A Classification Scheme for Characterizing Service Networks

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Abstract

This paper introduces an extended definition of service networks. The service network definition, which can be used for classifying service networks, comprises two parts: the service network declaration and the service network specification. The service network specification consists of the specification of the network characteristics, the node characteristics, and the link characteristics. Each of these three characteristics comprises a set of criteria. One fraction of the criteria has been identified through literature research on services, networked organizations, and service network concepts. The remaining fraction of criteria is the result of a case study analysis. The service network case study has been taken from the information technology sector (i.e., the network of Cloud computing services). The analysis of the case study identified characteristics that are important for describing IT service networks but cannot be captured with the existing definitions of service networks.

1 Introduction

In order to create new services or service combinations that provide added value to customers because of their combinations, different service providers align their services by building networks that address diverse needs of customers. These networks are called service networks. Examples for these service networks exists in different industry sectors (e.g., travel industry, consulting, retail, health care, restaurants, software industry, and information technology (IT) industry). Figure 1 shows an example of an IT service network.

In the literature, it has been argued that existing production models, which have traditionally been used for describing the optimized production of physical products, cannot be applied in the services context (Chesbrough and Spohrer, 2006; Maglio et al., 2006; Rai and Sambamurthy, 2006). The existing models fail to describe the existence of informal relationships between suppliers, service providers, and customers. These relationships are important as they foster knowledge creation, knowledge exchange, customer experience, service offering capabilities, and formal business relationships between service providers.

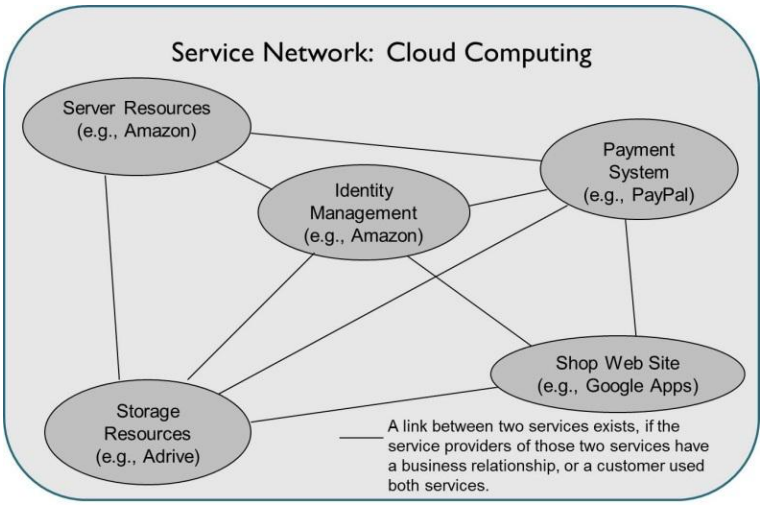

Figure 1: Example of a service network

Although existing literature has made substantial effort in defining services (Achrol and Kotler, 1999; Regan, 1963; Riedl et al., 2009; Silvestro et al., 1992; Winch et al., 1997) and network organizations (Achrol and Kotler, 1999; Basole and Rouse, 2008; Schroth, 2007; Antti, 2004), some shortcomings can be found in the characterization of service networks. It appears that an understanding of what impacts the structure of service networks is missing (Basole and Rouse, 2008). Although Basole and Rouse (2008) argue that the service value network is influenced by many external factors (e.g., customers), they do not consequently define a service network as a system of cooperating service providers linked through customer actions. In Gaur et al. (2006), the authors give a very good definition of service networks, but they do not discuss the variety of service providers and services as well as the type of service processes. In Maitland et al. (2003), interfirm service networks are defined but do not consider special customer and service characteristics. Karni and Kaner (2006) discuss a hierarchy within service networks. They differentiate between service system and service networks. The service system can be an individual or an organization. The cooperation between service systems results in a service network. Barros and Dumas (2006) discuss about Web service ecosystems. These service ecosystems explicitly focus on Web services (e-services). They do not consider traditional services (e.g., face-to-face services).

Based on this literature review, we can state that the existing works fail to provide a comprehensive service network definition that allows a characterization and classification of traditional service networks and IT service networks. These works show that a classification of traditional face-to-face services and IT physical services with the existing schemes is not comprehensive enough to capture the essentials of these different service network types.

The need for a service network definition that can provide a comprehensive classification comes from the fact that an increasing number of standard physical services are supported by distributed, service-oriented information systems. A typical, though futuristic, scenario for this is the smart-phone-supported shopping in department stores. Within this scenario, a customer enters a department store for browsing goods and for spending leisure time. This shopping experience of the customer is enhanced through additional product information delivered via the customer's smart phone. While the act of purchasing a good is also performed via the customer's smart phone, the delivery of the product requires standard physical services. This scenario demonstrates that the underlying service network needs to integrate face-to-face services with IT services of different providers. This service network also needs to consider the level of customer sophistication and the level of automation of services. Consequently, there is a need for a definition of these kinds of service networks.

Within this paper, we address this need for a comprehensive classification scheme for service networks. For this, we apply the following methodology. At first, we cover existing research on cooperating firms and service networks through an extensive literature review. In particular, for this literature review, we used the keywords: service network, cooperative strategies, inter-organizational relationships, matrix organizations, inter-firm service networks, value networks, Web business communities, strategic alliances, joint ventures, and business networks. Based on the criteria found in literature, we develop an initial service network classification scheme. In order to check the workings of this initial service network classification scheme, we applied it to an IT service network case study. The case study describes the service network of Cloud computing. The examination of this case study identified characteristics of Cloud computing that the existing definitions of service networks cannot capture, making them inappropriate to comprehensively describe IT service networks. Consequently, we extended the list of existing criteria so that the new criteria could capture these characteristics, making the new classification scheme useful for a larger set of service networks. Since we only analyzed one case study, we do not claim to provide a complete list of new criteria.

Based on this and social network theory, we offer an extended definition of service networks, which can be used for classifying service networks. In detail, our classification scheme comprises two parts: the service network declaration (i.e., the declaration of nodes and links) and the service network specification (i.e., the specification of the network characteristics dimension, the node characteristics dimension, and the link characteristics dimension). The three dimensions represent three groups of service network criteria, namely criteria dealing with nodes (i.e., services), links (i.e., relationships between the services), and the overall network. The background for this grouping into dimensions comes from social network theory, which uses graphs (networks) to express informal and formal relationships between entities. Therefore, a service network in this paper is considered to be a social network.

Our definition of service networks (i.e., classification scheme) is significant with respect to three facts. First, the similarities and differences of service networks can be identified by comparing the criteria values of those service networks. Second, it allows for defining classes of service networks, which are defined through a vector of criteria values. The value propositions of these classes of service networks can be analyzed further with respect to management cost and revenue. The third essential benefit of this classification scheme is its use for designing new service networks based on best practice cases. Depending on the objective, a service network can be designed that improves customer satisfaction, the revenue of service providers, or the

efficiency. Considering these three facts, our classification scheme is the first step towards establishing a new methodology for assessing the performance of service networks.

The remainder of the paper is organized as follows. The next section introduces the Cloud computing case study. Section 3 shows the existing service network definitions along with a description of new criteria. Within Section 4, we present our definition of service networks (i.e., the classification scheme) as well as its application to the Cloud computing service network. Further directions of this research are described in the final section, Section 5.

2 Service Network Case Study: Cloud Computing

This case study has been selected to identify the characteristics of IT service networks, which cannot be captured with the existing service network definitions. The Cloud computing case study comprises brief descriptions of the background and the business model, which is based on Osterwalder (2004). These descriptions are necessary to derive the benefits of the Cloud computing service network.

2.1 Background

Cloud computing, which represents a service-oriented computing model, can be considered a new kind of IT service network. It offers IT services globally via the Internet. Although Cloud services vary in terms of technology, service complexity, and heterogeneity, they can be combined by customers, following certain standards (Bernstein et al., 2009). The autonomous Cloud service providers offer software-as-a-service (SaaS), platform-as-a-service (PaaS), and infrastructure-as-a-service (IaaS) (Greenberg et al., 2009).

Examples of Cloud providers are GoGrid, Enomaly, and Amazon. GoGrid is a Cloud provider that runs on-demand, dedicated, and mixed server infrastructures. GoGrid, which is the point of contact for a customer, operates its own data center and manages thousands of servers of customers. Enomaly is a platform provider, which offers software that integrates customer data centers with commercial Cloud computing services. Amazon offers Elastic Compute Cloud (EC2), allowing customers to rent virtual computers on a per-usage basis.

2.2 Value Proposition / Business Model

The following characterization of the Cloud computing business model is based on our analysis and the two works of Altmann et al. (2007) and Bany Mohammed et al. (2010).

1. Value proposition: Cloud computing service networks offer their customer a wide range of services including supercomputing power, server computing power, storage capacity, software environments, and software services. Cloud computing allows the customer to buy those resources on demand, therefore, reducing the cost through over-provisioned resources. However, since business data need to be transmitted outside of organizations, Clouds entail potential security challenges.

2. Target customer: Cloud computing service networks target customers globally, although many laws prevent the processing of data outside country boundaries. Any customer using IT is a potential customer for the Cloud. Yet, to-date, small and medium-sized enterprises (SMEs) are the primary customers.

3. Distribution channel: Cloud services are provided mainly over the Internet and always over computer networks. Payments for Cloud services and settlements of accounts are performed via Web services.

4. Relationship: Cloud computing services are delivered based on the real-time interaction between customers and service providers. The interaction between providers and customer usually happens on the Internet.

5. Value configuration: The value configurations in the Clouds are network based and can be described through value networks. In other words, Cloud providers create non-hierarchical links with other service providers and sell their services through multiple channels. This allows the existence of many service providers for adding value and many different stakeholders.

6. Capability: Capabilities of Cloud service networks are flexible and dynamic. Cloud service networks tolerate adding or removing of service providers in a dynamic way. This allows users to consume more customized and scalable services if they become available.

7. Partnership: Cloud computing service networks are based on cooperative strategies and partnership schemes between the participating small or me5dium-sized organizations in the Clouds. This partnership requires common standards of interfaces.

8. Revenue model: Cloud computing service networks have different revenue models, which are based on service diversity, customization, and pricing schemes. The basic model is a “use per hour”-model, which can be extended to dynamic pricing. Others incl5ude subscription models for long-term contracts, ads-based pricing, and transaction fee pricing.

9. Cost structure: Cloud computing service creation costs vary, depending on whether they are hardware-based or software-based. The fixed cost is high for all kind of Cloud resources. The variable cost for platform services is almost zero, while the variable cost for hardware services varies according to time and volume.

3 Service Network Criteria

3.1 Existing Service Networks Criteria

The following list of 11 criteria has been derived from literature on service networks and similar concepts of service networks:

1. Number of nodes: The number of nodes can vary from three nodes to arbitrary finite number of nodes. As the number of nodes grows, we expect the service offerings to be more comprehensive. We expect that each additional service within the service network adds value to other services. However, a network limits (if possible) the number of nodes to avoid overcrowding, while seeking profit maximization and cost minimization (Basole and Rouse, 2008; Gaur et al., 2006).

2. Customer orientation (Degree of interaction and customization): This factor describes the level of service flexibility and customization. The customization of services depends on how services can be composed or bundled to present a new service (Silvestro et al., 1992).

3. Interoperability: A low service interoperability may cause that not all services of a service network could be combined. The more interoperability exist, the higher the opportunities for customized and complex services exist (Barros and Dumas, 2006; Basole and Rouse, 2008). The range of interoperability goes from open to closed.

4. Sharing of tasks and workloads: The service providers that offer the services within the service network exchange certain management data about their services, in order to improve the effectiveness of their service offerings. Besides, tasks, which have to be executed by many service providers, can be aggregated and, therefore, executed at lower cost (Gaur et al., 2006; Maglio et al., 2006).

5. Provider relationship: The provider relationship, i.e., the formal or informal interaction between service providers, impacts the service provisioning (Basole and Rouse, 2008; Maglio et al., 2006; Maitland et al., 2003). For instance, large and reputable service providers tend to build networks with other big players while SMEs tend to build networks among each other.

6. Configuration: Service networks can vary in the duration of their existence. Some networks have been created with a long-term perspective; others have a short-term perspective, fulfilling operational goals. The more strategic the goals of the network are, the longer the time span and the more fixed the configuration of the network is. Moreover, the configuration of the network defines the sustainability and stability of the service network (Gaur et al., 2006).

7. Digitalization: Service characteristics can vary from soft services as information to hard traditional services. For our classification, we differentiate between digital, physical, and both (Riedl et al., 2009).

8. Technology orientation: Service networks have different levels of technology orientation. The more technologically complex the services are, the higher the degree of knowledge is needed for joining the service networks (Barros and Dumas, 2006; Basole and Rouse, 2008; Gaur et al., 2006; Karni and Kaner, 2006). This affects delivery channels, which describe the way services are conveyed to customers. Delivery channels are usually correlated with service characteristics. Delivery channels define requirements for service networks and their networking. The Internet is one key delivery channel for information goods (Herbig and Milewicz, 1995; Tapscott et al., 2000).

9. Point of contact: One important aspect of service networks is the point of contact. This factor describes the way a customer gets served. Service networks can either have one point of contact or multiple points of contact. Service networks with multiple points of contact have a more decentralized network structure (Basole and Rouse, 2008).

10. Service provider size: The size of the company providing the service has an impact on how the services get accepted in the market (Maglio et al., 2006).

11. Power hierarchy: Networks differ in their power distribution between service providers of the services in the service network. This can vary from hierarchical to polycentric. In a hierarchical network, one service provider usually controls the network. In polycentric networks, the power hierarchy is self-governed (Gaur et al., 2006; Maitland et al., 2003).

With respect to these criteria, Table 1 describes the Cloud computing service network. It gives an explanation of the criteria within the context of the Cloud computing service network.

Service Network Criteria	**Service Network Criteria Applied to the Cloud Computing Case Study**
Number of nodes	The number of services is in the range of 1000+. They are digital and can be accessed via a Web Service Interface.
Customer orientation	De-facto standardized services are offered in the Cloud, although the technology for stronger customer orientation exists.
Interoperability	There is no sharing of back office operation. The network tiers exist because of little standardization and de facto standards set by large companies.

Sharing of tasks and workloads	The principle of service oriented computing allows for sharing of functionality of Cloud services.
Provider relationship	The provider relationship is impacted by large providers, around which smaller providers offer aligned services, without any formal relationship.
Configuration	Services are combined for short-term.
Digitalization	All services are digital and therefore do not require high labor after provisioning.
Technology orientation	A high level of technology is required at the customer side and the provider side in order to use these services.
Point of contact	The customer has many points of contact.
Service provider size	The service providers are large companies (e.g., Amazon) as well as small companies (e.g., FluidDynamics) providing support services.
Power hierarchy	The large service providers do not control the service network but set de facto standards that small providers have to follow.

Table 1: Existing service network criteria applied to the Cloud computing case study

3.2 New Service Network Criteria

The existing service network criteria do not capture comprehensively the characteristics of Cloud computing service networks. Based on the Cloud computing business model, a detailed description of Cloud computing requires not only more criteria but also a wide range of criteria values. Table 2 describes the Cloud characteristics and the potential values.

Description of Characteristics of Cloud Computing	**New Criteria**
One the one hand, many services can be offered by a single provider (e.g., Amazon). On the other hand, a large variety of providers exist s that can offer computing resource services.	Variety of providers
One the one hand, a service network of computing resources can very homogeneous (e.g., a double auction marketplace). On the other hand, a service network that allows the composition of business processes is heterogeneous, as it requires the integration of different types of services.	Variety of services
Many offerings are located around the world, i.e., geographically distributed. However, the use of Cloud services can be restricted through laws and contracts, making them national or even local services.	Proximity
The service process of some services is customer-designed (e.g., Web2.0 service composition). Other services, which solve more complex problems for customers, it is network-designed (e.g., DropBox).	Service process
Customer type plays an important role in Cloud computing offerings. Many customers in Cloud computing are large or medium-sized enterprises, which prefer to keep their data within their organization boundaries and, therefore, consume very specific computing and platform services. Individual customers, on the other hand, let providers handle their private data across a large variety of services.	Customer type
The large amount of services in Cloud computing requires checking the quality of services, as past bad experiences of consumers will make them stay absence from online services. This past experience can be captured through reputation systems, which will make the performance visible to potential customers.	Past customer experience
The level of sophistication required by customers varies widely as well. Service consumption for individual customers has been made user-friendly (e.g., DropBox), requiring little sophistication. Companies, which want to integrate Cloud services into their IT infrastructure, need IT expertise in-house however.	Customer sophistication
In principle, Cloud services are separable, although market power and customer lock-in attempts of service providers make it difficult to replace a service of one provider with a service of other providers.	Inseparability
Description of Characteristics of Cloud Computing	**New Criteria**
Infrastructure services cannot be stored. If they are not consumed, they are lost. Platform and software services, however, are none perishable goods.	Perishability
Human interaction is needed for the provisioning of customized Cloud services, in particular for establishing service level agreements (SLAs). The management of service level agreements has not been automated yet. However, the more the Cloud service is standardized, the less human interaction is necessary.	Degree of automated interaction
The service class for Cloud computing services can be search services (e.g. basic algorithm implementations), experience services (e.g., Google search), and credence services (e.g., computing services).	Service class

Table 2: New service network criteria description within the Cloud computing case study

In summary, the analysis of the Cloud computing case study revealed 11 criteria. Although these criteria have not been considered in literature in the context of service networks, some of them have been identified in the area of marketing, organization, e-business, and service science (van Triest, 2005; Smith et. al, 2002; Herbig et. al, 1995; Prahalad, Hamel, 1990; Regan, 1963; Shostack, 1977; Zhang et al., 2005; Järvinen et. al, 2004; Cook et al., 1999).

It is to be noted here that the analyses of further case studies might reveal further criteria that are important. Consequently, we cannot and do not want to claim that the criteria shown here represent a complete list of criteria. However, as can be seen in section 4, any new criterion could easily be integrated into our definition of service networks (i.e., the classification scheme). Any new criterion will detail one of these three dimensions but will not affect the structure of the classification scheme.

1. Variety of providers: Service providers can belong to different branches (e.g., ski resort: hotels, travel agencies, restaurants) or to the same branch (e.g., healthcare provider in a healthcare center, software vendors in a software development network). While networks that are built of services of providers from the same branch are called homogeneous, the other networks are called heterogeneous.

2. Variety of services: Services in a network can be heterogeneous services (e.g., ski resort services, which provide accommodation services, travel services, and restaurants), i.e., services belonging to different branches. Alternatively, services can be homogeneous services, i.e., they belong to the same branch (e.g., server services and supercomputer services belong to the IT services).

3. Proximity: This factor describes the geographic concentration between service network members. If service providers are located in a geographically close area, the service network is geographically concentrated. Geographically dispersed service networks are stronger than others, since they can access bigger markets. The operation of the service network can be local, national, or international.

4. Service process: There are two ways how value is added by the service process. First, the activities of the service process depend on each other so that the customer is more or less guided through the whole process. The service process is actively designed by the providers. Second, the customer decides which activity (i.e., which part of the value adding) he wants to make use of and in what sequence. The providers react to the customer's decision on which service to consume. Therefore, the service process is either called "provider-designed" or "customer-designed". This makes a significant difference with respect to the management of the network. A provider-designed service process makes the management of the customer experience easier than a customer-designed process.

5. Customer type: It is important to analyze which kind of customers the network has. This will affect the kind of services and how they are offered from the service network. Customers can either be a large organization, SME, individual (home office), or a mix of these classes. These customer classes correlate with employee number or revenues of the organization (van Triest, 2005).

6. Past customer experience: The experience of a customer in the past determines the expectations the customer has when consuming the service the next time. Customers with good experience are loyal and have a little quality sensibility (Smith and Wheeler, 2002).

7. Customer sophistication: The sophistication of a customer impacts service provisioning and the creation of new services. The sophistication can also be an indication for the service quality that is demanded by the customer (Herbig and Milewicz, 1995).

8. Inseparability: The service in the service network can vary from single services to bundles of services. The dependency between services of a bundle determines the degree of inseparability of the service (Prahalad and Hamel, 1990; Regan, 1963; Shostack, 1977).

9. Perishability: The perishability of a production service is higher than for an information service, since a production service is less storable, transportable and more time dependent (Prahalad and Hamel, 1990; Regan, 1963; Shostack, 1977; Zhang et al., 2005).

10. Degree of automated interaction: Services differ in the degree of human involvement during production. This defines the degree of labor intensity. Traditional services are more labor intensive than information services because they can only be offered face-to-face. Many information services have even eliminated personal interaction entirely, making the interaction fully automated (Järvinen and Lehtinen, 2004).

11. Service class: Service can be differentiated into three types: search services, experience services, and credence services. Search services are simple to rate as customers can get sufficient information to evaluate the quality of the services before use (e.g., accommodation services). The customers can only rate experience services after using them. Too little information exists before using them (e.g., finance services). Credence services are considered most complex because customers cannot evaluate the services before or after using them. Instead, customers have to trust the expert, who offers the service. To evaluate this class of service, it needs to be compared with similar services (Cook et al., 1999).

4 Definition of Service Networks

Our definition of service networks comprises two parts: the service network declaration and the service network specification. The service network declaration defines the components of the network (i.e., nodes (service), links (relationships between services based on customer interactions and business relationships)), which follows social network theory. The service network specification identifies the characteristics of the network and its components. With those two parts, any service network can be described.

Service network declaration: Since our approach on defining service networks is based on social network theory, it considers a service network to be a social network (graph), which is composed of a set of services (i.e., nodes) and a set of relationships (links) between these services. The services can be owned by different legal, autonomous entities (i.e., service providers). A relationship between two services exist, if a customer consumed those services jointly (i.e., at the same time or within a certain time period sequentially) or if a business relationship between two service providers which offer the services exist. Consequently, two types of links (i.e., business-related and customer-related link) can be differentiated. The weights attached to the customer-related links indicate the frequency of joint use of those services by customers within a certain time period. These customer-related links represent the value created for consumers and, consequently, the competitiveness of the jointly offered services. The set of provider-related links represents the openness of the network. The more business relationships exist, the closer the service providers collaborate.

Based on the definition of the service network declaration, Figure 2 shows an example of a service network. The example shows five Cloud services (i.e., server resource service, storage resource service, identity management service, payment service, and shop Web site service) that are offered in Cloud computing. A link between two services exists, if a customer jointly consumed those services for the execution of one task. The link weights represent how often two services have jointly been used. For example, if one customer uses three services jointly, each of the links between the three services gets increased by 1. Two services are also connected (although through a different type of link), if they providers of those services have a formal business relationship. In Figure 2, Paypal, the provider of the payment service, has a formal relationship with Adrive, the storage resource provider.

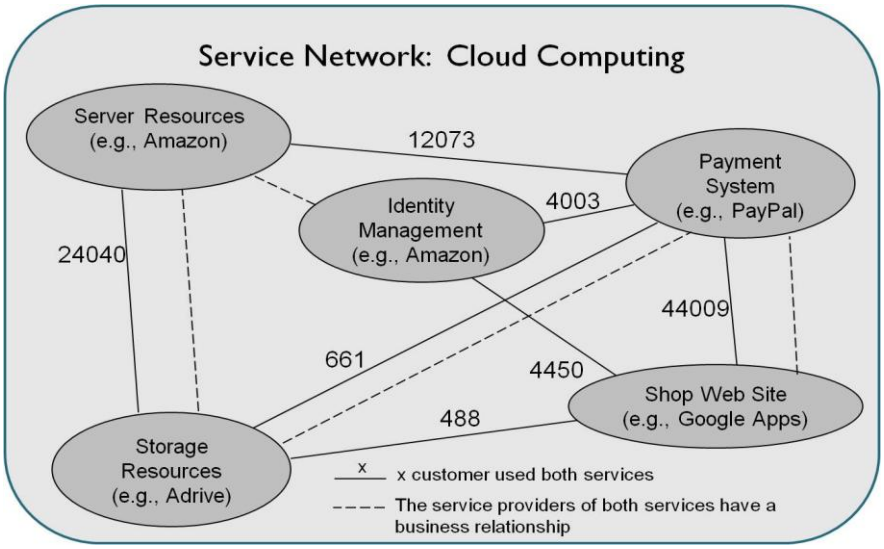

Figure 2: An Example of the Cloud computing service network. While the services and their relationships have been identified through research, the link weights are made up

Service network specification: The network, the nodes, and the links can be characterized through a set of criteria, which were identified through our analyses of one case study and a supporting literature review. These criteria are grouped into three criteria dimensions: network characteristics dimension, node characteristics dimension, and link characteristics dimension. While the network characteristics dimension addresses the overall network, the node characteristics dimension relates to the services, and the link characteristics dimension relates to the relationships between services.

As the network characteristics dimension defines the characteristics of the overall network, it deals with criteria that describe the set of services, the set of providers, the purpose of the network, and the overall network organization. Therefore, this dimension consists of six criteria: number of nodes, configuration, technology orientation, proximity, power hierarchy, service process, variety of services, variety of providers, and sharing of tasks and workloads.

The node characteristics dimension represents the second dimension of the classification scheme and entails a set of criteria that describes the service offered by service providers. This dimension captures: interoperability, digitalization, inseparability, perishability, degree of automated interaction, customer orientation, point of contact, and service class.

The link characteristics dimension is the third of the three dimensions. It describes the actors that establish the relationships between services. These actors are customers and service providers. The kind of customers and the kind of providers have a large impact on how relationships are established between services. The link characteristics dimension consists of customer-related and provider-related criteria: customer type, past customer experience, customer sophistication, service provider size, and provider relationship.

5 Conclusion

This paper proposed a new definition of service networks. The need for a service network definition that can provide a comprehensive classification of service networks comes from the fact that an increasing number of standard physical services are supported by distributed, service-oriented information systems. This interaction requires understanding the service networks built through the combination of traditional services and IT services.

The classification scheme is the result of a literature research and one case study analysis. The case study revealed a set of criteria that have not been considered in literature earlier. The classification scheme, which follows a social network approach, comprises 22 criteria, sorted into three dimensions: network characteristics dimension, node characteristics dimension, and link characteristics dimension.

The benefit of the service network classification scheme is threefold: First, the similarities and differences of service networks can be identified by comparing their criteria values. Second, it allows for defining classes of service networks, which value propositions can be analyzed with respect to management cost and revenue. Third, best practice cases can be identified for designing new service networks.

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