The Value of Community Clouds for Collaboration in the Public Sector

Full paper

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Abstract

The public sector has discovered cloud computing technologies and therefore demands an adequate cloud provisioning model. The community cloud seems to be a good balance between safety and trust as well as efficiency, cost reduction, and competitiveness for public facilities. Following this presumption, we analyzed the network potential for cooperation in the public sector. First, we reviewed the scientific literature around this concept and clarified the term 'community cloud'. Then, we conducted a study of network theories to derive common values that are addressed in cooperation. We developed a framework that characterizes a network and assesses its specific network value. For evaluation purposes, we applied the framework to community cloud implementations in the public sector and discussed the results regarding the network value. The research findings reveal basic network values for community clouds in the public sector and will serve as analysis and assessment guidelines.

Keywords

Cloud computing, community cloud, network value, government, public sector.

Introduction

Cloud computing has been established as a technology and business concept in the information technology (IT) industry. With this concept, customers can obtain freely scalable IT resources (infrastructure, platform, software) in an on-demand manner via networks and pay usage-based fees (Mell and Grance 2011; Weinhardt et al. 2009). These resources "as a service" avoid long-term capital expenditures and can load for cost reductions. In the public sector, due to limited budgets, structural rigidities, and extreme risk aversion (Fischer and Figliola 2013), financial investments in innovative IT technology are rare to date. Recently, public institutions have begun to realized that modern IT technologies are more efficient, enable cost reductions, can even increase safety (Liang 2012) and allow attractive e-government offers for the citizens (Tan et al. 2013). Therefore, there is increasing demand for a provisioning model that fits most closely to the conditions in the public sector. A public cloud allows freely scalable services, while a private cloud ensures critical or personal data. A hybrid cloud combines these two dimensions and processes critical data in a private environment and non-critical data on public cloud resources.

Combining all cloud advantages, a community cloud makes use of great synergies. Companies with the same needs, legal requirements, goals or the same data can cooperate and operate on a common IT resource pool without dependencies on third party vendors (Briscoe and Marinos 2009b). This concept will overcome the lack of scalability and resource efficiency of private clouds as well as the loss of trust with public cloud services (Briscoe and Marinos 2009b; Liang 2012; Repschläger et al. 2011). While the hype wave on public and private cloud services is over, the community model rises as a relevant technology trigger in practice (Butler 2012; Gartner 2013). It is expected that government, healthcare, and financial sectors will roll out the earliest community cloud implementations, but the adoption process is slow (Haff 2010). Reasons for this can be high entry barriers, high risks and investments, uncertainty of success, and a late reward. Nevertheless, forecasts for community clouds predict a market increase by a factor of five from 2013 to 2018 (MarketsAndMarkets 2013).

To support this valuable migration of the public sector institutions into community cloud environments, we analyze how the community cloud should be applied to reach the highest benefits from the perspective of cooperation. Within this scope, we refer to general network theories and analyze the reasons for companies to cooperate. We address the research with two research questions:

1. How can network theories and network characteristics contribute to a framework that evaluates the cooperation value of a network?
2. Which community cloud type that can be derived from the literature has the highest value of cooperation within a community?

To answer the research questions, we structure the remainder of this article as follows: first, we introduce the related work regarding community clouds in the public sector and derive different cloud community types. Then, we present the research approach that addresses the research questions. Following this approach, we investigate generic network and cooperation theories to derive the basics for cooperative behavior and combine this with the characteristics of cooperative networks. Based on the results, we develop a framework to characterize a network and to assess its value regarding the reasons for cooperation. Afterwards, we analytically evaluate the framework with an application to the different community cloud categories. We use implemented community cloud examples in the public sector to discuss the network value for the different community cloud types and to derive implications for practice and future research.

Related Work

Regarding the literature on cloud concepts in the public sector, in-depth research is rare so far (Yang and Tate 2012) and reveals a gap for e-government specific implications (Haag et al. 2014). The public sector is mentioned as predestinated for community cloud provisioning (Marston et al. 2011). The differences in the broadband internet connection inherently influence the adoption worldwide, where the USA still has the pioneering role in this process (Evans and Yen 2006; West 2010).

A community cloud describes a close cooperation between companies or organizations in the cloud computing business. Government bodies often collaborate to develop a common cloud strategy (Corbin 2012) or build a common cloud platform for their facilities (Wyld and Maurin 2009). Particularly, the security and compliance aspects are enhanced with a community cloud (Paugh 2012), therefore, collaborative networks are recommended also for the healthcare sector (Bach et al. 2001). Research confirms that the customer's choice of a deployment model is driven by security and costs aspects; and the community cloud provides a compromise of both factors (Liang 2012). Detailed studies have analyzed specific cloud aspects such as benefits, risks, and adoption challenges of software as a service (SaaS) for the public sector (Janssen and Joha 2011) but have not focused on special community aspects. Other studies reported roadmaps and migration strategies for governments of different countries to prepare for the cloud, for example, Arab countries (Al-Khouri 2013) and USA (Wyld 2010).

Within the cloud sector, there are two distinct points of view for a community cloud model. Some researchers emphasize the customer side and describe the community cloud as a deployment model "for exclusive use by a specific community of consumers from organizations that have shared concerns" (Mell and Grance 2011). Others focus on a community at the provider side and describe it as a deployment model for cooperative value generation. They concentrate on merging resources to profit from a major resource pool without dependences on third party vendors or additional acquisition (Briscoe and Marinos 2009b; Saovapakhiran and Devetsikiotis 2011). Hence, in offering or using a distinct cloud service, providers and/or customers can cooperate. The cooperation intensity between the customers is relatively low and not emphasized within academic publications. Cooperation at the provider side is analyzed primarily at a technical level with B2B integration scenarios (Schubert and Legner 2011), government cloud federations (Kurze et al. 2011; Villegas et al. 2012), and inter-clouds (Aoyama and Sakai 2011; Grozev and Buyya 2014). For both provider-based and customer-based community clouds, organizational systematizations are rare. Deepening these thoughts, we propose a taxonomy with two dimensions for the differentiation between the customer and the provider side (see Figure 1).

In the **provider dimension**, either a single vendor provides the cloud service or more than one provider participates in the service creation. If more providers are involved, they can cooperate with each other by providing the cloud service or they can act independently. Within the literature, the provider-based community is closely related to "inter-cloud-computing" (Aoyama and Sakai 2011; Grozev and Buyya 2014; Popp et al. 2013) and "cloud federation" (Kurze et al. 2011; Toosi et al. 2014). We made the same distinction for the **customer dimension**, so that the cloud service can be used as a single-tenant service by one customer or as a multi-tenant service by more than one customer. The customers can also cooperate using the cloud service or procure the service independently.

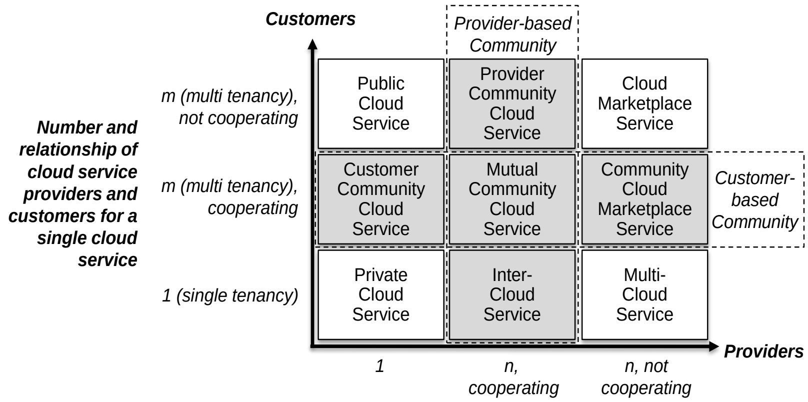

Figure 1. Taxonomy of cloud computing services

A cloud service that is provided by a provider (first column of the figure) in a single-tenant manner to one customer is a *private cloud service*. If a group of customers (with shared concerns) use the cloud service, we can identify a *customer community cloud* (Mell and Grance 2011). For example, this can be a "platform as a service" (PaaS) offered by a single provider for a gaming community where the customers commonly develop and modify applications with given cloud-based engines (Maximilien et al. 2008). If the cloud service is multi-tenant and open to all customers, it describes a *public cloud service*.

A group of cooperating providers (second column of the figure) can provide an *inter-cloud service* (Grozev and Buyya 2014) to one customer to enable a dynamic coordination of services and loads. With this joint service provisioning a customer avoids a vendor lock-in and profits from synchronized service levels, and reduced administration (Grozev and Buyya 2014). If a community of providers serves also a group of cooperating customers (overlap of providers and customers is possible), we can identify a *mutual community cloud*. For example, NeCTAR is an association of Australian education institutions that commonly provide, maintain, and use cloud databases and tools (NeCTAR). If the provider-based community service is open to the market, we have a *provider community cloud*. An exemplary scenario here is an association of IT service providers for "infrastructure as a service" (IaaS) (Kurze et al. 2011). The providers can collaborate and merge their IT resources regarding the distribution of risks and the assurance of high availability services (e.g. disaster management (Aoyama and Sakai 2011; Grozev and Buyya 2014)).

A cloud service that involves multiple independent providers (third column in the figure) for value creation and is used by one customer, describes for example the *multi-cloud scenario* (Grozev and Buyya 2014). If more than one customer consumes the service, we can identify a *cloud marketplace* relationship. At a *community cloud marketplace*, the customers can cooperate, e.g. to exchange experiences with various services and service providers (Martens et al. 2011).

Research Approach

In order to answer the research questions, we applied the design science research approach (Hevner et al. 2004) to provide an artifact for subscription in practice (Gregor 2006). We pursue the publication scheme for a design science research study (Gregor and Hevner 2013) and followed the design science research guidelines. We aim to provide an evaluation framework for cooperation networks in cloud computing (Guideline 1: Design as an Artifact). This framework contributes to the promising, but rarely studied topic of community clouds. It supports the slow adoption process with a method to prove the network value of a community cloud design (Guideline 2: Problem Relevance). The evaluation part was conducted with an analytical assessment of the applicability and usability of the artifact. We analyzed community cloud implementations in the public sector, assigned them to the types of provider-based and customer-based communities and discussed their network value (Guideline 3: Design Evaluation). The combined foundations, the developed artifact as well as the derived implications for practice and future research shape the contribution of this research (Guideline 4: Research Contribution). We used and adopted the theoretical knowledge base to deductively develop a new artifact (Gregor and Hevner 2013) (Guideline 5: Research Rigor). Within the development process, we first investigated economic and psychological network theories to examine their decision criteria for cooperation (Lado et al. 1997; Uzzi 1996). We used and iteratively extended a keyword search in different bibliographic databases for keywords such as "business network", "business cooperation", "network cooperation", "business network", "business community", "community cloud", "inter-cloud", "cloud federation", and "collaboration network". Researchers have applied network theories to explain specific cooperation issues (Clemons and Row 1992; Lado et al. 1997). We combined all the observed theories and their related concepts and revealed common values of network cooperation. The consideration of different theories in parallel is recommended by the literature (Grandori and Soda 1995; Ketchen and Hult, G. Thomas M. 2007; Madhok 2002; Poppo and Zenger 1998). The derived values represent the frame of the artifact. In the second step, we extended the literature search with the keywords "characteristics", "attributes", and "properties" to deductively derive cooperation-based characteristics from the academic literature. We analyzed the literature and iteratively discussed the assignment of the network characteristics to the values of a network cooperation. The developed framework shows how the characteristics of a network serve for an assessment of the network regarding its network value (Guideline 6: Design as a Search Process) (see Figure 2). We plan to present the research results to an academic audience as well as to practitioner forums in order to increase the visibility and give recommendations for action (Guideline 7: Communication of Research).

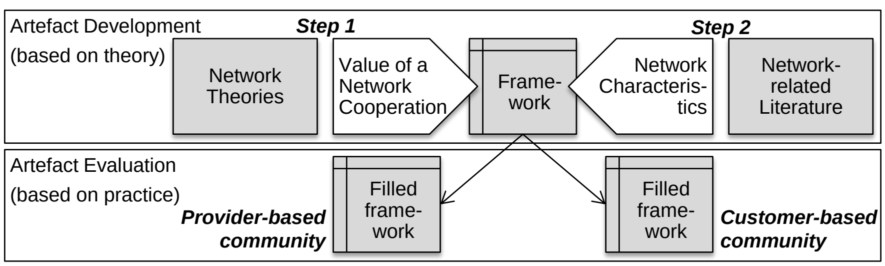

Figure 2. Research structure

Cooperation Framework

Cooperation is the change from an individualistic behaviour to a collectivistic behaviour that enables advantages if all parties cooperate (i.e. "prisoner's dilemma"). With an agreement in advance, this strategy results in a stable state (Axelrod and Hamilton 1981). Strategic networks have a positive effect on the performance of a company in general (Alvarez et al. 2009; Hinterhuber and Levin 1994; Rosenfeld 1996; Uzzi 1996). We studied various theories to build a rigorous framework from different perspectives. Within this process, we analyzed the New Institutional Economic Theories (Uzzi 1996; Williamson 2000) with Transaction Cost Theory (Coase 1937; Ebers and Gotsch 1995; Williamson 1979, 1985), Principal Agent Theory (Laffont 2003; Pratt et al. 1991), and Property Rights Theory (Demsetz 1967; Möller 2006). Strategic Research was also considered with Knowledge-Based View (Grant 1996), Capability-Based view (Wernerfelt 1984), Resource-Based view (Wernerfelt 1984), and Market-Based View (Makhija 2003; Srivastava et al. 2001). Furthermore, Organization Theories with Resource Dependency Theory (Pfeffer and Salancik 1978) and Inter-Organizational Relations Theory (Evans and Yen 2006) influence network creation. Additionally, we considered Co-opetition Theory (Bengtsson and Kock 2000; Brandenburger and Nalebuff 1997), Game Theory (Axelrod and Hamilton 1981; Neumann and Morgenstern 1944), Evolution Theory (Darwin 2009; Margolis 1984), and social influences (Granovetter 1983; Hofstede and Hofstede 2005; Uzzi 1996) to complement the framework. With an overview of the network theories, we can derive five common values that are addressed within the theory description (see Figure 3): reduction of the transaction costs, interdependencies between the members, a strengthened market situation, access to rare resources and economies of scale. These common values constitute the categories for the evaluation framework of cooperation networks.

Network Theory	Cooperation Value in the Network	Common Value
Transaction Cost Theory	A network decreases transaction costs with middle specific and middle uncertain services as well as a high number of similar transactions.	Cost Savings
Property Rights Theory	A network is the optimal cooperation model to decrease transaction costs and external effects.	
Principal Agent Theory	A network establishes interdependencies through equal rights between client and supplier, which causes a high trust level and lower agency costs.	Inter-dependencies
Resource Dependency Theory	Network cooperation causes interdependencies that equate the strength of all members and enhances the trust and risk tolerance regarding resource dependencies.	
Interorganizational Theory	A network grows with the trading of more complex goods and services and leads to interdependencies and relationships of trust between the partners.	
Game Theory	Network cooperation can ensure higher economic benefits within an unstable Pareto equilibrium.	
Evolution Theory	Cooperative behavior can increase the moral obligation and commitment of the community regarding future group interests.	
Social influences	Network cooperation can induce social influenced behavior that avoid destructive decisions or strategies.	
Market-Based View	Network cooperation is used to establish barriers to market entry.	Market Strength
Co-opetition Theory	Network of cooperation and competition leads to a high rate of innovations supported by an enhanced access and usage of resources, knowledge or capabilities.	
Resource-Based View	Network cooperation is used to optimize the access and usage of rare resources.	Resource Access
Knowledge-Based View	A network optimizes the access, intensity, structure, and process intelligence of special knowledge and enables the development of new process knowledge or common standards.	
Competence-Based View	A network reduces the operating expenses through joint planning, management and monitoring as well as an optimal use of the resources.	Economies of Scale

Figure 3. Common cooperation values of the network theories

Regarding the **transaction costs** category, we have found a few characteristics that have an influence on the transaction of services and property rights. The *number of parties* (Blecker and Liebhart 2006; Borchert and Urspruch 2003) can increase the volume of similar transactions in a network. The *relations* between the legally independent individuals or organizations can have economic, political, or social bindings (Blecker and Liebhart 2006; Borchert and Urspruch 2003; Harland 1996) that are established e.g. to decrease external effects of property rights. The *type of* distributed *services* within a network are batch or interactive jobs (Grozev and Buyya 2014) whereas only batch jobs decrease the transaction costs.

The network value of **interdependencies** is affected by a high number of network characteristics. The *degree of cooperation* for a network can vary between no cooperation (market, external procurement of services) to full cooperation (hierarchy, in-house production of services) (Oxley 1997; Powell 1990; Thorelli 1986), while a middle degree of cooperation causes the highest mutual interdependencies. The *participation level* of the organization can include the entire company, individual areas, or just a few employees (Bellmann and Gerster 2006; Borchert and Urspruch 2003), whereas the last variant does not establish high interdependencies. The *relation intensity* between the members varies from verbal agreement via a written contract to capital equity (Bellmann and Gerster 2006; Borchert and Urspruch 2003; Laffont 2003; Möller 2006; Pratt et al. 1991) and enhances the interdependencies. The *development* of a community can be on an ad hoc basis or grown over the course of time (Bellmann and Gerster 2006; Borchert and Urspruch 2003; Möller 2006). When growth is not well planned interdependencies can especially increase(Evans and Yen 2006). The *temporal existence* of a network is defined as unlimited in duration or for a fixed period of time or task (Borchert and Urspruch 2003). Interdependencies will grow with the intended duration. The *cooperating roles* of the members in a network can be customers (similar to principal), providers (similar to agent) or coordinators (Briscoe and Marinos 2009a, 2009b, Pratt et al. 1991). The highest interdependencies occur with mutual overlaps between the roles.

The category of **market strength** is addressed by the following characteristics. The *identity* of a cooperative network can be established by a uniform public appearance (Bellmann and Gerster 2006; Borchert and Urspruch 2003) to reach a better market position as a larger player. Further, the geographic *distribution* of the members characterizes a cooperation network (Bellmann and Gerster 2006; Borchert and Urspruch 2003; Grozev and Buyya 2014; Hofstede and Hofstede 2005) and is relevant to strengthen the market situation especially for local and regional player.

Characteristics that focus on the **resource access** are for example the *company size* of the members (Bellmann and Gerster 2006; Borchert and Urspruch 2003). Primary medium- and small-sized members profit from networks (Rosenfeld 1996) while large organizations often have enough resources on their own to compete in the market. Further, we distinguish the *involvement* that describes an active or passive participation of the members (Borchert and Urspruch 2003; Evans and Yen 2006). The value of knowledge sharing will increase with higher involvement. The *value added stage* considers cooperating organizations on a horizontal level e.g. to extend their resource capacities, or a vertical level e.g. to access related but not available resources (Möller et al. 2005). Usually participants with the same interests collaborate; therefore, a lateral cooperation is rare.

Regarding increasing **economies of scale** through cooperation, the *scope* of responsibility distinguishes between supporting services core competences (Bellmann and Gerster 2006; Bengtsson and Kock 2000; Borchert and Urspruch 2003; MarketsAndMarkets 2013), where supporting services have a higher standardization to enable economies of scale. Second, the type of the shared *competences* is defined by its function, e.g. sourcing or production (Bellmann and Gerster 2006; Bengtsson and Kock 2000; Borchert and Urspruch 2003). Networks can be particularly valuable in specific *branches* such as government, healthcare, financial, logistics, education, and gaming (MarketsAndMarkets 2013). The network value regarding economies of scale is high within the same branches with the same needs. Activities at the value creation side have lower risks in networks than on the value delivery side (Brandenburger and Nalebuff 1997). Regarding governance, we distinguish an internal or an external *management* (Bellmann and Gerster 2006; Borchert and Urspruch 2003; Grozev and Buyya 2014). An internal management has a higher potential to enable economies of scale, especially when its *coordination* mechanism (Briscoe and Marinos 2009b) is centralized.

For a cooperating venture, categorized with the network characteristics, the framework shown in Table 1 can offer an evaluation whether the community model provides a valuable contribution to the business. The expressions of characteristics with the highest network value are highlighted in *italics*.

Value	Characteristic	Expression of Characteristic						
Transaction Cost	Number of parties	*High*	Middle	Low				
	Relations	*Economic*	*Political*	Social				
	Type of service	*Batch*	Interactive					
Interdependencies	Degree of cooperation	High	*Middle*	Low				
	Participation level	*Entire company*	*Individual areas*	Few employees				
	Relation intensity	*Capital equity*	*Written contract*	Verbal agreement				
	Development	Ad hoc	*Grown*					
	Temporal existence	*Unlimited*	Temporary					
	Cooperating roles	Customers	Providers	Coordinators	*Mixed*			
Market Strength	Identity	*Uniform appearance*	No uniform appearance					
	Distribution	*Local*	*Regional*	National	International			
Resource Access	Company size	Large	*Medium*	*Small*	Single individuals			
	Involvement	*Active*	Passive					
	Value added stage	*Horizontal*	*Vertical*	Lateral				
Economies of Scale	Scope	*Supporting services*	Core competencies					
	Competencies	*Sourcing*	*Research*	*Infrastructure*	Technology	Development	Production	Supply
	Branches	*Same*	Different					
	Management	*Internal*	External					
	Coordination	*Centralized*	Decentralized					

Table 1. Community cloud framework

Framework Evaluation

The developed framework supports new cooperation ventures to describe, analyze, and assess the network value of their community cloud implementation. We evaluated the framework regarding its usability and applicability in the practical context. For this reason, we compared the network value of the community cloud types that were derived from the related work earlier. We found 16 highly relevant cases in the public sector, classified them as customer-based or provider-based community (see Table 2), and compared the results of the framework application.

Case	Government Cloud Service	Country	Community Type
A	Since 2008, the distributed institutions of Carlsbad (California) use the online communication and collaboration services by Microsoft (http://info.apps.gov/content/city-carlsbad-california).	USA	Customer
B	Since 2008, Washington D.C. is using the “Google App Services” in 86 departments. Los Angeles (California) also provides Google’s cloud services to their departments since 2009. Since 2012, the State Orlando and the US Department of Interior uses Google’s email services as well (http://gov.googleapps.com/).	USA	Customer
C	Since 2009, the General Service Administration (GSA) offers a platform with IaaS, PaaS and SaaS for public institutions in the USA (www.apps.gov). The platform closed in 2012 and was replaced by an information site on cloud computing in government (http://info.apps.gov/).	USA	Customer
D	Since 2011, Amazon provides the AWS GovCloud for the public authorities of the US (http://aws.amazon.com/de/govcloud-us/) and the CIA (http://fcw.com/Articles/2013/03/18/amazon-cia-cloud.aspx).	USA	Customer
E	Since 2012 with the Nebula project, the NASA uses a unified platform for web space, development tools and centralized services for scientists and researchers on a cloud basis (http://www.nasa.gov/open).	USA	Customer
F	In 2011, Canada’s economic action plan is to reduce the data centers and consolidate the IT services with the “Shared Services Canada” (http://news.gc.ca/web/article-en.do?nid=614499)	Canada	Customer
G	Since 2012, Canada uses the “IBM SmartCloud Enterprises” to enhance delivery capabilities (https://apps.na.collabserv.com/).	Canada	Customer
H	In December 2013 started a program named “Meghraj” that means king-cloud and aims to move government data, services and application to a shared government cloud (http://www.livemint.com/ Industry/RN7yyjLwbeV66tPCXfrJUM/Cloud-computing-Govt-to-roll-out-Meghraj-in-Dec.html). Political and data security issues slow down the development. (http://www.ciol.com/ciol/features/18 6703/cloud-governance-why-indias-adoption-low).	India	Customer
I	In 2009, Japan’s Ministry of Internal Affairs and Communications (MIC) decided to build an inter-ministerial cloud platform named “Kasumigaseki Cloud”. The implementation consolidates all IT systems of the public sector and is targeted for 2015 (http://www.cloudbook.net/directories/gov-clouds/gov-program.php?id=100016).	Japan	Customer
J	Since 2011, Singapore starts to implement Google Apps, e-learning platforms, a cloud-based toll-system and expands its broadband network (http://www.ngp.org.sg/documents/Cloud_Computing _in_Singapore_1st_Edition.pdf).	Singapore	Customer
K	The eHealth action plan 2012-2020 aims to unite the European countries by providing smarter, safer and patient-centered health services (http://ec.europa.eu/information_society/newsroom/cf/itemdetail.cfm?item_id=9156)	Europe	Customer
L	Since 2010, the British authorities plan the government cloud “G-Cloud” as a network for all British public institutions with IaaS, PaaS, and SaaS (http://www.cloudbook.net/directories/gov-clouds/uk-government-cio-council).	U.K.	Customer
M	Since 2011, the services of the Danish procurement authority are sourced to the largest telecommunications company in Denmark IDC (http://www.datacentres.com/news/tdc-gets-danish-cloud-computing-framework-deal).	Denmark	Customer
N	In 2010, the Australian project National eResearch Collaboration Tools and Resources (NeCTAR) starts to deliver virtual laboratories, electronic research tools, and a federated research cloud on a shared environment (http://www.nectar.org.au/).	Australia	Mutual
O	Since 2010, a Cloud-Enabled Space Weather Modelling and Data Assimilation Platform (CESWP) is a science community and enables space weather simulations to scientists around the world (http://www.cybera.ca/projects/completed-projects/ceswp/).	Canada	Mutual
P	Since 2011, the Government Green Cloud Laboratory (GGC-Lab) analyses saving potentials with an energy efficient load balancing between public IT service providers (http://www.ggc-lab.de).	Germany	Provider

Table 2. Practical community cloud cases for the evaluation

Customer-based Community Cloud

Customer-based communities in the public sector describe government institutions that cooperate to increase the bargaining power in negotiations for private cloud structures. Therefore, governments often make a deal with a large cloud service provider (e.g. Amazon, IBM, or Oracle) to combine data, cloud resources, and services to create a smart government platform for the distributed facilities of a government. For example, more than 100 government organizations in the USA are using the cloud services of Amazon’s AWS (Chandra and Bhador 2012) (Case D) and a other governments are using Google App Services (Cases B, J). The joint management of capabilities and knowledge can reduce the operating expenses and ensure optimal use of resources, unified knowledge, processes and federal structures.

In consideration of the **transaction cost** characteristics in the framework, many institutions cooperate to increase the value of shared information, e.g. regarding the citizens (Cases A-D, F-L). A customer-based community cloud in the public sector often cooperates on a political basis, while social aspects are rare. The type of collaboration cloud services used is primarily interactive (Cases A-C, E-H, J-L).

Regarding the **interdependencies**, the customers in a community cloud act at a middle cooperation network level, but they have a little minor cooperation effort with tendencies to the market mode (Cases A-D, F-J, M). If the community serves as a shared IT resource pool for the customers (e.g. Case D), only the IT departments are involved in the community. Contractual relations are the basis for the cooperation. Due to critical data in the public sector, a community cloud is a sensitive topic so that implementations in the government sector show a planned cooperation development. The existing customer-based communities are rather long-term government networks, but a temporal limit is conceivable as well in the public sector, e.g. for a legislative period. The cooperating roles are primarily the customers with integrated coordinators (Cases A-M).

To increase the **market strength**, the given implementations of customer-based communities in the public sector show a uniform identity (Cases A-D, F-M) that confirms the cross-linked market power and increases the trust and growth potential. The location of the customer-based communities affects developed countries in around the globe where the community can cross borders and reach from regional (Cases A, B) to international (Cases E, K).

To benefit from **resource access**, primary small to medium-sized government institutions collaborate and rather passively use a shared resource pool or cloud hardware and software service. They act at a horizontal value added stage and aim at the availability of complementary and substitutable resources as well as shared data (e.g. nationwide data of citizens) and IT services (Cases A-D, F-M). This implies a reduction of redundantly stored data, facilitates the exchange of information, and accelerates the processes in the public sector.

The precondition for **economies of scale** is reached with similar structures and processes in the same branch when they share basic IT services (e.g. security, backup, applications) or process data with similar business applications. In the case of basic IT services (Cases A-D, F-M), the type of the shared competences in the network is rather far from the consumers at the value creation site but in sharing the same specialized services with data near the customer (Case E), the competencies move closer to the customer at the value delivery side. Primarily, an external provider with a centralized architecture manages the cloud services, data bases, knowledge sharing, common rules, and standards.

Provider-based Community Cloud

Provider-based communities in the public sector describe governmental IT service providers that work together in the value creation of their services. They describe federated inter-clouds in academic and industry projects. The academic projects are usually realized as a mutual community cloud that provide and use research and data on a cloud basis (Cases N, O). Implementations are less frequent and not in the same stage of development as customer communities.

Regarding the **transaction costs**, the number of parties is rather low in provider-based communities, because of the exponentially increasing administration effort (Case P). These communities cooperate in political as well as economic relations to profit from the cooperative agreement that limits the adjustments of property rights. The shared jobs are rather interactive services in collaboration communities (Case N) and batch jobs (Cases O, P) in a cooperative IT provision.

The **interdependencies** will be established with a middle degree of cooperation that has tendencies towards hierarchy (Case P) to ensure a higher trust level between the provider-based community members. With a cooperation between providers in a shared value creation, often the entire company is part of the community and a higher cooperative involvement is required (Case P). The contractual relations strictly define requirements, penalties, and revenue streams (Case P). Also provider-based communities are developed ad hoc and are established without a fixed end. The cooperating roles are IT services providers (Case P) or individuals (Case N, O) that join in a community and share IT services and data in mixed roles from the provider- and the customer perspective.

The **market strength** will not be increased with a uniform identity (Case N-P), because a common market strength on the provider side is rather obstructive regarding competition regulations (Case P). Due to individual restrictions for providers in different countries (especially the data protection requirements), provider-based communities in the public sector are rather located in regional or national areas of developed countries (Case P) and borders are crossed only in uncritical cases (Case O).

To make use of the **resource access** the cooperating providers are middle-sized companies that rather actively operate a defined order in a community, share knowledge and create common standards (Case N-P). The providers act within a heterarchical network of equal rights at a horizontal level (Case N-P). A vertical cooperation along the value-added chain is conceivable if the relation is not a simple procurement process, but a close partner contract.

Regarding the use of **economies of scale**, the analyzed communities have good opportunities by cooperating in their supporting services in the value creation within the same high potential branch (e.g. infrastructure, service operation, and analytics) (Case P). Provider-based communities in the public sector prefer an internal management to share competencies and use economies of scale (Case P). Regarding the coordination, providers do not want to lose sovereignty and prefer a polycentric leadership (Case P). This architecture represents the interests of all members in the community, but requires a high coordination effort. The considered mutual science communities (Cases N, O) show similar expressions of the characteristics as the customer-based communities.

Comparison and Discussion

The community-related implementations reviewed show an imbalance in favor of the customer-based communities. Even the provider-based communities identified in practice tend to be mutual community clouds where the cooperating members are provider and customer at the same time.

Regarding the decrease in **transaction costs**, the customer-based communities benefit with a high number of transactions between many participants and bindings that decrease political external effects. The rather interactive transactions are not applicable for large distances between the members. Provider-based communities do not maximize the number of transactions because of administration effort between many members (Provan and Kenis 2008). On the valuable side, their political and economic bindings limit the adjustments of property rights and the processed batch jobs cause lower transaction costs in a network (Coase 1937; Williamson 1979, 1985).

For both types, **interdependencies** are established with a middle cooperative network mode that is the optimal compromise for better reliability of the service than with internal provisioning or a higher trust level than with external procurement. The networks are established for rather long-term periods (Holland and Lockett 1998) and contractual relations in the community provide safety and risk reduction (Laffont 2003; Pratt et al. 1991). The high trust level between the governmental IT service providers and their customers is a sound condition for cloud computing in the public sector, i.e. between public authorities, as well as between public authorities and the citizens. Trust is an essential precondition in a community cloud, because cooperating members sacrifice knowledge advantages in contribution to the success of the community. However, provider-based communities have higher interdependencies with a more intense relationship than in customer-based communities. The most profitable advantage of interdependencies appears in mutual communities of overlapping roles where each member acts as a principal and agent at the same time (Briscoe and Marinos 2009a, 2009b, Pratt et al. 1991). This reduces agency costs, because it is not profitable to increase the individual's utility level at the expense of other members.

In the **market strength** perspective, customer-based communities benefit from a uniform appearance to reach a greater market power for negotiations with providers while this uniform identity can be disadvantageous for provider-based communities. Both types have a high market benefit in combining local and regional institutions.

Regarding the **resource access**, it is conspicuous that customer-based as well as provider-based communities use the cooperation concept to increase the resource benefits of small and medium sized companies while large enterprises often have enough resources on their own to compete in the market. Both community cloud types have cooperating members in the same branch but members in provider-based communities are more actively involved in the cooperation than in customer-based communities. Therefore, the benefit from knowledge alliances, new process knowledge, and common standards is much higher in this community type.

Due to **economies of scale**, cooperating companies in both types profit from increased similar transactions in standardized infrastructure services (Ebers and Gotsch 1995). Especially the public sector can benefit from standardized services to compensate for future personnel shortages. The shared services in provider-based communities have higher benefits for networks because the risk is lower of the services that are located at the value creation side (Bengtsson and Kock 2000). Customer-based communities need to take care not to share too much of their core competencies. The external management in customer-based communities induces a loss of control for the community members and is therefore not advisable for communities with critical data or services. Provider-based communities have an internal management but struggle with a complex architecture. This implies the presumption that the establishment of a provider community cloud is a more difficult venture compared to a customer community.

Regarding the strategic network value, the provider-based community can provide more overall advantages. They profit from higher interdependencies, better availability and usage of resources or knowhow, and higher economies of scale with resource efficiency. The customer-based communities only reach a slightly better network value within the market perspective (see Figure 4).

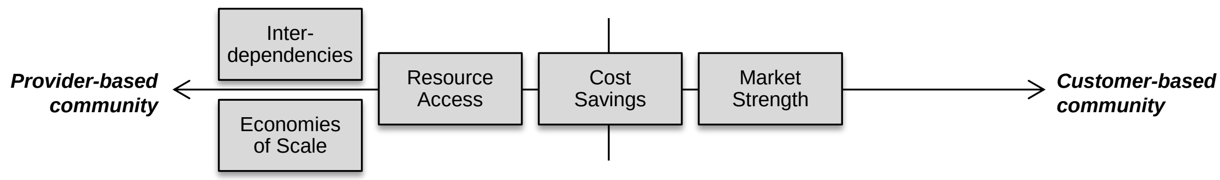

Figure 4. Network value of provider-based and customer-based communities

Conclusion

Summarizing our research, we can confirm the community cloud as an appropriate provisioning model for the public sector. The research revealed that the establishment of a community cloud is a complex and difficult venture and needs to be supported.

To address this need, our contribution is manifold. First, we enlighten the reader regarding the community cloud concept and propose the distinction between provider-based and customer-based community clouds. Then, we gave an overview of network theories that are used by scientific authors to explain cooperation. Based on these theories, we created a framework to characterize a community cloud and evaluate its network value. This framework serves as an analysis guideline to assess the community cloud model for new or existing cloud ventures and answers the first research question. Finally, we evaluated this framework for provider- and customer-based community clouds to answer the second research question. We exposed the community cloud type that has better chances to establish particular network value. The provider-based community showed the most benefits from a network cooperation.

Practitioners can use the framework as a guideline for the assessment of a planned community cloud implementation. The framework is not only valid for the public sector and can be used in a related context. The evaluation results of both community types serve as an orientation guide for relevant network values that should be addressed in the implementation process in detail.

The academic research can support this gap by further investigations of community clouds. An increasing acceptance of cloud computing, especially in the public sector, will overcome the mentioned challenges to reap the benefits. A deeper case study research of community clouds and other evaluations in practice can complement the results and eliminate limitations.

The framework does not give an artifact with a comprehensive and final set of network characteristics but it is extendable. Another drawback of the research is the sample-based evaluation, where the community clouds are distributed unevenly in practice and the information was gathered by web search only. These limitation can be remedied with the further research suggestions.

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