	71 / 3	48 / 1	37 / 0		
cloud	39 / 2	104 / 4	87 / 2	8 / 0	44 / 1	65 / 2	26 / 0		

(number of results / relevant results)

Figure 4: Keywords and number of hits in different literature databases
Source: (own illustration)

Searching for 'cloud computing' and 'IT service management' or 'cloud computing' and 'ITIL' results in many search hits but most of them were rather unrelated. Hence, after screening these findings for relevance by analyzing title, keywords, abstract and conclusion 20 relevant publications were identified. After analyzing the whole article, 17 publications remained. With the additional publications the backward and forward search yielded, 28 publications formed the literature review's result set. An overview of the research model underlying the literature review can be seen in **Figure 5**.

[1] Cloud computing in Google Trends: http://www.google.de/trends/explore?q=cloud+computing#q=cloud%20computing&cmpt=q, accessed at 30.08.2013.

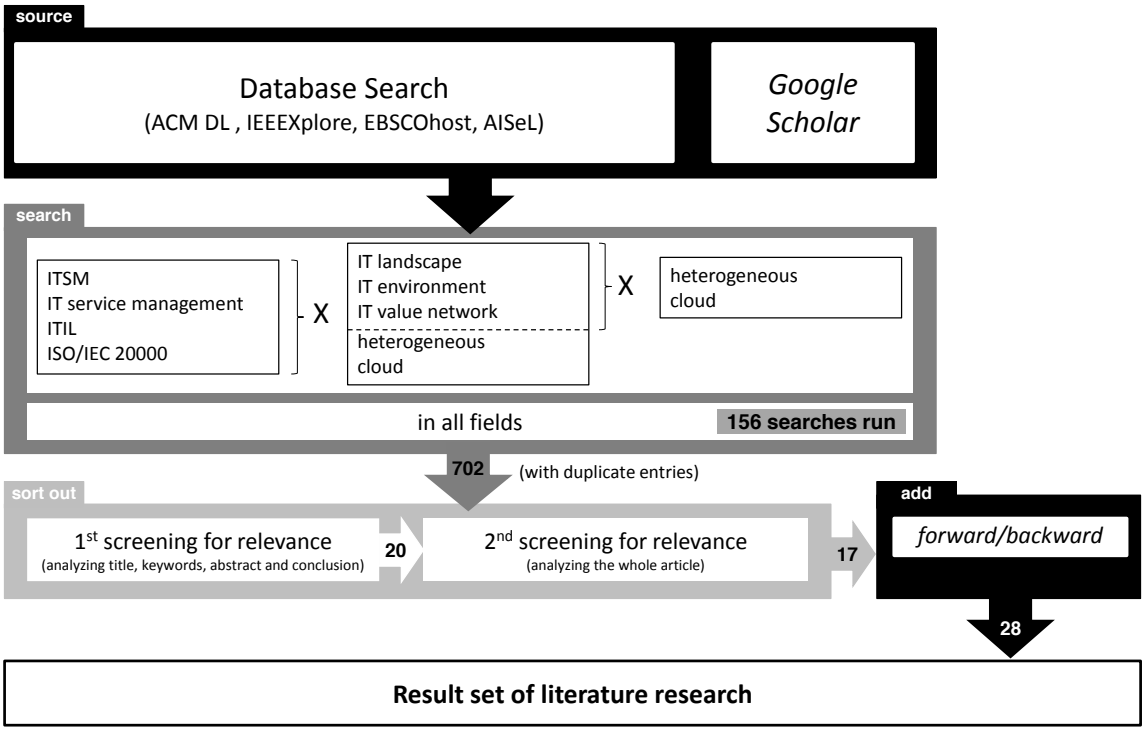

Figure 5: Research model of the conducted literature review
Source: own illustration; structure based on Heininger et al. (2012)

Most of the publications are concerning complexity or heterogeneity of self-contained IT landscapes from a single enterprise point of view (e.g. Beetz & Kolbe, 2011; Chen, Nepal, & Pandey, 2012). It would be an interesting field of research to proof the portability of those solutions and models to a value network-based heterogeneous IT landscape as mentioned above. Another group of papers describes only single aspects or artifacts of IT service management, for example service level management, incident management, or configuration management databases (e.g. Hommel & Knittl, 2009; Unterharnscheidt & Kieninger, 2010). In the following, some particularly interesting publications are presented.

Reitbauer, Kohlmann, Eckert, Mansfeld, and Alt (2008) present a reference model for the investment process of the financial industry and an overview of roles in the value chain of the investment process. Additionally, the authors presents two instruments named network model and service map covering the layers strategy, process and systems to manage more networked business models.

Reviewing the state-of-the-art of managing choreographed service networks with a cloud computing background is the subject of Janiesch et al. (2011)'s article. Based on process analytics and complex event processing, the authors develop an architecture for event-driven business activity management of service networks. The architecture is a software independent conceptual model. In the context of cloud-based service networks it provides the abilities to define business rules dynamically and correlate events from multiple resources.

Pansa et al. (2010) introduce a model for business-driven IT management in order to decouple the IT service management processes from the functionality offered by a heterogeneous tool chain. The authors recommend web services for supporting the automatable parts of IT service management processes and suggest a meta-model by capturing functional requirements derived from ISO/IEC 20000. To enable a web service-based integration of existing management

tools, a management service meta-model is introduced. Finally, to demonstrate the usage of the model, an application encompassing the meta-model is presented.

A similar tool-oriented approach under the business-driven IT management paradigm is presented by Richter and Schaaf (2011). As well as Pansa et al. (2010) the authors point out that IT service providers are using a variety of different tools to manage their infrastructure and services. In order to address the needs of IT service providers for efficient tool support to manage IT services, a maturity model for tool landscapes is presented. By providing a specific and a global view, different requirements are addressed.

Erbes et al. (2012) discuss a conceptual architecture of the operating environment for hybrid IT service portfolios in order to enable service consumers to procure and manage services provided by external service providers. Also, the authors define how to develop support systems for the supply chain management of IT services. The authors point out that IT will have to act as a broker, integrator, or manager of a hybrid portfolio of services to remain relevant in an enterprise where the business functions could acquire services out of the cloud. Following the ITIL service lifecycle model, a five-phase approach including strategy, design, implementation, operation, and continuous improvement is introduced.

With the focus on software-as-a-service, Winkler, Goebel, Benlian, Bidault, and Günther (2011) investigated the impact and factors of using cloud services on IT governance by combining a contingency perspective with a multi-case approach. Doing so, a contingency model for governance arrangements on the application level was derived and verified by four comparative case studies. The model can be used for better understanding the reasons for certain modes of governance in relation with software-as-a-service applications. However, the portability of this contingency model to other cloud service models has not yet been verified.

Widjaja, Kaiser, Tepel, and Buxmann (2012) define heterogeneity in an IT landscape as a statistical property. They further develop a generic mathematical model to quantify heterogeneity in IT landscapes. By analyzing relevant literature the authors define heterogeneity as follows: “Heterogeneity in IT landscapes is a statistical property and refers to the diversity of attributes of elements in the IT landscape” (Widjaja et al., 2012, p. 4). Examples of attributes are vendors, products, and other element specific characteristics. The model can be used in a wide array of theoretical contexts on the one hand. On the other hand it offers a comprehensive way to operationalize IT heterogeneity for example in enterprises as well as in IT service value networks.

In conclusion, this literature review shows that there are several publications concerning heterogeneity, cloud computing, and IT service management. Interestingly no paper could be found that either addresses heterogeneity in IT service management caused by cloud computing or IT service management in heterogeneous IT landscapes. Future research should therefore address this research gap by providing answers to the following seven questions:

- How could heterogeneity in IT service management be measured and visualized appropriately?
- What are drivers of heterogeneity in IT service management?
- What types of heterogeneity are relevant in IT service management?
- Which aspects or artifacts of IT service management are most influenced by heterogeneity?
- Which methods/tools can be used to manage heterogeneity in IT service management?
- Which degree of heterogeneity in IT service management is recommended?

- Which adaptions to the common IT service management standards (e.g. ITIL) are recommended or might be necessary?

TOWARDS A FRAMEWORK OF HETEROGENEITY IN IT SERVICE MANAGEMENT

Measuring and Visualizing Heterogeneity in IT Service Management

Against the background of a rising demand for cloud services along with the increasing level of industrialization, IT service management faces the change from the common one-to-one service model towards complex value networks. One consequence arising from this is a distributed service generation in service value networks. Building on the works of Widjaja et al. (2012) and the research questions mentioned above, a visualization model of heterogeneity in IT service management can exemplarily be developed. A first approach is shown in **Figure 6**.

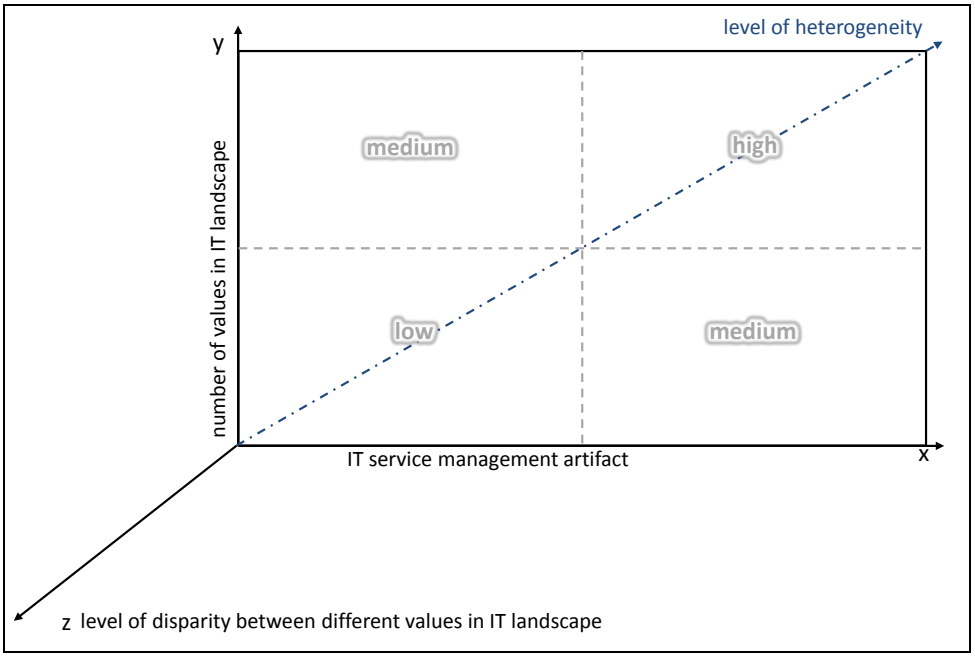

Figure 6: Visualization model for heterogeneity in IT service management
Source: own illustration

By using the recommended measurement methods of (Widjaja et al., 2012) the visualization of heterogeneity in IT service management is achieved by combining the following three values:

- The number of different IT service management relevant values (e.g. vendors or respectively actors).
- The relationship to a specific IT service management artifact (e.g. objects such as service level agreements, functions such as the service desk, process roles, or processes).
- The level of disparity between the IT service management and relevant values in the IT (service) landscape.

A set of eight actors can be found in the generic value network of cloud computing according to (Böhm, Koleva, et al., 2010) as mentioned above. The IT service management artifacts can be derived from existing literature on IT service management, respectively ITIL or ISO/IEC 20000. The determination of disparity between IT service management and the relevant values will be a challenge that has to be mastered in order to construct a three-dimensional model. A basic approach can be derived from the works of Widjaja et al. (2012). The transferability to disparity between the IT service management values still needs to be examined.

Drivers of Heterogeneity in IT Service Management

There are several factors influencing heterogeneity. This influence is bilateral and can increase heterogeneity as well as reduce it. Some authors emphasize factors of cloud computing which will reduce heterogeneity, for example through standardization, commoditization and, easy access to highly aggregated and specialized cloud services (cf. Böhm, Herzog, et al., 2010; Gupta, 2012; Singer, 2010). In contrast other authors referring to supply chain management problems and distributed service generation and suggesting increasing heterogeneity (e.g. Ferguson & Hadar, 2011; Hamm & Yampolskiy, 2008; Heininger et al., 2012). Both approaches are correct in the author's opinion. In fact, the correlations between those factors and heterogeneity caused by cloud computing respectively homogeneity brought by cloud computing are not researched until now. Focusing on the question: 'What are drivers of heterogeneity in IT landscapes?' based the current literature, a model of drivers of heterogeneity in IT landscapes could be achieved. A first conceptual approach based on types and aspects of heterogeneity is mentioned for example in Widjaja et al. (2012) and Kim and Nam (2009) and is depicted in **Figure 7**.

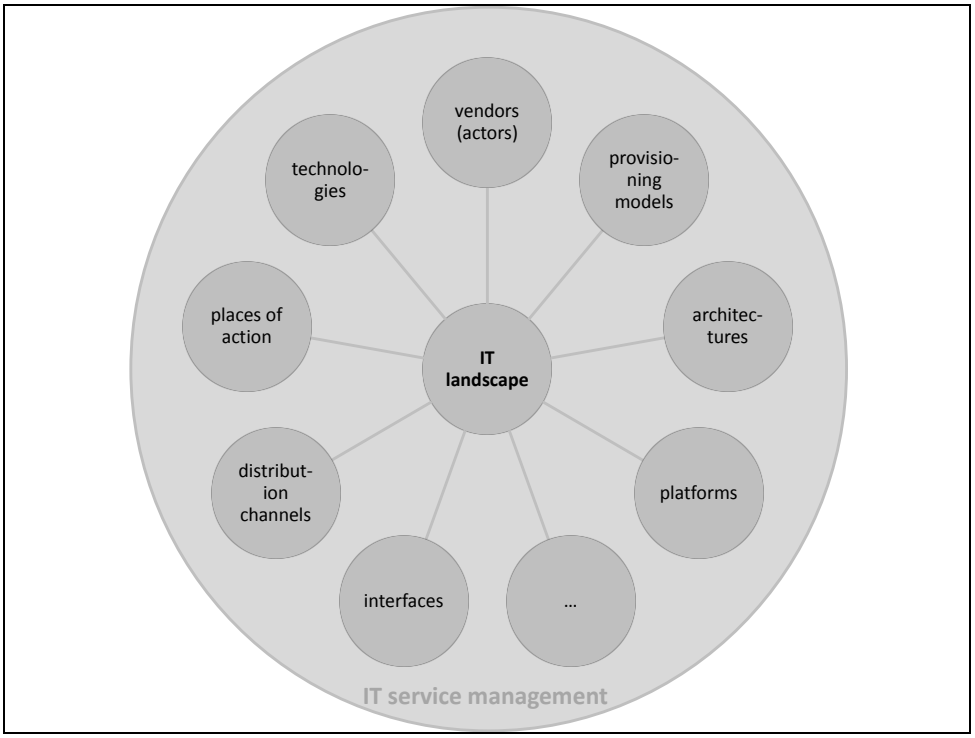

Figure 7: Drivers of heterogeneity in IT landscapes: a conceptual approach
Source: own illustration

Figure 7 presents a non-exhaustive list of drivers influencing the heterogeneity of IT landscapes. These include vendors (actors), architectures, provisioning models, and so on. All of these drivers could possibly increase and reduce heterogeneity. It will be the task of future research to first identify relevant drivers and second evaluate their influence on IT landscapes. IT service management will have to address these drivers, especially those which increase heterogeneity.

SUMMARY AND OUTLOOK

The impact and manageability of heterogeneity in IT service management or in heterogeneous IT landscapes respectively has not been examined until today. However, it is obvious that cloud computing will accelerate modularization, standardization and concentration on core competences in the IT industry. This will increase the number of actors in the IT value creation network on the one hand and further the allocation of service generation on the other hand. Until today, IT service management standards are not examined in these premises.

This literature review gives an overview on recent research concerning IT service management, cloud computing, heterogeneous IT landscapes and the integrated perspective of these research domains. The review showed that there is a large body of knowledge for each of the research domains. However, there is little research that integrates these domains. Hence, research on IT service management and cloud computing is still limited and no research could be found concerning heterogeneity in IT service management in the context of cloud computing. The research agenda presented in this paper might be useful to gain an insight into this emerging field of research. We proposed a first starting point for measuring and visualizing heterogeneity in IT service management and presented a non-exhaustive list of its drivers to provide a step stone for future research.

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