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Towards a Model of Heterogeneity in IT Service Value Networks: Results from a Literature Review

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Abstract

At the dawn of the Digital Economy, companies are facing with dematerialization and digitization of products and the trend towards service delivery. By supporting specialization and modularization of service providers, cloud computing involves the trend towards distributed service generation. Hence, multi-vendor networks arise and IT departments have to handle heterogeneous IT Service Value Networks (ITSVN). This research paper analyzes the concept of heterogeneity in ITSVN. Based on a literature review, this paper introduces a model of heterogeneity in ITSVN. Elements of this model are applications, platforms, infrastructures, actors, technologies, interfaces, and tools. Heterogeneity is caused by the diversity and alterity of the attributes of these elements. This article offers a fundamental understanding of the effects of heterogeneity in ITSVN, a definition of heterogeneity in ITSVN, and a model of influencing factors on heterogeneity in ITSVN.

Keywords: Cloud computing, heterogeneity, literature review, IT service, value network

1 Introduction

Cloud computing is both an important driver of digitization and a basis for developing new business models (Böhm, Koleva, Leimeister, Riedl, & Krcmar, 2010). Thus, it is

important to understand the impact of cloud computing on value creation. Actually, with cloud computing the way of generating and delivering IT services changes fundamentally towards service value networks (Böhm, Herzog, Riedl, Leimeister, & Krcmar, 2010). Cloud computing leads to an increase in modularization and specialization in the IT industry (Böhm, Herzog, et al., 2010, p. 50), it transforms IT services from vertically integrated services to complex IT supply cloud chain models (Ferguson & Hadar, 2011, p. 1) and induces the emergence of multi-stage supply relationships and value networks (Böhm, Herzog, et al., 2010, p. 50). These multi customer-supplier relationships result in heterogeneous IT service landscapes (Knittl & Lauchner, 2010), whose impact in the value creation process have not often been on the focus of past research (Heininger, Böhm, & Krcmar, 2013). Next, hybrid clouds involving both private cloud and public cloud (Chang, Walters, & Wills) and thus, IT service landscapes nowadays are often composed by the use of common IT services and cloud services.

However, emerging service value networks lead to an increase in the complexity of managing IT service landscapes. The term IT service landscape describes the holistic end-to-end consideration of an IT service. Complexity can be defined as the number and the heterogeneity of components and relations (Schütz, Widjaja, & Gregory, 2014). Heterogeneity is related to the variety of IT elements (Widjaja, Kaiser, Tepel, & Buxmann, 2012). In practice, IT departments are facing problems resulting from increasing heterogeneity in IT service landscapes and by becoming service aggregators, the IT departments of tomorrow will have to aggregate modularized services into value-added, complex solutions (Böhm, Koleva, et al., 2010, p. 7). Therefore, a deeper understanding of heterogeneity and their effects on IT service landscapes is needed. Provisioning IT services nowadays means, among others, to orchestrate several vendors and therefore leads to supply chain management problems in the field of IT service management (ITSM) (Ferguson & Hadar, 2011, p. 1).

The relevance of heterogeneity increases, especially when more flexibility in the information systems of the organizations is required (Widjaja et al., 2012). In addition, the requirements of the business organization towards IT also increase, demanding more information processing capability (March, Hevner, & Ram, 2000). In a preliminary literature search[1], we were not able to find publications that integrate the concept of heterogeneity and the generic value network framework as proposed by Böhm, Koleva, et al. (2010). Furthermore, we could find neither a definition of heterogeneity in service value networks nor a description of factors influencing heterogeneity in service value networks.

In order to gain a better understanding of heterogeneity and service value networks as well as how both of these aspects are interrelated with each other, developing a model seems to be a success-promising concept which will make a contribution to fill this research gap. This model may be useful to strengthen and structure the research concerning the mechanism, the management, and the controllability of heterogeneity in service value networks. Therefore, we will answer the following research question:

What are the main influence factors of heterogeneity in IT Service Value Networks?

[1] The search engines used for the search process were Web of Knowledge (WoK) and Google Scholar (GS). The terms that we searched for were: definition, characterization, description, and clarification of heterogeneity or homogeneity. The search was conducted in February 2014. The total number of results after the search was 159. Three researchers read and categorized the papers and all results were discussed in order to identify the relevant papers. After the filtering process the number of relevant papers left was 19. Based on these 19 papers a concept matrix including 39 aspects of heterogeneity was created. By grouping these 39 aspects, the following seven aspects related to heterogeneity were derived: differences, categories, communication, characteristics, components, levels, and variability.

The remainder of this paper is structured as follows. At first, the terms IT service, IT service value network and heterogeneity are defined. The following section will give a short description of the literature review process. Subsequently, the results from the literature review are analyzed, synthesized and interpreted. Further, we introduce a model of heterogeneity in IT service value networks. The final section provides a short conclusion and an outlook.

2 IT Service and IT Service Value Network

Considering the idea of a service value network, the term IT Service Value Network (ITSVN) will be introduced to describe multi-stage supply relationships across a set of IT service landscapes. IT services can be defined as "[…] *services whose delivery relies on information systems and result in an IT-supported organizational element, i.e. a process or a function of the service customer*" (Schermann, Böhmann, & Krcmar, 2006, p. 3). They are intangible, perishable, and heterogeneous (Kim & Nam, 2009, p. 4). "*A value network is any web of relationships that generates both tangible and intangible value through complex dynamic exchanges between two or more individuals, groups, or organizations*" (Alee, 2003, p. 192). Bensch, Schrödl, and Turowski (2011) define a value network as "[…] *an integrated combination of companies to solve a customer-specific problem as a whole, economically and technically*" (Bensch et al., 2011). Due to the complexity of value networks, they cannot be managed without information technology support (Bensch et al., 2011). With regard to IT services, 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). On the other side, cloud computing consists from a business viewpoint of different actors, playing different roles on different levels of the cloud ecosystem (Böhm, Koleva, et al., 2010). By analyzing a dataset of 2628 cloud services, Böhm, Koleva, et al. (2010) discovered eight generic roles and arranged them into a generic value network of cloud computing. This network presents a business perspective on cloud computing and constitutes the ecosystem that has developed around cloud computing. However, companies also may combine cloud services with other forms of outsourcing and traditional in-house IT service provisioning by building an IT service landscape which cloud be also named as hybrid cloud. The IT service delivery network in this landscape is the ITSVN. By combining all of this aspects, we define ITSVN as follows:

> *An IT Service Value Network is a multi-staged construct of networked but autonomous service suppliers whose delivery relies on information systems which generates a tangible and intangible value for an IT service consumer through complex dynamic exchanges between all participants of the network.*

3 Heterogeneity

Heterogeneity has been widely discussed in IT literature (Widjaja et al., 2012) and it is a topic of highly practical relevance. Nevertheless, there is only few research conducted about heterogeneity in ITSVN (e.g. Bensch et al., 2011; Bucchiarone & Presti, 2007; Castro, Villagra, Fuentes, & Costales, 2014; Liu & Datta, 2010). The majority of publications concerning heterogeneity in IT focus on technological aspects. In fact, there are various publications concerning heterogeneity of e.g. systems, data or applications, but only few publications are dedicated to the topic of heterogeneity itself (Widjaja et al., 2012). However, we identified a research gap in the field of heterogeneity in value networks. Especially in connection with the particular characteristics of a service value network e.g. distributed service generation, increasing modularization and an increase of actors working together. As shown in a preliminary literature review, heterogeneity

in value networks is not researched in general and there is no holistic approach concerning the effects of heterogeneity in service value networks.

Heterogeneity can be defined in general as the outcome of components which communicate with each other at different levels and have variable characteristics. Widjaja et al. (2012) define heterogeneity in an IT landscape as a statistical property referring to the diversity of attributes of elements in the IT landscape. Diversity describes the amount of differences of the elements in an ITSVN. Apart from diversity, we also assume the relevance of the alterity of the ITSVN elements. Alterity is about the degree of distinction of the differences of the ITSVN elements. If we focus on an international team, the amount of different native languages could be understood as diversity. Alterity refers to the differences between those languages. For example, the differences between English and Chinese are greater than the differences between English and German. To summarize, heterogeneity is caused by the diversity and alterity of the attributes of the elements which builds the ITSVN. In a later chapter, we introduce an extended definition of heterogeneity in an ITSVN based on the results of our literature review.

4 A Literature Review on Aspects of Heterogeneity in the ITSVN

Following the recommendation from vom Brocke et al. (2009) we adapted their five step framework. According to the taxonomy of Rowe (2014), the literature review aimed to gain a better understanding of heterogeneity in ITSVN. At first, we defined the taxonomy of the literature review as recommended by Cooper (1988). In order to understand heterogeneity in ITSVN in general, the focus were set to the research outcomes and the application of the research results. Against this background, we aimed to integrate and synthesize the past literature. We also wanted to identify central issues of heterogeneity in ITSVN. The representation of the results was neutral, but this will not preclude taking a strong position based on cumulative evidence (Cooper, 1988). We conducted an exhaustive search including the entire literature or most of it (Cooper, 1988). Therefore, our search extended to both the six major IS databases (IEEE Explorer, Science Direct, ACM Digital Library, EBSCO Host, Emeralds, and AIS Electronic Library) and the 22 A-ranked journals based on WI-Association (2008).

To conceptualize the topic of the literature review and to identify the key terms which are relevant to our topic, we did a preliminary literature search (see footnote 1) as recommended from vom Brocke et al. (2009). Using the seven attributes from this step and the terms from the ITSVN as described by Böhm, Koleva, et al. (2010), we built search strings consisting of up to three terms as shown in Figure 1. The search was conducted within the abstract, title, and keywords. Although the search brings up a large amount of publications, only a very small number of them turned out to be relevant. Therefore, in each case only the first 100 hits were considered for a detailed analysis of the abstract. Most of the publications were dealing with heterogeneity only peripherally and concerning e.g. mathematics formulas. Although some of the search terms (see Term 2 in Figure 1) were derived from cloud computing, most of the search strings (e.g. ‘heterogeneity’ & ‘value’ & ‘communication’) were very general and do not only focus on cloud computing. The search in the six databases and 22 a-ranked journals using the described search string in the abstract, title and keywords leads to a number of approximatively 40,000 search hits.

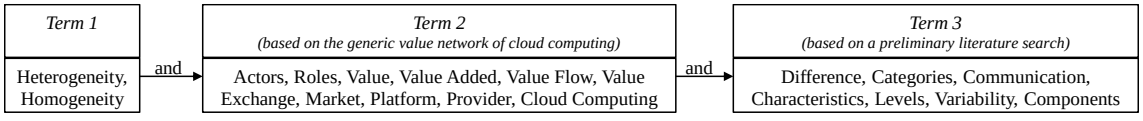

Figure 1: Search Terms (own illustration)

At first we screened the title, abstract and keywords for information related to heterogeneity in IT. During the second screening, we analyzed the full text of the remaining publications. In doing so, we recognized, that most of the publications mention heterogeneity in the context of cloud computing but do not provide any concept or analysis of heterogeneity in itself. After the forward and backward search as recommended by (Webster & Watson, 2002) we identified 61 relevant scientific articles related to the subject of heterogeneity in ITSVN in total.

Thus, in total we analyzed and synthetized 61 publications. In the first step, we extracted and categorized the information from the publications regarding heterogeneity in IT. Two researchers reviewed the 61 publications independently and assigned them to thematic groups. In the next step, the results where compared and the differences have been discussed carefully. Based on these results we identified seven main elements of the ITSVN where heterogeneity can occur and arranged them within a model (see next chapter). We used object-oriented system analysis methods (Goll, 2011) to identify entity objects and their attributes. Finally, we discussed the results and each of the identified elements and attributes in a group consisting of four researchers. In several increments, we consolidated this concept matrix and finally derived seven elements of an ITSVN.

5 Factors Influencing Heterogeneity in ITSVN

The publications describe different aspects of heterogeneity in different parts of the IT (service) landscape by also proposing frameworks for managing it. In order to answer the research question, we describe the main factors influencing heterogeneity in ITSVN and develop a model for heterogeneity in ITSVN by describing the elements of the model and their attributes.

	Elements							**Sources of literature (extract)**																									
Attributes	Applications	Platforms	Infrastructures	Actors	Technologies	Interfaces	Tools	Al-Hazmi et al. (2012)	Amato et al. (2013a)	Amato et al. (2013b)	Bensch et al. (2011)	Böhm et al. (2010b)	Bucchiarone and Presti (2007)	Castro et al. (2014)	Demchenko et al. (2013)	Gonidis et al. (2013)	Grabowski et al. (1999)	Guillén et al. (2013)	Hartmann et al. (2013)	Kertesz et al. (2012)	Liu and Datta (2010)	Machado et al. (2013)	Maximilien et al.(2009)	Moscato et al. (2011)	Nair et al. (2010)	Quinton et al. (2013)	Sanaei et al. (2014)	Suneja et al. (2011)	Tordsson et al. (2012)	Xia et al. (2004)	Yeo and Lee (2011)	Zhonghong et al. (2013)
Pricing policy				x				x		x												x							x			
Service level / Quality of Service	x	x	x					x	x												x											
Resource type	x	x	x					x																	x							
Standardization	x	x	x	x	x	x	x	x								x								x				x		x		
Federation	x	x	x					x												x												
Technology level		x	x		x				x																							
Metrics							x			x																						
SLA Terms				x						x							x							x								
Interoperability	x	x	x							x					x								x									
Portability	x	x								x					x																	
Service/Resource location	x	x	x					x					x																			
Access mode					x									x			x										x			x		
Communication					x	x									x		x															
Performance			x										x															x				
Compatibility	x	x	x		x											x			x					x	x							
Tool obligation		x																x					x									
Interfacing mechanisms						x	x												x													
Constraints (Resources, Spez.)				x																	x								x			
Service interface				x		x																x							x			
Security level	x	x	x																			x										
Service functionality	x	x	x																			x										
Terminology				x																				x								
Version	x	x	x			x	x																				x				x	x
Ecosystem		x	x	x																					x				x			
Requirements (Purpose)				x													x															
Role				x						x		x													x				x			
Procurement process				x							x																					
Data	x	x	x																			x					x					

Table 1: Concept matrix (extract) with elements and attributes of heterogeneity in ITSVN

Following Merriam-Webster Dictionary (2014), a model is a "*description or analogy used to help visualize something*". By focusing on the relevant aspects only, a model represents a segment of reality (cf. Krcmar, 2015). Therefore, a model representing heterogeneity in ITSVN should be composed of elements and their attributes.

According to Webster and Watson (2002), we synthesize the literature in a concept matrix by identifying the terms regarding to heterogeneity in ITSVN. We identified seven elements of an ITSVN where heterogeneity can occur: *applications*, *platforms*, *infrastructures*, *actors*, *technologies*, *interfaces*, and *tools*. We also identified several attributes for these elements. Table 1 shows an extract of the final results of this consolidation process as well as the assignment of the attributes to the sources of literature. This concept matrix represents an intermediate step towards a model of heterogeneity in ITSVN.

As mentioned before, the elements are influenced by their *diversity* and *alterity*. If we focus on the attribute version of the element application, for example, *diversity* means how many different versions of an application are part of the ITSVN. *Alterity* means in which degree these different versions differ from each other and to what extent they interoperate, respectively causing mutual obstructions. Thus, we introduce an extended definition of heterogeneity in an ITSVN:

> *Heterogeneity in an ITSVN can be defined as the diversity and alterity of the attributes of the summed applications, platforms, infrastructures, actors, technologies, interfaces, and tools of the ITSVN.*

Figure 2 shows a model consisting of the seven elements and their attributes representing the influencing factors. In the following text, these elements are described.

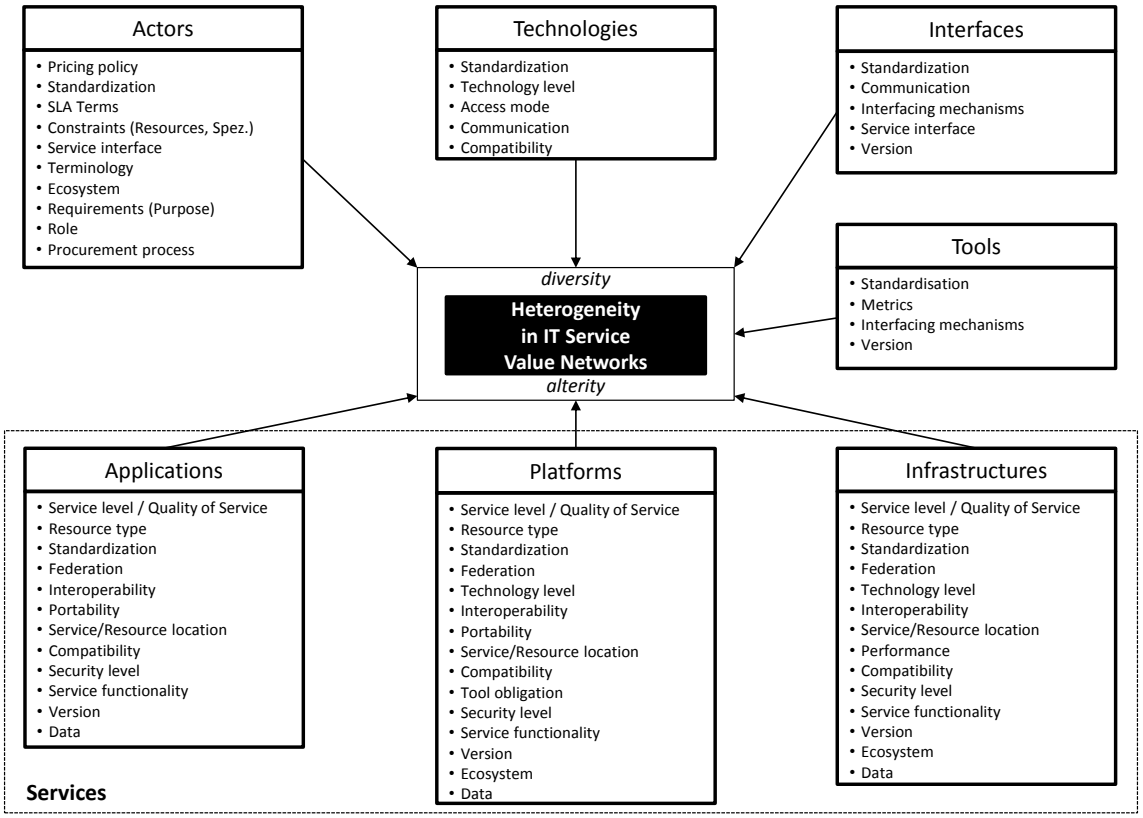

Figure 2: Model with elements and attributes of heterogeneity in the ITSVN (own illustration)

Applications: Application is one of the elements of the ITSVN where heterogeneity arises. In an ITSVN, applications are all the software components that are part of the network. Different publications focus on different aspects of the applications that cause heterogeneity. The most mentioned aspect that causes heterogeneity between the applications is compatibility (Gonidis, Simons, Paraskakis, & Kourtesis, 2013; Hartmann et al., 2013; Moscato, Aversa, Di Martino, Fortis, & Munteanu, 2011; Nair et al., 2010). Further aspects are service levels (Al-Hazmi, Campowsky, & Magedanz, 2012; A. Amato, Cretella, Di Martino, & Venticinque, 2013; Liu & Datta, 2010), interoperability (A. Amato et al., 2013; Demchenko et al., 2013; Maximilien, Ranabahu, Engehausen, & Anderson, 2009) and the different versions (Sanaei, Abolfazli, Gani, & Buyya, 2014; Yeo & Lee, 2011; Zhonghong et al., 2013) of applications. Other reasons that cause heterogeneity between applications are also portability (A. Amato et al., 2013; Demchenko et al., 2013), the service or resource location (Al-Hazmi et al., 2012; Bucchiarone & Presti, 2007), security level (Machado, Bocek, Ammann, & Stiller, 2013) and service functionality (Machado et al., 2013).

Platforms: A platform comprises the entire environment in which applications can run, which includes hardware infrastructure, operating systems and also different libraries. Platforms are also part of the ITSVN infrastructure where heterogeneity can arise because of different reasons. Since platforms are the basis on which the applications run, the attributes assigned to the platforms are similar to the attributes of the applications. Once again the mentioned aspects are: compatibility (Gonidis et al., 2013; Hartmann et al., 2013; Moscato et al., 2011; Nair et al., 2010), service levels (Al-Hazmi et al., 2012; A. Amato et al., 2013; Liu & Datta, 2010), interoperability (A. Amato et al., 2013; Demchenko et al., 2013; Maximilien et al., 2009), different versions (Sanaei et al., 2014; Yeo & Lee, 2011; Zhonghong et al., 2013) of platforms, portability (A. Amato et al., 2013; Demchenko et al., 2013), the service or resource location (Al-Hazmi et al., 2012; Bucchiarone & Presti, 2007), security level (Machado et al., 2013), and service functionality (Machado et al., 2013). Furthermore, other typical reasons for heterogeneity in platforms are tool obligations from the provider (Guillén, Miranda, Murillo, & Canal, 2013; Maximilien et al., 2009) and also the ecosystem (Nair et al., 2010; Tordsson, Montero, Moreno-Vozmediano, & Llorente, 2012) of the platform.

Infrastructures: In an ITSVN, the infrastructure includes the whole hardware ecosystem that supports the service delivery. They build the basis for platforms to operate. For this reason the factors causing heterogeneity in the infrastructures are partly similar to those causing heterogeneity in the applications or platforms. These are compatibility (Gonidis et al., 2013; Hartmann et al., 2013; Moscato et al., 2011; Nair et al., 2010), service levels (Al-Hazmi et al., 2012; A. Amato et al., 2013; Liu & Datta, 2010), different versions (Sanaei et al., 2014; Yeo & Lee, 2011; Zhonghong et al., 2013) of infrastructure components, the service or resource location (Al-Hazmi et al., 2012; Bucchiarone & Presti, 2007), security level (Machado et al., 2013), service functionality (Machado et al., 2013) and the ecosystem (Nair et al., 2010; Tordsson et al., 2012). Performance (Bucchiarone & Presti, 2007) is also a further aspect where heterogeneity can arise with regard to infrastructure.

Services: As analyzed above, most of the attributes of the application, platform and infrastructure are similar. The three categories could also be named as Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS), which are the most common cloud service models (Mell & Grance, 2011). Therefore, we grouped these three elements in a higher-level element named *service*. Thus, service stands not for an element but for the group of the three elements applications (SaaS), platforms (PaaS), and infrastructures (IaaS).

Actors: Actors are all the interacting members of the ITSVN. They could be the customers, the service providers, service brokers, service integrators etc. The different

roles (A. Amato et al., 2013; Böhm, Koleva, et al., 2010; Nair et al., 2010; Tordsson et al., 2012), the defined constrains (Liu & Datta, 2010) in form of resources or specifications, the used terminology (Moscato et al., 2011), the pricing policy (Al-Hazmi et al., 2012; A. Amato et al., 2013; Machado et al., 2013; Tordsson et al., 2012), the SLA terms (Alba Amato, Di Martino, & Venticinque, 2013; Grabowski et al., 1999; Moscato et al., 2011), the standardization (Al-Hazmi et al., 2012; Gonidis et al., 2013; Moscato et al., 2011; Xia, Gang, & Miki, 2004) and also the requirements (Grabowski et al., 1999) that the actors set for the system can bring heterogeneity in the ITSVN. Other factors that can bring heterogeneity to the actors in an ITSVN are the offered service interfaces (Machado et al., 2013; Tordsson et al., 2012), the defined procurement processes (Bensch et al., 2011) and also the ecosystem (Nair et al., 2010; Tordsson et al., 2012) where they act.

Technologies: Technologies in an ITSVN include all the used capabilities and communication and exchange methods that are used from providers like communication technologies etc. In the used technologies heterogeneity can arise regarding standardization (Al-Hazmi et al., 2012; Gonidis et al., 2013; Moscato et al., 2011; Xia et al., 2004), access modes (Castro et al., 2014; Grabowski et al., 1999; Sanaei et al., 2014; Xia et al., 2004), communication (Demchenko et al., 2013; Grabowski et al., 1999) and compatibility (Gonidis et al., 2013; Hartmann et al., 2013; Moscato et al., 2011; Nair et al., 2010).

Interfaces: The interfaces in the ITSVN include all the offered access possibilities to the offered service. The offered service interface (Machado et al., 2013; Tordsson et al., 2012) and interfacing mechanisms (Hartmann et al., 2013) can cause heterogeneity in the ITSVN. Furthermore, the interface version (Sanaei et al., 2014; Yeo & Lee, 2011; Zhonghong et al., 2013), the communication (Demchenko et al., 2013; Grabowski et al., 1999) and the standardization (Al-Hazmi et al., 2012; Gonidis et al., 2013; Moscato et al., 2011; Xia et al., 2004) are also factors responsible for bringing heterogeneity in the ITSVN.

Tools: Tools include both the resources that a provider offers to facilitate the use and application of the provisioned service and the resources the actors of the ITSVN use to manage the service delivery. However, different tools boost heterogeneity in the ITSVN e.g. by having different standardization (Al-Hazmi et al., 2012; Gonidis et al., 2013; Moscato et al., 2011; Xia et al., 2004), metrics (A. Amato et al., 2013), interface mechanisms (Hartmann et al., 2013) and versions (Sanaei et al., 2014; Yeo & Lee, 2011; Zhonghong et al., 2013).

6 Conclusion and Outlook

This paper analyzes the concept of heterogeneity in ITSVN. We showed that there is only limited research regarding heterogeneity in ITSVN. By conducting a literature review, we found and analyzed 61 publications that treat aspects of heterogeneity in different levels of the ITSVN. We summarized these publications and presented a structured overview. Based on the results from these publications we extracted the main influence factors of heterogeneity in the ITSVN and proposed a model for heterogeneity in ITSVN consisting of seven elements where heterogeneity can occur. Additionally, we assigned attributes to these elements. Next, we defined heterogeneity in an ITSVN as the diversity and alterity of the attributes of the summed *applications*, *platforms*, *infrastructures*, *actors*, *technologies*, *interfaces*, and *tools* of the ITSVN.

Although this research is based on a thorough and comprehensible literature search, the model was derived by analyzing 61 publications and therefore makes no claim to completeness. Hence, further studies should be conducted in order to validate and further extend the model of heterogeneity in ITSVN.

In order to verify and review the model, it should be assessed by a group of experts. To do so, we are planning to initiate a cognitive process by using the Delphi Study method (Schmidt 1997). An anonymous survey will be conducted by using a universal computer-based questionnaire system. The questions of the questionnaire will be derived from the model of heterogeneity in ITSVN. Finally, the results from the Delphi Study will be built into the model of heterogeneity in ITSVN. Doing so, a revised version of the model of heterogeneity in ITSVN and a weighted list of influence factors on heterogeneity in ITSVN will be derived. Based on this list, we are planning to develop guidelines and best practices for handling heterogeneity in ITSVN.

However, by providing a state-of-the-art of heterogeneity in the ITSVN derived from a literature review, this research contributes to theory by the model for heterogeneity in ITSVN. The model may be useful to strengthen and structure research about the management and controllability of heterogeneity in ITSVN. Next, the model for heterogeneity in ITSVN, the implications of heterogeneity, and the weighted list of influence factors "[…] provides an explanation of how, why, and when things happened" (Gregor, 2006, p. 619). Thus, a greater understanding and insight by others into heterogeneity in ITSVN will be promoted. According to Gregor (2006, p. 619), this thesis complies with the explanation goal of theory. Next, our model may be useful to strengthen and structure research about the management and controllability of heterogeneity in ITSVN. Possible approaches may be found in the fields of ITSM or service governance.

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