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Information Governance in Service-Oriented Business Networking

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Information governance in service-oriented business networking

PROEFSCHRIFT

ter verkrijging van de graad van doctor aan de Technische Universiteit Eindhoven, op gezag van de rector magnificus prof.dr.ir. F.P.T. Baaijens, voor een commissie aangewezen door het College voor Promoties, in het openbaar te verdedigen op dinsdag 25 oktober 2016 om 16:00 uur

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Mohammadreza Rasouli

geboren te Tabriz, Iran

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Mohammad Reza Rasouli
Eindhoven, 2016

Contents

1

Introduction

Chapter 1

Introduction

Competition in current business environments has forced organizations to focus on their core competencies and outsource other activities (Kothandaraman and Wilson, 2001; Ritter et al., 2004). Organizations focusing on their core competencies collaborate with globally distributed business parties to provide products and services to customers (Ernst and Kim, 2002). This highlights the importance of business networking to achieve competitive advantage (Gereffi et al., 2005). In this way, competition is nowadays often between business networks (BNs) rather than between single organizations (Zhang, 2006).

Empowerment of customers in globalized markets has shifted the locus of BNs from producers and retailers to buyers and users (Christopher and Ryals, 2014). Nowadays customers have increased access to information and are globally connected within customer communities via social media technologies. This has forced BNs to give greater consideration to customers' experiences (Aral et al., 2013). On the other hand, stronger collaboration among parties within networked e-business structures (Grefen, 2015a) has enabled BNs to collaboratively innovate and develop new products and services (Emden et al., 2006).

Business intelligence, in light of "big data" technologies, has reduced the time to market and has enabled greater specification of value proposed for customers (Chen et al., 2012). In this environment, BNs now require co-creating mass customized integrated solutions with customers through deeper interactions within value networks to rapidly respond to sensed market opportunities (Pine, 1999; Camarinha-Matos et al., 2011; Gaiardelli et al., 2015). This highlights that service orientation in BNs is a necessity to survive in the current global business environment (Gebauer, 2008; Jacob and Ulaga, 2008; Christopher and Ryals, 2014).

Service orientation in BNs refers to deep interactions with customers in order to co-create value (Payne et al., 2008; Prahalad and Ramaswamy, 2004a) as well as dynamic and agile collaboration with suppliers to deliver mass-customized products and services (Christopher, 2000). In this way, a service-oriented business network (SBN) can be described as a collaborative network of independent parties within a market that co-creates mass customized packages of products and services in the form of integrated solutions (Storbacka, 2011; Rasouli et al., 2014).

Service orientation in BNs requires sensing environmental changes (e.g. customer needs) and responding to these changes rapidly through agile orchestration of resources distributed among parties (Sambamurthy et al., 2003). Agile orchestration of distributed resources within a BN is realized by managing dynamic networked business processes (Grefen et al., 2009b). Agility stresses information-intensity in managing networked business processes (Sambamurthy et al., 2003). Information-intensity highlights the role of information as a strategic asset (Tallon, 2013) that supports composing and enacting networked business processes. More precisely, information-intensity addresses dynamic evolution of networked business processes in order to rapidly respond to sensed environmental requirements (Reichert and Weber, 2012). The importance of information-intensity to support operations agility in BNs is further highlighted by emerging IT-related developments such as big data, cloud computing, and internet of things which enable BNs to generate, store, access, and use globally distributed information to manage networked business processes.

Using information assets to support agility and dynamism within information-intensive networked business processes requires the application of Information Governance (IG) mechanisms. These mechanisms ensure that high quality and secure information is exchanged between collaborating parties (Kooper et al., 2011; Tallon, 2013). However, the characteristics of SBNs result in emerging issues regarding the governing of information assets, like difficulties relating to the formation of high quality process cubes (or data warehouses), syntactically and semantically inconsistent information services provided by highly dynamic and autonomous collaborating parties and problems regarding secure access to information assets which are often distributed among collaborating parties with heterogeneous security policies. These issues strongly reduce the ability of a BN to exploit information assets to support and enable dynamic networked business processes in SBNs. Therefore, it is hugely important to address these issues in order to allow a BN to successfully govern its information assets in this context. This thesis will focus on addressing these issues.

The dissertation that is introduced in this chapter concentrates on IG in SBNs. For introducing the research, the research groundwork is described in Section 1.1. The research questions within the described context are addressed in Section 1.2. Section 1.3 points out the research objectives and an overview on approaches that are used in this dissertation. The structure of the thesis is represented in Section 1.4.

1.1 The research groundwork

According to the title of the dissertation, its groundwork can be described within the two main notions, respectively, service-oriented business networking, and information governance (IG). Specifically, we concentrate on IG in the context of service-oriented business networking. These two foundational notions of the research are described further.

1.1.1 Service-oriented business networking

Business networking, which is the overall focus of this dissertation, has been given increasing attention in recent years. Within strategic management research, BNs have been highlighted in the light of the core competency theory (Prahalad and Hamel, 1990) that indicates that organizations need to focus on their core competencies and outsource other activities to achieve sustainable competitive advantages. In the context of operations management, cross-organizational collaboration and coordination in BNs have been increasingly addressed by supply chain management research (Balakrishnan and Geunes, 2004). In the context of e-business research, networked structures of e-business have been developed further in recent years due to the growth of technologies which enable cross-organizational integration and interoperability (Grefen, 2015a).

A BN can be described as the organization and management of IT-enabled business relationships with internal and external business partners to provide value for customers (Alt et al., 2000; Grefen, 2015a). BNs consist of a variety of organizations that are largely autonomous, geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital and goals. However they collaborate to achieve common or compatible goals (Camarinha-Matos et al., 2009).

New dominant logics and theories in the context of marketing and operations management have led BNs to be more and more customer-centric. Examples of these include the S-D logic of marketing, which highlights the importance of co-creating value with customers. This results in the need to reframe BNs into value networks consisting of loosely-coupled parties who collaborate to co-innovate, co-produce and co-create value for customers (Vargo and Lusch, 2004; Lusch, 2011) . On the other hand, the servitization theory (Vandermerwe and Rada, 1989; Roy et al., 2009) stresses the need to provide product service systems that support utility of products within their whole life cycles (Vandermerwe and Rada, 1989; Roy et al., 2009).

Based on these theories, we concentrate on a specific type of BNs that is addressed by service-oriented BNs (SBNs). A SBN is a collaborative network of independent parties who together offer a mass customized package of products and services in the form of an integrated solution by co-creating value with customers (Storbacka et al., 2013; Rasouli et al., 2014).

1.1.2 Information governance

The importance of information has been increasingly considered as a key asset enabling agility in dynamic business environments (Sambamurthy et al., 2003). This has been further highlighted by emerging paradigms such as big-data and cloud computing that facilitate the creation of business value from information assets (LaValle et al., 2011). The creation of business value from information assets needs to use mechanisms to enhance information quality and safeguard these assets from opportunistic behaviors (Tallon, 2013).

Information governance (IG) is a holistic approach to different mechanisms that are required to enable high quality and secure information exchange (Kooper et al., 2011). IG aims to maximize the value of information for all stakeholders and safeguard information as an asset within its whole lifecycle. In this way, IG addresses information quality, information security, and metadata domains (Khatri and Brown, 2010).

Information quality typically is defined by information “fitness for use” (Wang, 1998). IG in the context of BNs examines the fitness of information assets provided by all parties and assesses its suitability to be used within managing collaborative business processes.

Information security underlines the protection of information confidentiality, integrity and availability (Bishop, 2003). Safeguarding information as an asset involves effective risk analysis to ensure that information is only accessed by authorized parties in a BN. Metadata is information about information that enhances the usability and understandability of an information asset by different parties within a BN (Khatri and Brown, 2010). It also enhances semantics of information that is exchanged among parties.

IG mechanisms are different from information integration and interoperability solutions like federated database management systems (e.g. (Sheth and Larson, 1990; Afsarmanesh et al., 1998)) and syntactic and semantic interoperability approaches like XML based standardization or ontological mapping tools (e.g. see techniques in (Kalfoglou and Schorlemmer, 2003)). The difference between IG and these information integration and interoperability techniques can be described by the difference between governance and management notions (Dallas and Bell, 2004). The notion of management addresses the execution of resources effectively and efficiently to achieve the desired objectives. The notion of governance emphasizes the importance of directing the execution to keep it aligned with environmental changes. In this way, information management in the context of BNs aims to execute different techniques to support integration and interoperability of information sources and services. IG concentrates on directing these techniques and solutions to keep them aligned with changes.

1.2 The research questions

The most important mechanism that enables the formation and execution of BNs is interactions among parties within a market (Provan et al., 2007). These interactions handle collaborative decision-making and interoperations to propose and provide value for customers. Collaborative decision-making requires a BN to integrate high quality information within knowledge bases (Mehandjiev and Grefen, 2010). Interoperations among collaborating parties require high quality information exchanges among work process systems (e.g. syntactically and semantically interoperable message exchanges among software services (Papazoglou et al., 2007; Papazoglou et al., 2008)). In order to ensure high quality and secure information exchanges among parties, a BN must govern the information assets within it.

On the other hand, service orientation in BNs shifts stable and pre-defined interactions among parties towards dynamic and on-the-fly co-operations (Lusch, 2011). The dynamism of business networking that supports agility for responding to customer requirements in SBNs can also result in problems such as unsecured information access, low quality information products stored in distributed databases, and ontological misalignments (Silvola et al., 2011; Tallon, 2013; Haug et al., 2013; Rasouli et al., 2015c). These problems can strongly disrupt the performance of a BN by threatening the quality of collaborative decision-making and interoperations. In order to prevent business failures resulting from low-quality information, these emerging IG issues need to be properly recognized and addressed. Therefore, the main objectives of this dissertation are **to characterize service orientation in BNs, comprehensively identify emerging IG issues in SBNs and develop solutions to address these issues.**

In order to identify IG issues resulting from service orientation in BNs, we firstly need to characterize SBNs in a structured way. This enables us to concentrate on IG issues resulting from service orientation in BNs and also derive principles that can be adhered to when developing solutions to the IG issues.

Therefore the first research question is:

RQ1- What are the characteristics of SBNs which aim to co-create integrated solutions with customers?

Co-creating integrated solutions has been addressed by emerging theories in the context of marketing (Vargo and Lusch, 2004), operations management (Neely, 2007; Gebauer, 2008; Roy et al., 2009; Meier et al., 2010; Cavalieri and Pezzotta, 2012), and information systems (Goldman et al., 1995; Sambamurthy et al., 2003; Grefen et al., 2009b). These theories have been used in recent years to develop service-oriented businesses (e.g. (Kindström, 2010; Storbacka, 2011; Lüftenegger, 2014)).

The design of service-oriented businesses, particularly in the context of single organizations, has used these theories. However an inclusive and coherent view on different aspects and dimensions of service orientation in the context of BNs is lacking. . Descriptive research studies in the context of BNs often highlight a single aspect of service orientation such as the characterization of service-oriented value (Kowalkowski, 2010; Jaakkola and Hakanen, 2013; Cavalieri and Pezzotta, 2012) or the characterization of structures and interactions in this context (Gebauer et al., 2013; Jaakkola and Hakanen, 2013; Lusch et al., 2010). Therefore there is no coherent view on different aspects of service orientation in BNs.

These descriptive theories have mainly focused on a specified set of activities within a whole value chain such as new service development (Eisingerich et al., 2009; Spring and Araujo, 2013), operations and logistics management (Lockett et al., 2011; Durugbo and Riedel, 2013), or value proposition (Jaakkola and Hakanen, 2013; Mencarelli and Rivière, 2014). But, an inclusive view comprising consequences of service orientation on all activities within a value chain in a BN is missing.

On the other hand, prescriptive research studies that introduce tools and models to develop SBNs (Lüftenegger, 2014; Grefen, 2015b) do not inclusively describe different characteristics of SBNs that can be realized using these models and tools. These studies focus more on design concerns rather than the characterization of service orientation characteristics. Therefore we intend to provide an inclusive and coherent view on different aspects and dimensions of service orientation in BNs. This will provide a well-established basis to characterize SBNs. The characterization of the SBNs in a structured way can bridge the gap between the described descriptive and prescriptive research by directing design options regarding the relevant descriptive knowledge.

After the characterization of SBNs in a structured way, in order to have a more concrete view on the way that the characteristics of SBNs can be realized, the capabilities supporting service orientation in BNs are addressed. Regarding the general objective of the dissertation (i.e. IG in SBNs), the elaboration of capabilities supporting service orientation in BNs can provide a better understanding on how parties in SBNs dynamically collaborate within adaptive networked business processes to provide customer-centric solutions. To do so, the sub question RQ1-1 is formulated as:

RQ1-1- What are the capabilities that support co-creating integrated solutions with customers in SBNs?

According to the main objective of the thesis, which addresses governing information assets in SBNs, answering this sub research question provides an overall insight in how information supports and enables BNs to co-create integrated solutions. Therefore, this sub research question bridges the gap between the first RQ that concentrates on characterizing SBNs as the context of this research and the second and the third RQ that focus on governing information assets in this context.

Co-creating integrated solutions with customers necessitates highly dynamic interactions among parties to respond to emerging customer requirements rapidly. Based on a BN engineering perspective (Alt et al., 2000; Grefen, 2013; Grefen, 2015a; Grefen, 2015b), interactions among collaborating parties can be seen from a strategic and an operational perspective. In the context of SBNs, networked interactions from a strategic perspective concentrate on the definition of a collaborative strategy to form a value network that supports customers' experiences. Networked interactions from an operational view are seen within networked business processes that support inter-operations among parties collaborating within a value network to co-create integrated solutions with customers. Networked business processes are composed to propose a value in the form of an integrated solution for customer and are enacted to co-create the proposed value with customers (Mehandjiev and Grefen, 2010; Grefen, 2015b).

Information is a key asset that is exchanged among collaborating parties in order to support and enable composing and enacting networked business processes. These information assets need to be governed to ensure high quality and secure information exchanges among collaborating parties.

Previous research on IG has focused on governing information assets within boundaries of a single organization (Khatri and Brown, 2010). Studies that go beyond the boundaries of a single organization and discuss cross-organizational interactions have investigated IG in stable BNs such as conventional supply chains (Otto et al., 2011; Kravets and Zimmermann, 2012; Tallon, 2013). However, the dynamism of networked business processes in the context of SBNs results in emerging IG issues such as context aware semantic information exchange or collaboratively created information ownership. Therefore, the second research question concentrates on a thorough identification of these emerging IG issues in the context of SBNs. To do this, the second research question is stated as:

RQ2- What IG issues need to be addressed to ensure high quality and secure information exchanges in dynamic networked business processes within SBNs?

In order to propose and co-create integrated solutions with customers through composing and enacting dynamic networked business processes within SBNs, a BN needs to address the identified IG issues. Therefore the third research question concentrates on solutions to ensure high quality information exchanges among collaborating parties in SBNs. In this way, the third research question that is addressed in the dissertation is formulated as:

RQ3- How can information be governed through an architectural solution to ensure high quality information exchanges among collaborating parties within dynamic networked business processes in SBNs?

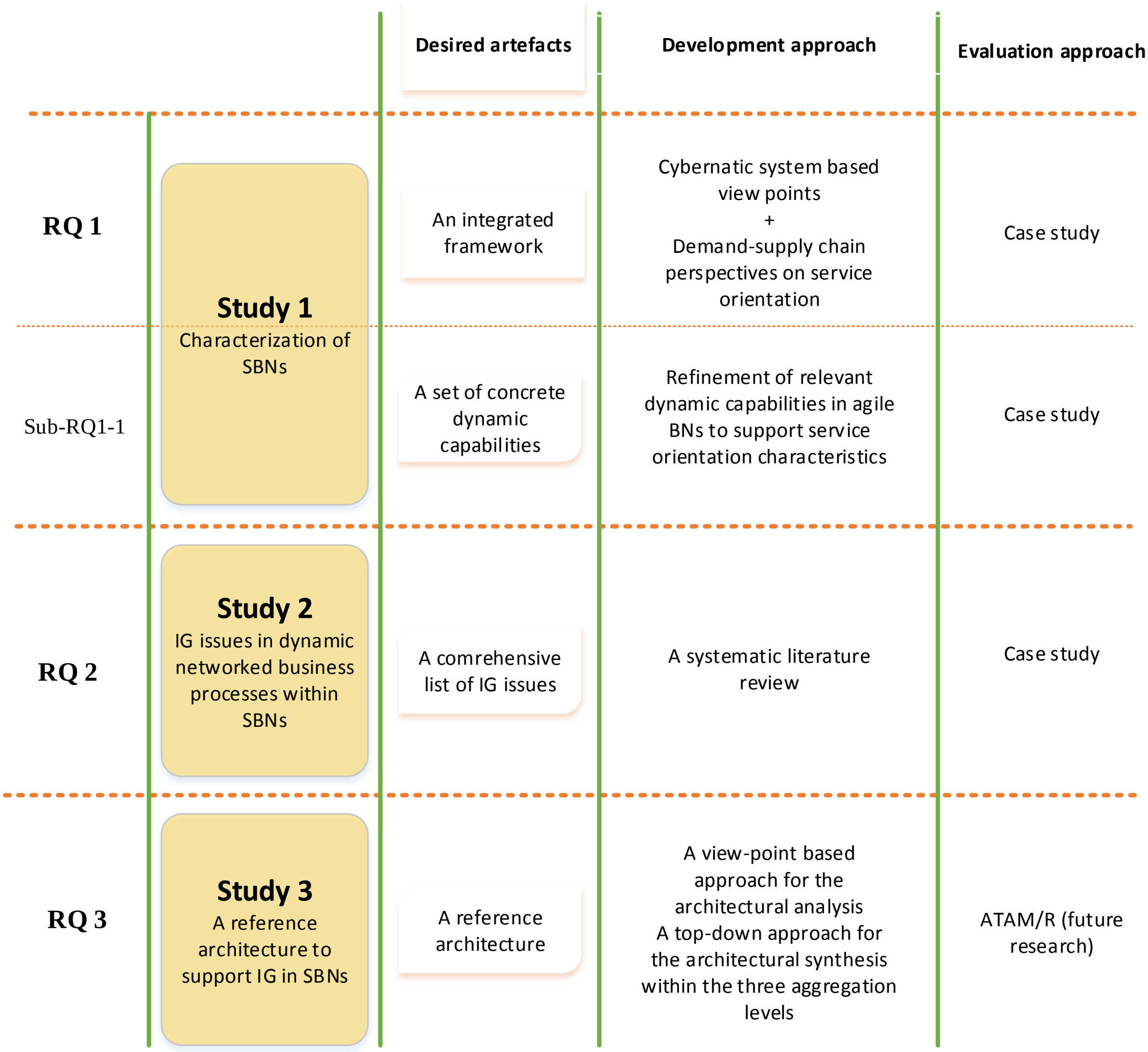

Figure 1.1- The research approach

1.3 Research approach

According to the described research questions, we conduct three studies as part of this research (see Figure 1.1).

The first study, in accordance with the first research question, characterizes SBNs in a structured way and describes the capabilities supporting service orientation in BNs. The second study addresses the second research question by the identification of the IG issues within dynamic networked business processes in SBNs. The third study answers the third research question through the development of a solution in order to ensure high quality information exchanges among collaborating parties within SBNs.

Based on a design science research approach (von Alan et al., 2004; Peffers et al., 2007) two main phases are conducted to answer the described research questions. These are a development phase and an evaluation phase.

The first phase within the described studies concentrates on the development of an artifact to answer the relating research question. The second phase evaluates the developed artifact based on the core quality characteristics that are expected. The developed artefacts and the evaluation approaches that are used within each study are described shortly below and are fully explained in the remainder of the thesis.

In the first study an integrated framework is developed to provide an inclusive and coherent view on the characteristics of SBNs. The inclusiveness of the integrated framework gives a thorough view on different theories that underline service orientation within different activities of a whole value chain in a BN. The coherence refers to the investigation of service orientation in BNs from different relevant aspects in a structured way. Within the construction phase, a cybernetic system view (Von Bertalanffy, 1956) is used to explore different aspects of a BN, including the output, the interactions, and the governance aspects (which supports coherence of the developed integrated framework). To characterize service orientation within each of these aspects a distinction is drawn between a supply chain and a demand chain dimension in a value chain (Hilletofth, 2011) (which supports inclusiveness of view on different dimensions of service orientation). The applicability and usefulness of the developed integrated framework to characterize service orientation in real-life BNs are evaluated by conducting a multiple-case study research in three BNs. These include a BN that provides certification services for energy suppliers, a BN that provides document management services, and a BN that provides financial services for customers. Due to the ability of the case study research to investigate a phenomenon within its real-life context (Yin, 2013), the used approach enables us to shows how the developed integrated framework can facilitate decision-making to direct service orientation transition in BNs. In-depth interviews facilitated by semi-structured questionnaires are used to gather relevant data. Based on the gathered data, we firstly describe each of the selected BNs. Then, service orientation transitions within the BNs are elaborated by using the developed integrated framework. Lastly, we discuss how the characterization of service orientation using the developed integrated framework provides new insights for decision-makers in the BNs to refine their service orientation transition.

In order to answer the sub-RQ1-1, a productive and deductive reasoning is conducted to refine the concrete dynamic capabilities that support the realization of the characteristics of SBNs. The practical relevance of the refined dynamic capabilities is evaluated by a case study in a SBN that intends to provide integrated mobility solutions for customers.

In the second study, a systematic literature review is conducted to comprehensively explore IG issues within dynamic networked business processes. To do this, five steps are conducted as follows (Tranfield et al., 2003; Keele, 2007):

- Plan the review
- Identify research
- Practical screening
- Extract quality evidences
- Synthesize and report evidences

The practical relevance of the identified IG issues is evaluated using a case study in a SBN that intends to provide integrated mobility solutions for customers. To do this, we select two networked business processes within the BN that intends to provide mobility solutions. Using data gathered by in-depth interviews, we investigate how the dynamism within the selected networked business processes result in the identified IG issues.

In order to answer the third research question within the third study, among different mechanisms that can be used for governing information assets (see (Van Grembergen et al., 2004; van Grembergen, 2007; Van Grembergen and De Haes, 2009; Tallon et al., 2013,)), we concentrate on a procedural mechanism. This procedural mechanism is described within a reference architecture that supports the governing of information assets. It particularly focuses on information that is exchanged within the composition and enactment phases of dynamic networked business processes in SBNs.

The development of the reference architecture is conducted in three steps: the architectural analysis, the architectural synthesis, and the architectural evaluation (Hofmeister et al., 2007). Architectural analysis identifies functional and non-functional requirements that should be considered when governing information assets. Architectural synthesis describes the system components and their interactions for governing information assets within networked business processes. In this research, we conduct a preliminary evaluation of the developed reference architecture. This preliminary evaluation discusses how the synthesized architecture conforms to its desired quality attributes including completeness, conceptual integrity, buildability, and applicability. The evaluation of the developed reference architecture by an adapted version of the Architectural Trade-off Analysis Method (ATAM/R) (Angelov et al., 2008; Angelov et al., 2014) is described as a future research.

1.4 The structure of the thesis

According to the described research, the dissertation that is titled by "information governance in service-oriented business networking" is organized within the eight chapters, see Figure 1.2. After introducing the thesis in the current chapter, based on the described research approach in Section 1.3, the dissertation is arranged within the three parts including the six chapters (i.e. Chapter 2 to Chapter 7). The research is concluded in Chapter 8. These chapters are described further.

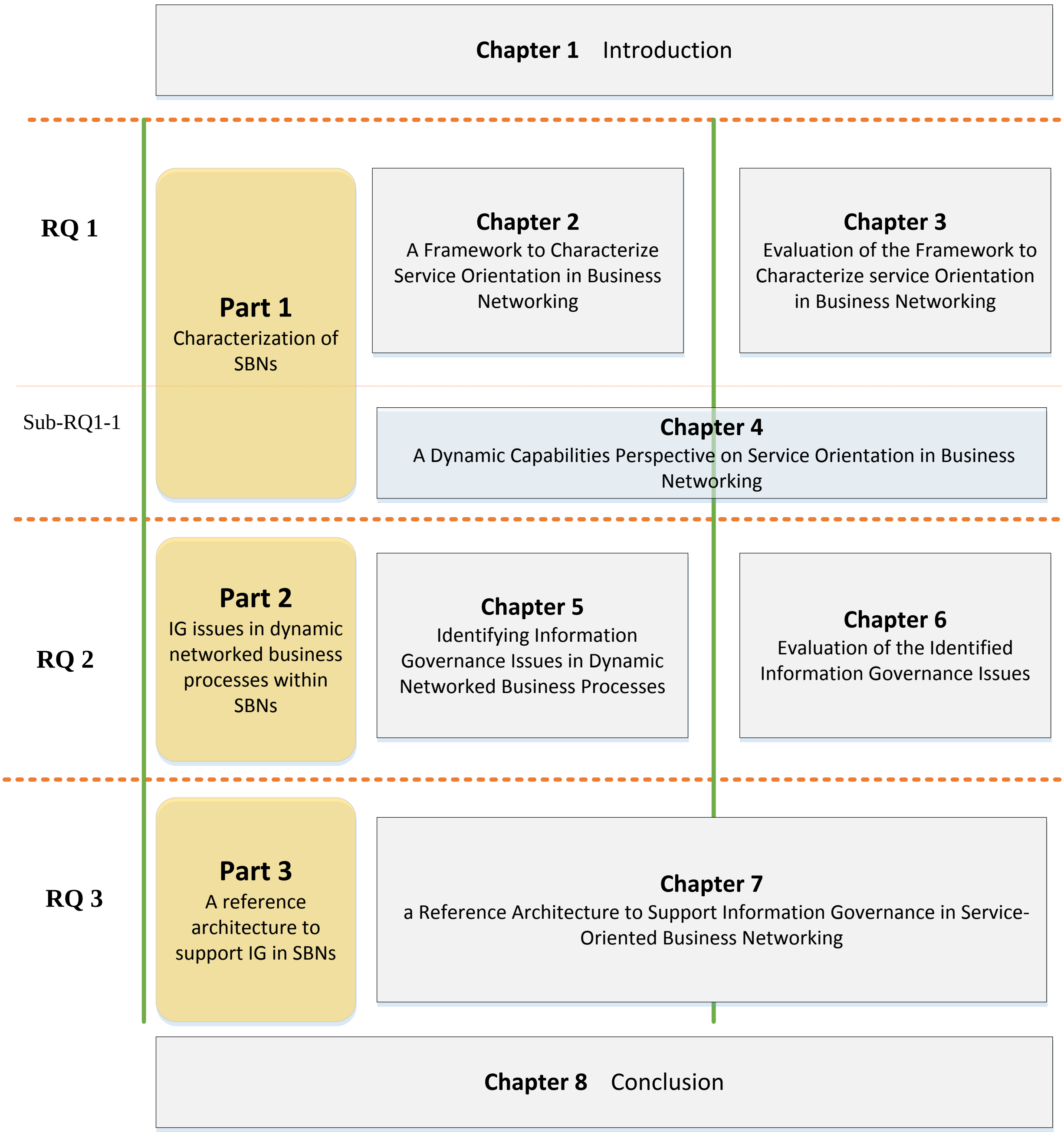

Figure 1.2- The structure of the thesis

Chapter 1: Introduction. The current chapter of the thesis introduces the research by positioning the research within a broader related research context. In this chapter we discuss the main objective of the research and relating research questions. A global view on the research approach that is conducted to answer the research question is depicted. Based on the described approach, the structure of the thesis is outlined.

Part One: Service Orientation in Business Networking. The first part of the thesis characterizes SBNs. In-depth understanding of the characteristics of SBNs in a structured way enables us then to investigate the resulting IG issues. According to the described research approach, this part is arranged within three chapters.

Chapter 2: A Framework to Characterize Service Orientation in Business Networking. This chapter describes the development of the integrated framework that characterizes service orientation within the aspects derived from a cybernetic system view. A demand chain and a supply chain dimensions are addressed within each aspect. A part of this chapter has been published as (Rasouli et al., 2014).

Chapter 3: Evaluation of the Framework to Characterize Service Orientation in Business Networking. In this chapter the applicability and usefulness of the developed integrated framework is evaluated using a case study. We investigate if the developed framework can be applied in real-life BNs to enhance their service orientation transition. We also examine if the framework can provide useful insights for decision makers in BNs about their service orientation transitions. The developed integrated framework in Chapter 2 together the findings on its evaluation that are reported within this chapter have been submitted as (Rasouli et al., under review-submitted in November 2015).

Chapter 4: A Dynamic Capabilities Perspective on Service Orientation in Business Networking. In this chapter we identify a set of concrete dynamic capabilities that enable BNs to realize the characteristics for service orientation. The practical relevance of the identified dynamic capabilities is investigated using a case study. The findings reported within this chapter have been published as (Rasouli et al., 2015c).

Part Two: Information Governance Issues in Service-Oriented Business Networking. This part addresses the second study that is addressed in the research approach in order to answer the second research question. In this way, this part of the dissertation reflects the exploration of the IG issues in dynamic networked business processes within SBNs. According to the two phases of the research approach, this part is represented within two chapters.

Chapter 5: Identifying Information Governance Issues in Dynamic Networked Business Processes. This chapter represents a systematic literature review to identify a comprehensive list of the IG issues in dynamic networked business processes in SBNs. The identified IG issues are categorized into information quality, information security, and metadata issues. This chapter has been based on the paper published as (Rasouli et al., 2016a).

Chapter 6: Evaluating the Identified Information Governance Issues in Dynamic Networked Business Processes. In this chapter the practical relevance of the identified IG issues is investigated using a case study. A part of this chapter has been published as (Rasouli et al., 2015b). The extended version of the findings, has been submitted as (Rasouli, et al., under review-submitted in January 2016).

Part Three: an Architectural Solution for Information Governance in Service-Oriented Business Networking. This parts reports the findings of the third study conducted within this dissertation. We design a reference architecture as a conceptual solution to support governing information assets within dynamic networked business processes in SBNs.

Chapter 7: A Reference Architecture to Support Information Governance in Service-Oriented Business Networking. After the characterization of the desired architectural solution within a broader context of possible IG solutions, we conduct the architectural analysis and the architectural synthesis steps. A preliminary evaluation of the designed reference architecture is addressed by discussing its completeness, conceptual integrity, buildability, and applicability. The general idea relating to this chapter has been published as a position paper in (Rasouli et al., 2015a). In addition, a part of this chapter relating to the architectural analysis step has been published as (Rasouli et.al, 2016b).

Chapter 8: Conclusion. We discuss the core contributions of the research, the practical and scientific implications, limitations of the dissertation, and an outlook onto possible future research.

Part 1

Service Orientation in Business Networking

In this part we describe the characteristics of service-oriented business networks (SBNs). This provides a basis for the next steps of the research by clarifying characteristics of service orientation in business networks (BNs). In this part we address the following research questions:

Research Question 1- What are the characteristics of SBNs that aim to co-create integrated solutions with customers?

An integrated framework is developed to answer this question. Based on a design science research approach, the development of the integrated framework is conducted in two phases; the construction phase and the evaluation phase. The construction phase is presented in Chapter 2. The applicability and usefulness of the integrated framework is evaluated in Chapter 3.

Chapter 4 addresses the Sub RQ1-1 by clarifying how the characteristics of SBNs can be realized through agile operating and partnering. In this way, this chapter bridges between the characteristics of SBNs and the next chapters of the thesis that concentrate on governing information assets in support of agile operating and partnering for co-creating integrated solutions. The capabilities enabling BNs to realize the characteristics of SBNs are addressed based on a dynamic capabilities perspective in Chapter 4.

2

A Framework to Characterize Service Orientation in Business Networking

Chapter 2

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Globalization of operations and markets has intensified competition between business networks (BNs) rather than between single organizations. BNs in this competitive environment need to co-create highly customized integrated solutions with customers through dynamic collaborations within value networks. Different theories have been developed in marketing and operations management to address this need for service orientation through co-creating mass-customized integrated solutions. However, to date, an inclusive and coherent view on the characteristics of a service-oriented business network (SBN) has not yet received sufficient attention.

In this chapter, we intend to present and discuss an integrated framework that brings together different service orientation related theories and describes them in a structured way. The development of this integrated framework is based on a cybernetic system view on different aspects of business networking as well as the distinction between a demand chain and a supply chain dimensions within value chains. This results in three two-dimensional matrices that together provide an inclusive and coherent view on service orientation in business networking.

In this chapter we first explain the need for the development of an integrated framework to characterize service orientation in BNs; see Section 2.1. We then describe the approach used to develop this framework in Section 2.2. The developed framework is represented in Section 2.3. The chapter concludes with a discussion on the integrated framework that has been developed in Section 2.4.

2.1 Introduction

Competition in globalized markets has forced organizations to focus on their core competencies and outsource other activities (Kothandaraman and Wilson, 2001; Ritter et al., 2004). This highlights the importance of business networking to achieve competitive advantage in globalized markets (Gereffi et al., 2005). Business networking can be defined as the organization and management of IT-enabled business relationships with internal and external business partners (Alt et al., 2000). Partners collaborating within a business network (BN) can be “mainly autonomous, globally distributed, and heterogeneous in terms of their operating environment, culture, social capital and goals, but, they collaborate to (better) achieve common or compatible goals” (Camarinha-Matos et al. 2009).

In globalized markets, competition is between business networks (BNs) rather than single organizations (Zhang, 2006). Meanwhile, the empowerment of customers in globalized markets has shifted the focus of BNs from producers and retailers to buyers and users (Christopher and Ryals, 2014). Information-enabled customers, who are globally connected within customer communities supported by social media technologies, have forced BNs to put more emphasis on improving customers’ experiences (Aral, Dellarocas, and Godes; 2013). In addition, deeper collaboration among parties within networked e-business structures enables BNs to collaboratively innovate and produce new products and services (Emden, Calantone and Droge, 2006).

Business intelligence in the light of “big data” technologies shortens time to market and enables greater specificity of value proposed to customers (Chen, Chiang, and Storey, 2012). In this environment, BNs require co-creating mass-customized integrated solutions with customers through deeper interactions within value networks in order to rapidly respond to sensed market opportunities (Pine, 1999; Gaiardelli, Martinez, and Cavalieri, 2015). This situation highlights that service orientation in BNs is a necessity to survive in the current global business environment (Gebauer, 2008; Jacob and Ulaga, 2008; Christopher and Ryals, 2014).

A service-oriented business network (SBN) can be described as a collaborative network of independent parties that together offer a mass customized package of products and services in the form of an integrated solution through the co-creation of value with customers (Storbacka et al., 2013; Rasouli et al., 2014). The co-creation of an integrated solution has been addressed by emerging theories in the context of marketing (Vargo and Lusch, 2004), operations management (Neely, 2007; Gebauer, 2008; Roy et al., 2009; Meier et al., 2010), and information systems (Goldman et al., 1995; Sambamurthy et al., 2003; Grefen et al., 2009b). These theories have been used in recent research to develop service-oriented businesses (e.g. (Kindström, 2010; Storbacka, 2011; Lüftenegger, 2014)). However, many of these studies rely on service orientation within a single organization. An inclusive view on service orientation in the context of BNs has not been given sufficient attention. In the majority of cases, service orientation has been examined from a single organization point of view and BN aspects of service orientation such as cross-organizational interactions or network governance for service orientation have not been explicitly addressed (Löfberg et al., 2015). Meanwhile, related research in the context of BN has generally focused on a specified set of activities within a whole value chain such as new service development (Eisingerich et al., 2009; Spring and Araujo, 2013), operations and logistics management (Lockett et al., 2011; Durugbo and Riedel, 2013), or value proposition (Jaakkola and Hakanen, 2013; Mencarelli and Rivière, 2014). However, an inclusive view comprising all activities within a value chain in a BN is lacking.

The purpose of this chapter is to provide an inclusive and coherent view on service orientation in BNs. According to the RQ1, we intend to "*inclusively and coherently describe the characteristics of a BN who is aiming to co-create integrated solutions with customers".* The inclusiveness points out considering different theories that underline service orientation within different activities of a whole value chain in a BN. In this way, the inclusiveness of the framework ensures that different dimensions of service orientation are considered within a value chain. The coherence refers to the investigation of service orientation in BNs from different relevant aspects in a structured way. Therefore, the coherence of the framework indicates that different relevant aspects of service orientation are consistently addressed. This inclusive and coherent characterization contributes to knowledge in the context of BNs by providing a well-established basis that brings together different service orientation theories such as service dominant logic and servitization theories. It also bridges the gap between the descriptive theories on service orientation and prescriptive approaches for designing networked business models (e.g. see (Lüftenegger, 2014)). From a practical point of view, this characterization provides a well-structured insight for decision makers in BNs to analyze their situation regarding service orientation and also to investigate their service orientation transition. The coherence of this characterization can enhance the alignment of different service orientation decisions.

In order to support the coherence and inclusiveness of the desired integrated framework, we base the development of the integrated framework on two foundations. The first foundation supports the coherence view on different aspects of service orientation in BNs. The second foundation ensures considering different dimensions of service orientation within a whole value chain. These two foundations are elaborated further in the next section.

2.2 Approach used to develop the integrated framework

In order to develop an integrated framework that coherently and inclusively describes SBNs, we are guided by two foundations. The first foundation, addresses using a cybernetic system view (Von Bertalanffy, 1956) on a phenomenon, which enables us to have a coherent view on different aspects of a BN. Due to inter-relationships among aspects proposed by a cybernetic system, this foundation supports alignment within service orientation transition by offering a coherent view on different related aspects. The second foundation highlights the distinction between supply chain and a demand chain dimensions within a value chain, which supports the inclusive characterization of different relevant service orientation theories, such as new service development, service-oriented operations, and service-oriented marketing in the context of BNs. In this way, the first foundation results in three different aspects that need to be taken into consideration in the characterization of SBNs. The second foundation addresses two different dimensions of service orientation that can be taken into consideration within each aspect of SBNs.

2.2.1 A cybernetic system view on BNs

System engineering approaches provide a well-established basis to analyze complex phenomena in a structured way (Von Bertalanffy, 1956). With respect to the complex nature of BNs (Borgatti and Foster, 2003), system engineering approaches can provide a relevant analytical basis when examining BNs. Different methods have been proposed for system engineering like object-oriented methods and viewpoint based methods (Hull et al., 2010). According to the purpose of this research, viewpoint based methods provides a well-established basis to derive relevant aspects for analyzing a BN in a structured way. These methods are established upon recognition of different aspects in order to separate various concerns regarding a system. In this research we rely on aspects suggested by the cybernetic system engineering approach (Marca and McGowan, 1987). The logic behind the aspects suggested by the cybernetic system engineering method helps us to establish a coherent view on a BN. This method also provides a well-established basis for the analysis of interrelationships between the identified aspects. More precisely, the coherence of the aspects proposed by cybernetic systems theories supports the coherence of the aspects used

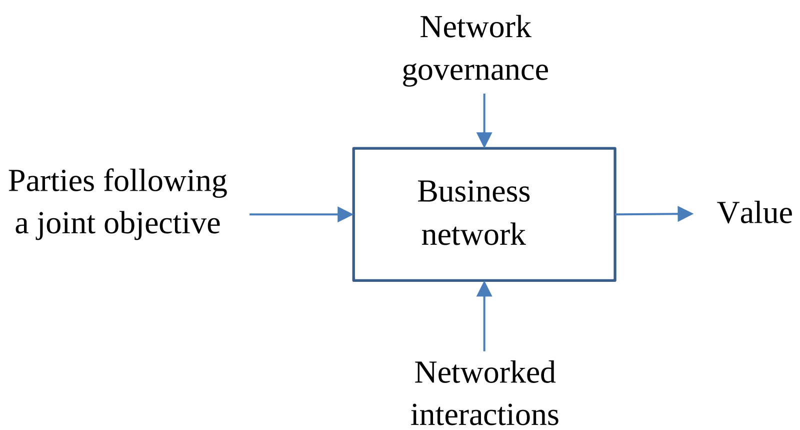

Figure 2.1- The cybernetic system based representation of the BN aspects

for the characterization of SBNs in this chapter.

The cybernetic system approach distinguishes between four main aspects of a system including input, output, supportive mechanism, and control (Marca and McGowan, 1987). Based on these four main aspects, we should determine concrete aspects to explore a BN. In other words, we should refine aforementioned four aspects for the context of a BN. This refinement determines aspects that are critically important in the context of BNs. The inputs of a BN are interacting parties who follow a joint objective (see the definition of BNs by (Borgatti and Foster, 2003) that concentrates on interacting parties as the basis for the forming of BNs). In this research we intend to explore the characteristics of a BN and not organizations forming it. Therefore we do not consider the input aspect in this research. The output of a BN is value that is produced and created for customers (Grönroos, 2011).

A BN is established upon interactions between interdependent parties (Provan et al., 2007). Therefore we focus on networked interaction as a critical supportive mechanism. Networked interactions among collaborating parties can be on a strategic or an operational level (Camarinha-Matos and Afsarmanesh, 2005). Networked interactions at a strategic level can be seen as sharing knowledge among collaborating parties. This knowledge sharing may include developing new collaborative products or services (e.g. see (Emden, Calantone, and Droge, 2006)). Operational interactions among collaborating parties can be seen as composing operational capabilities provided by different collaborating parties in order to provide a proposed value for a customer (e.g. see (Grefen et al., 2009)).

In line with previous research (Zaheer and Venkatraman, 1995; Jones et al., 1997) we reflect the control aspect of a BN by the notion of "governance". Network governance involves formal and informal bindings to adapt a network to environmental changes and to coordinate and safeguard interactions between parties (Jones et al., 1997). Within the network governance aspect we concentrate on governing inter-organizational interactions in SBNs. Therefore we do not address governance issues within boundaries of a single organization.
Using the cybernetic system based representation of a system, we distinguish between three aspects of a BN: the value, the inter-organizational interactions, and the network governance (see Figure 2.1).

2.2.2 Demand chain and supply chain dimensions within value chains

We rely on a value chain as a basis to address different activities in BNs in order to support an inclusive view on service orientation. More precisely, as value chains describe different activities to produce and create value inclusively (Grönroos, 2011), it enables us to thoroughly investigate service orientation within different dimensions. In this way, to explore service orientation within each of the described aspect of BNs, we distinguish between two dimensions of value chains: a demand chain dimension and a supply chain dimension. The distinction between these two different dimensions within BNs has been demonstrated previously (Jüttner et al., 2010; Hilletofth, 2011; Christopher and Ryals, 2014). Based on the value chain framework (Porter, 2008), the demand chain dimension of a value chain embraces the marketing, sales and customer relationship management activities. These activities respond to the need for understanding, creation and simulation of customer demand (Hilletofth et al., 2009). These activities can be reflected by the "value creation" notion in the marketing context (Grönroos, 2011).

The supply chain dimension, on the other hand, includes inbound logistics, operations and outbound logistics activities and aims to fulfill the customer demand (Jüttner et al., 2010). These activities that aim to fulfill demand (Christopher and Ryals, 2014) can be reflected by the "value production" notion (Svensson and Grönroos, 2008). Although the integration of these two dimensions within BNs is a crucial task, many argue that it is inevitable to strategically focus on one of these two dimensions (Jüttner et al., 2010; Hilletofth et al., 2009). Therefore, a BN needs to balance between these two dimensions within its service orientation transition.

In order to develop the desired integrated framework, we rely on the described three aspects of a BN as well as two dimensions of value chains. The two dimensions of service orientation (i.e. demand and supply chain dimensions) are elaborated for each of the three aspects of BNs (i.e. value, interaction, and governance). This approach leads to three two-dimensional matrices: service-oriented value, service-oriented networked interaction and service-oriented network governance. These three matrices, as an integrated framework, aim to characterize service orientation in a BN in a coherent and inclusive manner.

2.3 Development of the integrated framework to characterize service orientation in BNs

Based on the described aspects and dimensions, we develop the integrated framework in the form of three two-dimensional matrices. These three matrices together are called the integrated framework because they coherently describe different inter-related relevant aspects of SBNs. Each of the matrices elaborates a particular aspect of BNs (i.e. the value aspect, the networked interaction aspect, and the network governance aspect). Within each matrix, service orientation in a demand chain dimension and a supply chain dimension are elaborated separately.

2.3.1 Value aspect of service orientation in BNs

The concept of "value" is elusive and is conceptualized in different ways in the literature (Woodall, 2003). According to the described dimensions within value chains, we distinguish between a demand chain and a supply chain perspective on "value". This distinction has been considered in the context of marketing and operations management (Humphreys and

Grayson 2008; Cova, Dalli, and Zwick 2011; Grönroos and Voima 2013).

A demand chain perspective on value, originating from customer related processes, relies on the creation of value (Grönroos, 2011). Value creation can be defined as “process through which the customer becomes better off in some respect” (Svensson and Grönroos, 2008). On the other hand, the supply chain perspective, which originates from supply related processes, reflects the “production” of a value. The production highlights all activities required to design, manufacture, and deliver a product or service. The value production addresses the fulfillment of the value that is created by a customer (Christopher and Ryals, 2014). In this way, value creation can be seen as a marketing function, where value production is a supply chain function (Svensson and Grönroos 2008; Christopher and Ryals, 2014).

A BN should support activities relating to the both aforementioned dimensions, i.e. the value production and the value creation. A BN should produce a product or service and create value for customer during the usage of a product or service. However, regarding the theories in marketing and operations management contexts, service orientation within each of dimensions (i.e. value creation and value production) reflects different service orientation transitions. The distinction between service orientation within the value creation and the value production dimensions has also been addressed in previous research which investigates different service transitions (e.g. see (Kowalkowski, 2010; Leseure et al., 2010; Gaiardelli et al., 2014)). Based on this distinction, service-oriented value within the two dimensions is elaborated separately in the following paragraphs (see Figure 2.2).

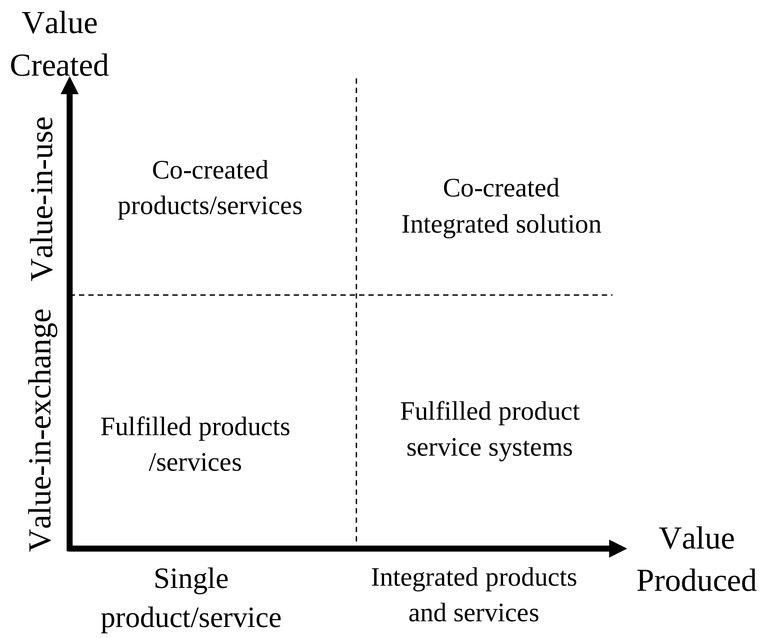

Figure 2.2- The characterization of the value aspect in SBNs

Service orientation within the value creation dimension highlights the service dominant (S-D) logic of marketing (Vargo and Lusch, 2004) and focuses on the creation of value by customers. The S-D logic states that value always is determined by customers in the form of value-in-use. The concept of value-in-use refers to value is created by a customer during the use of a service or product(Grönroos and Voima, 2013). This is contrary to the good-dominant (G-D) logic of marketing which views value from the supplier perspective as an economic benefit that is gained from a product or service fulfilled (i.e. value-in-exchange).
Hence, it can be concluded that service orientation within the value creation dimension leads to the shift from a supplier-centric view on value (i.e. value-in-exchange) to a customer-centric view (i.e. value-in-use); see Figure 2.2, co-created value axis. Service orientation in this direction is in line with the shift from focusing on the fulfillment of a product or service, for example through conventional supply chain processes, towards concentrating on co-creating value through deep understanding of desired value by a customer (Christopher & Ryals, 2014).

According to the S-D logic, which indicates that value is created by customers, the role of a supplier is not only in the delivery of a product but also to facilitate its use by a customer (Grönroos and Voima, 2013). In this way, the S-D logic highlights the interaction of customers and suppliers during the usage of product or service that is reflected by the value co-creation construct.

Service orientation within the value production dimension highlights the shift from the fulfillment of a product (or service) to fulfillment of its utility (Mont, 2002). In this way, service orientation stresses the servitization (Vandermerwe and Rada, 1989; Roy et al., 2009) and product service system (PSS) theories (Tukker and Tischner, 2006). These theories emphasize the importance of providing "marketable set of products and services capable of jointly fulfilling a user's need" (Goedkoop, 1999; Roy et al., 2009).
This dimension of service orientation is largely motivated by the need to cope with changing market forces and the recognition that services in combination with products could provide higher profits than products alone (Mont, 2002). Service orientation within this dimension can be realized within two main directions:

- Time based extension of provider responsibility: from product/service delivery towards product lifecycle management (PLM);
- Risk based extension of provider responsibility: from output oriented towards result oriented responsibility.

This dimension of service orientation is established following the development of supply chain capabilities to provide more integrated package of products and services that enhance their utilization for customers. This may include new product and service innovation, agile manufacturing, and maintenance. Hence, this dimension of service orientation leads BNs to fulfill integrated products and services, see Figure 2.2, the value produced axis.

The combination of the two aforementioned dimensions of service orientation within the value aspect can be addressed by the integrated solution notion. The notion of the integrated solution addresses a situation where a value in the form of integrated products and services is co-created by customers (Brady et al., 2005, Gummesson et al., 2012b). The provision of integrated solutions requires the interaction between customers and suppliers within the whole value chain encompassing supply chain and demand chain activities.

2.3.2 Networked interaction aspect of service orientation in BNs

The most important supportive mechanism enabling a BN is the interaction between collaborating parties (Provan et al., 2007). According to the described value aspect of SBNs, we distinguish networked interactions in a BN within a demand chain and a supply chain dimension. The demand chain dimension focuses on the customer-supplier interaction in the BN. The supply chain dimension, on the other hand, focuses on supplier-supplier interactions (see Figure 2.3). Customer-supplier interaction can be seen as interactions of business parties within a value network with customer communities (e.g. see interactions desribed in (Romero and Molina, 2011)). Supplier-supplier interactions refer to inter-organizational interactions among collaborating parties (e.g. see inter-organizational interactions addressed in (Mehandjiev and Grefen, 2010)).

Service orientation within the demand chain dimension, in line with the S-D logic of marketing, relies on the shift from transactional customer-supplier interactions towards relational interactions (Ballantyne and Varey, 2006) (see Figure 2.3, vertical axis). Transactional interactions, as a pre-dominant logic of marketing, are product oriented and aim to fit customers to a product. The transactional paradigm of marketing is based on

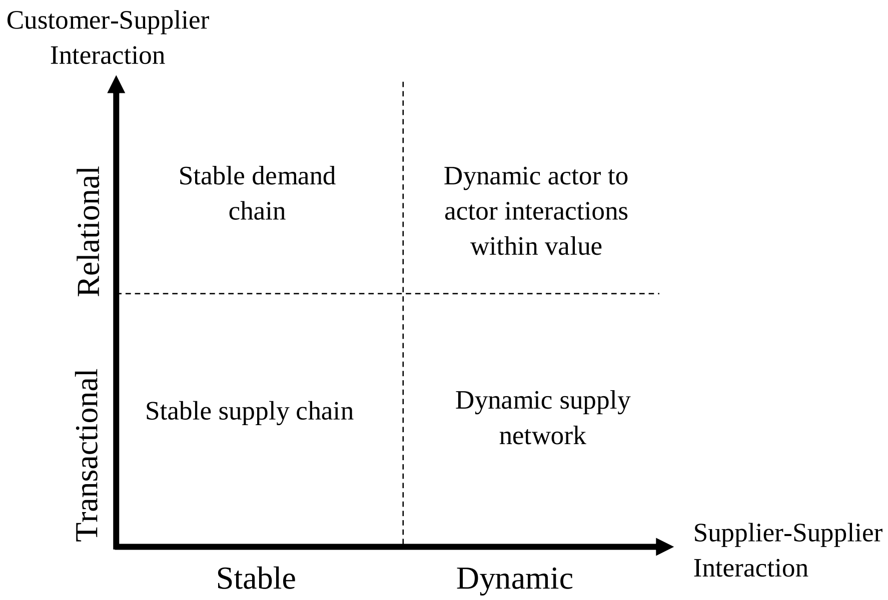

Figure 2.3- The characterization of the networked interaction aspect in SBNs

attracting a customer to buy a product. However, relational customer-supplier interactions, which are considered as the basis of the new dominant logic of marketing, can be seen as on-going processes supporting the creation of perceived value for a customer (Grönroos, 1997; Ballantyne and Varey, 2006). The relational view, instead of trying to fit a customer to a pre-determined product or service, aims to provide a better experience for a customer during the use of a product or service. In this way, the relational interaction largely focuses on the value co-creation processes that facilitate mutual contact between suppliers and customers (Prahalad and Ramaswamy, 2004b; Payne et al., 2008). This concentration on fulfillment of value, which is co-created by customers, shifts BNs from product-oriented supply chains towards value-centered demand chains (Christopher and Ryals, 2014; Heikkilä 2002); see Figure 2.3, the customer-supplier interaction dimension. A value-centered demand chain is organized to deeply understand a desired value among customers through value co-creation processes. It also aims to fulfill a co-created value by orchestrating capabilities distributed among collaborating parties in a BN.

The supplier-supplier networked interaction in the context of SBNs should support the provision of integrated products and services (see Figure 2.2). The provision of integrated products and services means that a BN needs to be enriched (Gebauer et al., 2013; Storbacka et al., 2013). This enrichment results from the need for new products and services as well as the need for the full support of a product or service during its life cycle. On the basis of the core competency theory (Prahalad and Hamel, 1990), the enrichment of a BN can be achieved by adding new parties with diverse competencies. However, this diversification of suppliers raises the complexity of interactions between them (Gereffi et al., 2005). This complexity should be reduced by developing technical and process standards within a BN (Grefen, 2013). Networked interactions between suppliers, which are supported by standardization, increase the modularity of a BN (Sturgeon, 2002). The BN modularity enables different suppliers to be linked and un-linked, resulting in dynamic interactions between suppliers (Grefen et al., 2009b; Rasouli, 2015b). In this way, it can be argued that the service orientation within the supply chain dimension, which addresses the provision of integrated products and services, leads to dynamic interactions between suppliers. This means that service orientation shifts stable relationships between suppliers in a product-oriented supply chain, towards dynamic interactions between suppliers in SBNs; see Figure 2.3, the supplier-supplier interaction dimension.

The combination of the both described dimensions of service orientation within the networked interaction aspect of a BN can be reflected by the value network concept. Value networks are modular suppliers who are loosely coupled and co-produce and co-create integrated solutions with customers (Lusch et al., 2010). This situation extends the interaction between customers and suppliers from demand chain activities (i.e. co-creation) to also include supply chain activities (i.e. co-production). This means that highly activated customers are perceived as partners within the supply processes of a product or service and have the role of the co-innovator, co-designer, co-manufacturer, and co-marketer (Romero and Molina, 2011). This results in a situation where all actors, including suppliers and customers, interact together to 'create value for themselves and others through reciprocal resource integration and service provision' (Vargo and Lusch, 2011).

2.3.3 Network governance aspect of service orientation in BNs

Governance of a BN refers to the adaption, coordination and safeguarding of interactions between collaborating parties (Jones et al., 1997). The adaption of interactions between actors is necessary due to environmental uncertainty, such as change in customers' requirements. Coordination refers to the asset specific exchanges between actors. In the context of BNs, coordination can be described as the management of inter-organizational processes to provide a product or a service to customers. Since actors within a BN share their assets together, safeguarding is necessary to prevent issues such as opportunism (Zaheer and Venkatraman, 1995).
The demand chain dimension of value chains focuses on the fit between BN abilities and customer expectations. Therefore its main focus is on highlighting adaption issues within the network governance aspect. However, the supply chain dimension of value chains, which underlines the interactions between suppliers, emphasizes coordination issues (see Figure 2.4).

As discussed within Figure 2.2 and 2.3, service orientation in demand chain dimension refers to the shift from viewing value from a suppliers' perspective (as value-in-exchange) towards viewing value from a customers' perspective (as value-in-use). This emphasis on the role of the customer results in a growing emphasis on customer-centered adaption of a BN rather than supplier-centered adaption (see Figure 2.4, vertical axis). This shift can be described as the difference between the internal and external legitimacy of a BN (Human and Provan, 2000; Provan and Kenis, 2008). The internal legitimacy that is supplier-centered endeavors to adopt a BN in a way that encourages suppliers to continue the participation within a BN. In contrast, the external legitimacy is customer-centered and tries to adopt a BN in a way that enhances the viability of customer interactions.

The supply chain dimension of the network governance aspect emphasizes the coordination between suppliers collaborating to provide integrated products and services. Within a stable supply chain that provides a single product or service, the focus of coordination would be on efficiency rather than innovativeness for the development of new products and services (Christopher, 2000; Gereffi et al., 2005; Provan and Kenis, 2008). In this case, coordination of interactions among suppliers is focused mainly on decreasing the cost of the product or service provision by eliminating unnecessary costs. Centralized coordination using formal mechanisms can be more appropriate for these types of BNs (Provan and Kenis, 2008). The formal mechanisms to coordinate interactions can be based on the standardization of interactions between parties (Wilding et al., 2012) or predefined contracts (Provan and Kenis, 2008). However, provision of integrated products and services requires additional collaborating partners as well as dynamic interactions among them (see Figure 2.3). The aim

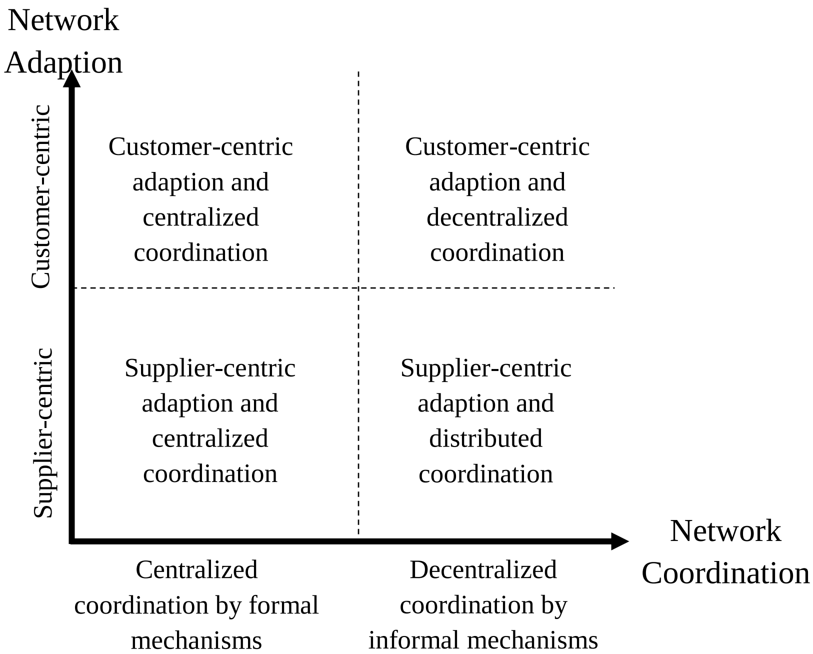

Figure 2.4- The characterization of the governance aspect in the SBN

of this type of BN is responsiveness by the provision of innovative products and services. Regarding the dynamic interactions between parties to provide a more complete package of products and services, a decentralized structure of coordination can be better fit with this type of BNs (Andersen and Christensen, 2005) (see Figure 2.4, horizontal axis). The aim of the decentralized coordination in this type of BNs is to share mutual knowledge in order to innovate and develop new products and services. In such contexts, interactions between parties do not have to be governed by formal mechanisms (Macaulay, 1963). Instead, participation, communication and trust are the key informal mechanisms that can be used more effectively (Joshi and Stump, 1999).

The two dimensions of network governance in SBNs imply that a SBN that is adapted based on customer experience can be coordinated in a centralized or distributed manner. A centralized coordination in customer-centered adapted SBNs, describes a structure in which a specified actor, who is responsible for customers' experience, centrally orchestrates all resources provided by collaborating parties to fulfill expected customers' experiences. A decentralized coordination of customer-centered SBNs refers to a structure that all collaborating parties are able to choreograph resources provided by collaborating parties in order to fulfill expectations of customers who interact with them (see (Grefen and Dijkman, 2013) for more details). The combination of both dimensions of service orientation within the network governance aspect reflects a situation where customers are active actors within a value network and orchestrate the services offered by other actors (including suppliers and customers) to shape the best experience for them. In other words, regarding the actor-to-actor interactions within a value network, all actors can be seen as orchestrators who each try to create the best experience for themselves.

2.4 Discussion

The three matrices described in this chapter can be seen together as an integrated framework that coherently and inclusively characterizes different aspects of service orientation in business networking. The coherence of the developed framework addresses different inter-related aspects of business networking that supports the alignment between different decisions relating to service orientation. The inclusiveness of the developed integrated framework points out considering different service orientation theories from different relevant contexts that are described in a structured way.

According to the developed framework a SBN is described as a dynamic customer-centric collaboration among parties to co-create integrated solutions with customers. Based on the description of service orientation in BNs, as described within the described matrices in Section 2.3, we summarize the characteristics of SBNs in Appendix A. According to the developed framework, these characteristics are classified within three aspects including the value, networked interactions, and governance and two dimensions including the demand chain and supply chain dimensions. The summarized characteristics highlight the critical changes that need to be conducted by BNs within service-orientation transitions.

The inter-relationship between the three matrices indicates that an alignment between service orientation transitions within different aspects is required. This means that, for instance, the provision of the co-created product or service would not be possible without relational interaction with customers and customer-centric network adaption.

The proposed integrated framework provides a well-established basis to investigate the alignment between different aspects within service orientation transitions. In this way it can bridge the gap between descriptive knowledge in the context of marketing and operations management and prescriptive knowledge in the BN engineering context. The integrated framework developed in this chapter can direct applying prescriptive business modeling tools (e.g. (Lüftenegger, Grefen and Weisleder, 2012; Lüftenegger, Comuzzi and Grefen, 2013)), networked business process management approaches (e.g. (Mehandjiev and Grefen, 2010)), and network governance engineering frameworks (e.g. see (Lankhorst et al., 2009)). This direction ensures that a service orientation transition in a BN is consistent from different relevant aspects.

As described in the previous paragraph, the developed framework, as an abstract framework bridges between descriptive knowledge on service orientation in BNs and prescriptive knowledge to design BNs. But, it does not directly propose concrete designing tool to engineer SBNs. In order to link the high-level conceptual characterization of SBNs with more concrete specifications of SBNs, we summarize high-level characteristics of service orientation in BNs, which are derived from the developed framework, within Appendix A. Characterization of service orientation in BNs, as described within appendix A, is a useful basis for future research to concentrate on the specification of concrete scales and measures of SBNs.

The developed framework does not provide a concrete set of measurable characteristics for SBNs. However, it provides a well-established basis supported by relevant theories to inclusively and coherently characterize SBNs in a high-level of abstraction. The abstraction of the developed framework supports the desired attributes as an inclusive and coherent framework to bring together different service orientation related theories originated in different contexts. But, this abstraction limits its ability to specify concrete and detailed characteristics of SBNs. Therefore, the developed framework provides a conceptual basis that brings together different service orientation related theories in a structured way. But, it does not specify concrete measurable scales for operational assessment and implementation of SBNs. More precisely, the developed framework can be used as a well-established basis to provide inclusive and coherent insights on the characteristics of service-orientation for strategic decision makers in BNs. It also can provide a useful basis to discuss service-orientation transitions in BNs. But, it cannot be used as a concrete tool that provides specific scales and measures for the operationalization of SBNs.

Our integrated framework eases applying service orientation theories to engineer real-life SBNs. However, it does not prescribe certain initiatives for service orientation. Therefore, although this integrated framework cannot be seen as an SBN engineering tool, it can support an SBN engineering process by providing an inclusive view on relating theories and aligning between different related aspects. It can be used in different industries and business contexts due to the nature of the developed integrated framework, as it does not prescribe context-centric initiatives.

This integrated framework can also provide well-structured insights for decision makers in BNs to respond to the need for offering highly customized integrated solutions to customers. This well-structured insight enables decision makers to view to different aspects of service orientation transitions coherently. The developed integrated framework is an excellent basis for bringing together the service orientation concerns of practitioners in different functional business domains. While people in the marketing domain have concerns about the value proposition and customer relationship management, those in operations management domain may worry about the issues such as how to design and implement intra and inter-organizational business processes in an effective and efficient way.

The majority of senior BN executives are concerned about governance issues. This refers to maximizing the value within the network, sharing the risks and rewards between parties, and protecting the BN against internal and external threats. Our integrated framework provides a basis where all concerns can be considered coherently, in order to make a well-established decision regarding service orientation transitions. Meanwhile, since a BN includes different parties from different contexts with various terminologies, the developed integrated framework can also provide a well-defined terminology for decision makers. The applicability and usefulness of the developed integrated framework for directing service orientation transitions within real-life SBNs are investigated in the next chapter of the thesis.

Each position within the developed integrated framework implies certain value and risk for a BN. Although service orientation needs to support achieving competitive advantage in globalized markets, this also results in emerging risks for BNs. These risks can be the consequence of different characteristics of SBNs. For example, dynamic interactions between parties within a BN can cause information quality problems such as information insecurity and syntactic and semantic interoperability problems. In addition, using the customer experience to develop new products and services (i.e. co-production) can result in privacy issues.

Because of these emerging issues, decision makers need to make trade-offs between market forces to be more service-oriented and risks resulting from this service orientation. Many of the mentioned risks are related to information assets within a BN because service orientation emphasizes the formation of information-intensive interactions. This highlights the need to develop theories further in relation to information and IT governance in dynamic service-oriented collaborations.

The development of concrete measures and scales to facilitate more precise specification and positioning of SBNs on the basis of the developed integrated framework can be a relevant direction for future research. To do this, empirical exploration of the characteristics of real-life SBNs by using case study or survey approaches can enhance the usability and concreteness of the developed framework. Meanwhile, the development of SBN engineering tools that supports designing and implementing service orientation in different dimensions regarding the developed integrated framework can be considered as another relevant research direction.

3

Evaluation of the Framework to Characterize Service Orientation in Business Networking

Chapter 3

Evaluation of the Framework to Characterize Service Orientation in Business Networking

This chapter will evaluate the developed integrated framework used to characterize SBNs. The integrated framework developed in Chapter 2 can be used by strategic decision makers and BN engineers who are responsible for developing network strategy and innovative networked business models. Therefore, we evaluate how the framework can be applied in these contexts and if it provides a useful insight for decision makers when managing service orientation transitions in BNs.

More precisely, the evaluation of the framework will address three areas:

- Provide an inclusive insight for decision makers to analyze real-life BNs from service orientation point of view.
- Investigate service orientation transitions in real-life BNs.
- Enhance alignment between different aspects of service orientation in BNs through a coherent description of inter-related aspects.

For this purpose, we conduct a case study research approach. A case study research compared with other alternative approaches, like a survey approach, enables in-depth exploration of evidence in a situation where boundaries between phenomenon and context may not be clearly evident (Yin, 2013). The case study approach is preferred in this context as the exploration of service orientation transition strongly requires an in-depth understanding of the context of a BN.

The design of the case study research is elaborated in Section 3.1. The collection of the relevant evidences through conducting in-depth interviews is described in Section 3.2. The analysis of the collected evidences is reflected in Section 3.3. In Section 3.4 the findings from the analysis of the case study evidences are reported. This chapter concludes by a discussion on the findings of the conducted case study in Section 3.5.

3.1 Designing the case study research

In this section we firstly elaborate why the case study research approach is most suitable for the evaluation of the developed integrated framework. We then describe the design of the case study research based on the established logic used to evaluate the integrated framework.

3.1.1 Suitability of case study methodology

This research uses a design-oriented methodology that has its roots in engineering (Simon, 1996). Many authors have characterized different evaluation methods that can be used in the design science paradigm (von Alan et al., 2004; Peffers et al., 2007; Venable et al., 2012). These evaluation models can be classified as artificial evaluation models and a naturalistic evaluation models (Venable et al., 2012).

Artificial evaluation includes laboratory experiments, field experiments, simulations, criteria-based analysis, theoretical arguments, and mathematical proof. The dominance of the scientific/rational paradigm brings stronger scientific reliability in the form of better repeatability and falsifiability (Gummesson, 2000). Naturalistic evaluation explores the performance of a proposed solution in its real environment. By performing evaluation in a real environment (real people, real systems, and real settings), naturalistic evaluation embraces all of the complexities of human practice in real organizations. Naturalistic evaluation is always empirical and may be interpretive, positivist, and/or critical. Naturalistic evaluation methods include case studies, field studies, surveys, ethnography, phenomenology, hermeneutic methods, and action research. The dominance of the naturalistic paradigm brings to naturalistic evaluation the benefits of stronger internal validity.

Regarding the nature of the artefact (i.e. the developed integrated framework) that is going to be evaluated in this chapter, the naturalistic evaluation methods are more appropriate. The reason is that the integrated framework developed in Chapter 2 reflects the characteristics of a complex business situation that needs to be understood by business strategists and business modelers. Therefore it needs to be evaluated using empirical evidence gathered via the involvement of target groups of people to evaluate its applicability and usefulness.
Among naturalistic evaluation methods, case study, survey, and action research approaches are the alternative methods to be used in this research. Each of these approaches has both strengths and weaknesses. The action research approach is appropriate when evaluating instantiated artefacts which are usually technological solutions (Venable et al., 2012). So, regarding the socio-technical nature of the developed integrated framework the action research approach would not be fit properly. In addition, the action research approach

requires more time than the two other alternative approaches and does not meet the time limitations regarding the scheduled plan for this research for this thesis.

Among the two other alternative research approaches, a survey's ability to consider the context of the designed artefact is limited as it uses structured questionnaires to gather relevant information for the characterization of a BN (Yin 2013). Limitations of structured questionnaires can severely restrict an in-depth evaluation of the applicability and usefulness of the developed integrated framework in the context of a BN. In this way, a case study approach, which enables a significant consideration the context of the research (i.e. business networking), is the most appropriate approach.

However, the most important drawback of this approach is the difficulty in generalizing the findings from cases. To address this, we use replication logic to enhance generalizability of the findings (Yin 2013). We also rely on an analytical generalization that is supported by underlying relevant theories. More precisely, the theories used to design the integrated framework in Chapter 2 provide a theoretical basis to generalize the findings from the case study.

3.1.2 Designing the case study research

We use a multiple-case design to evaluate the developed integrated framework. The replication logic used in the multiple-case study enhances the generalizability of the findings. We need to select cases in a way that they cover all possible service- orientation transitions in order to investigate the different possible service orientation transitions.

Based on the developed integrated framework three main service orientation transitions can be considered in a BN:

- Service orientation on the horizontal dimension of the developed integrated framework (i.e. the strategic focus is on value co-creation).
- Service orientation on the vertical dimension of the developed integrated framework (i.e. the strategic focus is on integration of products and services).
- Service orientation in a combination of aspects of both dimensions.

Table 3.1- Selected BNs to conduct multiple case study research

Selected BN	Domain	Service orientation Direction
A	quality assurance	Customization of certification schemas regarding the customer requirements
B	document management	Integration of related products and services to provide a complete package
C	financial service (car-leasing)	Co-creation of integrated mobility solution

In line with these three directions for service orientation, we select the three BNs. This means that each of the selected BN focuses on a certain direction to be service-oriented. To select relevant cases we conduct a preliminary analysis in five BNs in the Netherlands. This preliminary analysis is based on the strategic plan of each of these BNs.

Among these five BNs, we select three BNs which we refer to as A, B, and C (see Table 3.1). Two other cases have the same service orientation direction as case A and B. Among the three selected cases, case A is focused on service orientation within the value-co-creation dimension, case B focuses on service orientation within the value production dimension, and case C aims to be service-oriented in the both dimensions. These directions of service orientation for each of the selected BNs are elaborated further in the following section.

3.2 Collecting case study evidence

In this research we gather data from different sources (parties) positioned within each of the selected BNs (multiple cases). To do this, we establish a case study team of 9 members to conduct gathering data from the selected BNs. We develop a set of procedures and rules to be followed to counter the issue of inconsistency within information gathering and to support the reliability of research. The key rules are:

- All interviewers should have a consistent interpretation of the notions used in the developed integrated framework. To ensure this, all interviewers are involved in a joint discussion and share their understanding of the developed integrated framework. In this way, inconsistent interpretations are recognized and a reference interpretation is shared among all interviewers.
- Interviewees should also have a consistent interpretation of the notions used in the integrated framework. For this purpose a brief presentation is prepared to clarify the definitions of the used notions. After the presentation, interviewees are asked to describe their interpretation about the notions that are used. Then, any inconsistent interpretations are recognized and aligned. This rule supports the construct validity of the case study (Yin, 2013).

These rules ensure that the gathered data are not biased by interviewers and terminologies are used in consistent manner during in-depth interviews. To gather relevant evidence we use in-depth interviews (Rubin and Rubin, 2011) and relevant documents.

The in-depth interviews are supported by a pre-defined semi-structured questionnaire that covers the line of inquiry; see Appendix B. This questionnaire consists of six parts, each of which concentrates on a certain dimension of service orientation within each aspect of the integrated framework. To investigate service orientation within each of these six parts we develop two or three questions. Each of these questions addresses a key relevant characteristic and aim to investigate the extent to which this characteristic has been realized in the BNs.

Although the semi-structured questionnaire used for three cases is the same, we customize each by using some examples relating to the context of each case in order to improve clarity of questions in each context.

We aim to gather data regarding the current and the planned situation of the BNs from service orientation point of view. The interviewees we select are employees who are responsible for strategy development, business model innovation, enterprise architecture, or business process management within these BNs. We conduct 26 in-depth interviews. These include 8 interviews within case A, 7 interviews within case B, and 11 interviews within case C.

Since the cases in our research are BNs, through the in-depth interviews our aim is to explore the networked interactions between parties collaborating within the BNs. We triangulate evidences gathered from different parties to ensure the internal validity of the evidences relating to the BNs. To avoid gathering biased evidences, the in-depth interviews in organizations that collaborate within a BN, are conducted independently. This means that the interviewers avoid describing about the thought of other relating parties during the interviews.

3.3 Analyzing case study evidences

To analyze the gathered information for the evaluation of the applicability and usefulness of the developed framework we conduct three steps. These steps are elaborated in the sequel paragraphs.

In the first step, each of the selected BNs is described based on the information gathered. This description includes the identification of final customers of the BNs, products/services offered by the BNs, networked interactions between the parties, and the way that the BN is governed. To ensure the validity of our description on the investigated BNs, we present our descriptions on the BNs for the relating interviewees. Since visualization enhances the representation of interactions within a BN, we use the BPMN[2] conversation diagrams (see (Allweyer, 2010) for more details about this notation). These diagrams provide a standard notation to represent networked interactions among collaborating parties in a BN.

In the second step, we apply the developed integrated framework to characterize service orientation within each of the elaborated BNs. For this purpose, we rely on the evidences

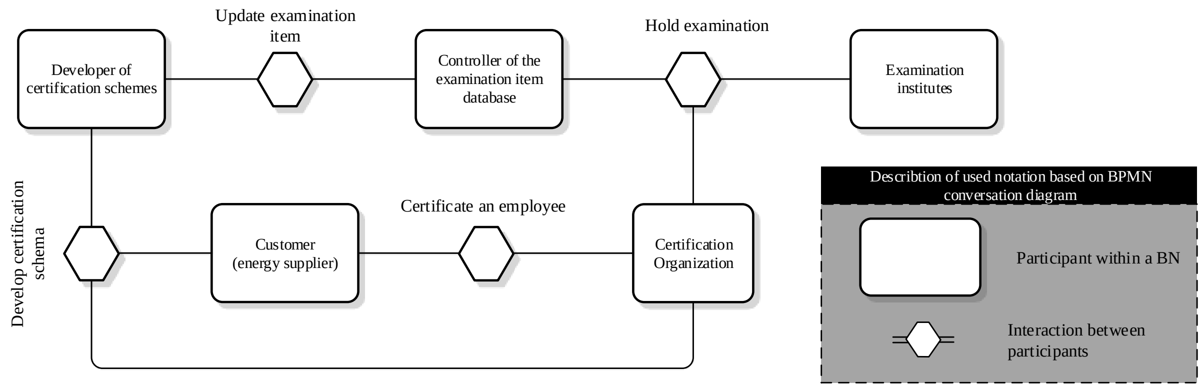

Figure 3.1- The BPMN scheme of case A; parties and interrelations

gathered by using the semi-structured questionnaire during in-depth interviews.

To investigate service orientation within each dimension of the three aspects, we develop three or four relevant questions. Each of these questions addresses a certain service orientation characteristic. This characterization results in the (qualitative) positioning of current and future state of the cases within the developed integrated framework. If this positioning is agreed on by interviewees, we can conclude that the developed integrated framework can be applied in real-life situations to characterize service orientation.

In the third step, we investigate how the characterization of service orientation, using the integrated framework, enables decision makers in these BNs to refine their service orientation plan. This will clarify the usefulness of the integrated framework to analyze service orientation transitions.

To characterize the service orientation, we discuss the current and future position of each of the BNs as well as their service orientation transition plan. Based on these discussions we investigate how the developed integrated framework assists strategic decision makers in real-life situations to refine their service orientation transition. In addition, in order to evaluate the usefulness of the developed framework to align service orientation from different relevant aspects, we discuss the consistency of the service orientation within the networked interactions. We also discuss the governance of the networked interactions that support the provision of value by the BNs.

3.4 Case study research findings

According to the described steps for analyzing the gathered evidences, we represent the results of the case study as follows.

3.4.1 Description of the selected BNs

Case A is a BN involved in the quality assurance domain. Parties collaborating within this BN provide a certification service to ensure the safety of employees who work for energy suppliers in the Netherlands. Customers of this BN are energy suppliers. This BN, which has been organized by a certification company, encompasses five types of parties: a certification organization (i.e. the certification bodies), a developer of the certification schemes, an organization controlling and maintaining the examination item database, examination institutes, and energy supplier organizations. The interactions between these parties within this case are shown in Figure 3.1.

Case B is a BN that provides document management services for companies who deal with large volumes of invoices. This BN is organized by a document management service provider that is a strategic business unit of a large scan/copy device manufacturer. The parties within this BN and the interactions between them are represented in Figure 3.2. This BN aims to integrate different products and services to offer an integrated package of the document management services to its customers.

Case C is a BN in financial services domain. This BN is organized by a car leasing organization. Other parties that participate in this BN are car dealers, car rental organizations, maintainers, fuel service providers, car insurers, and public transportation card providers; see Figure 3.3. This BN currently provides cars for its customers and its

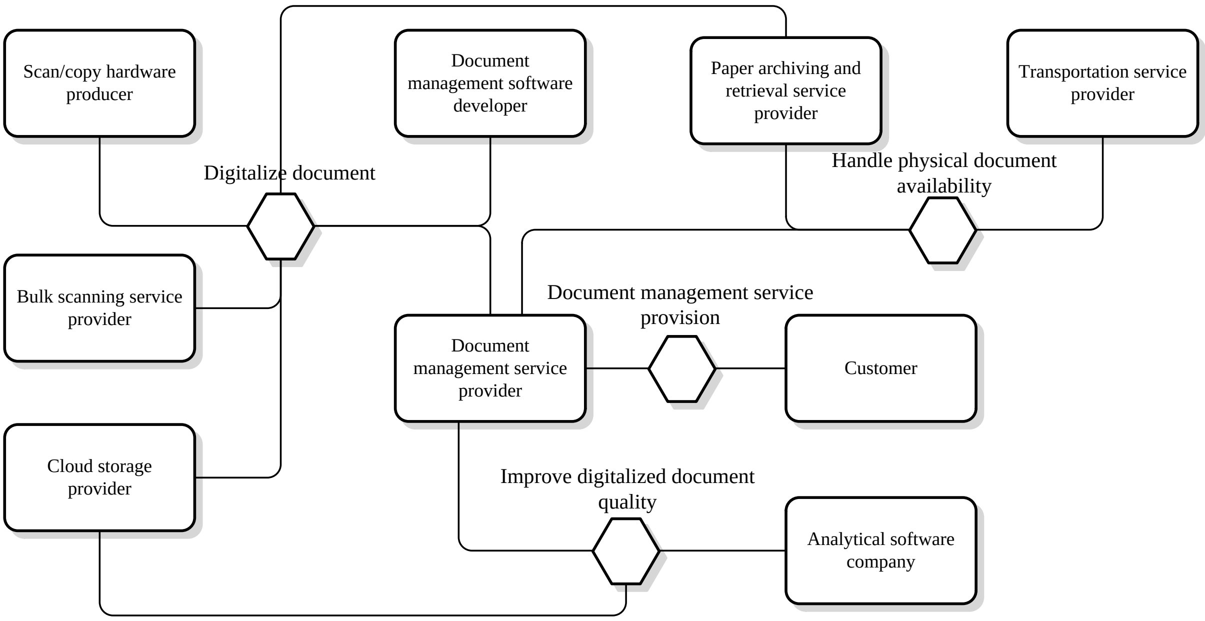

Figure 3.2- The BPMN scheme of case B; parties and interrelations

customers are companies that need transportation facilities. The car leasing organization, as the organizer of this BN, has already planned to move towards the provision of an integrated mobility solution. The integrated mobility solution needs to be co-created by customers based on their personal expectations.

3.4.2 Characterization of service orientation in the BNs by using the developed integrated framework

Service orientation in each of the selected BNs is characterized using the data collected via in-depth interviews. For this purpose, we use the integrated framework that includes three two dimensional matrices (as described in Chapter 2). We characterize service orientation from the three aspects within the value creation and value production dimensions (see Table 3.2). In this way, the investigated BNs are positioned within the developed integrated framework (see Figure 3.4).

Case A.

Value creation: This BN provides a quality assurance service by certifying employees who work in the energy domain. This certification schema should support the requirements of energy suppliers from the safety point of view. Therefore this BN needs to develop different certification schemas, each of which focuses on a certain aspect of safety for a certain type of activity. A dedicated actor within this BN is responsible for developing these certification schemes through the collaboration with other actors, particularly with energy suppliers. Based on this fact, it can be said that services are co-developed in this case (see Figure 3.4, Matrix a, the current position of case A within the value creation dimension).

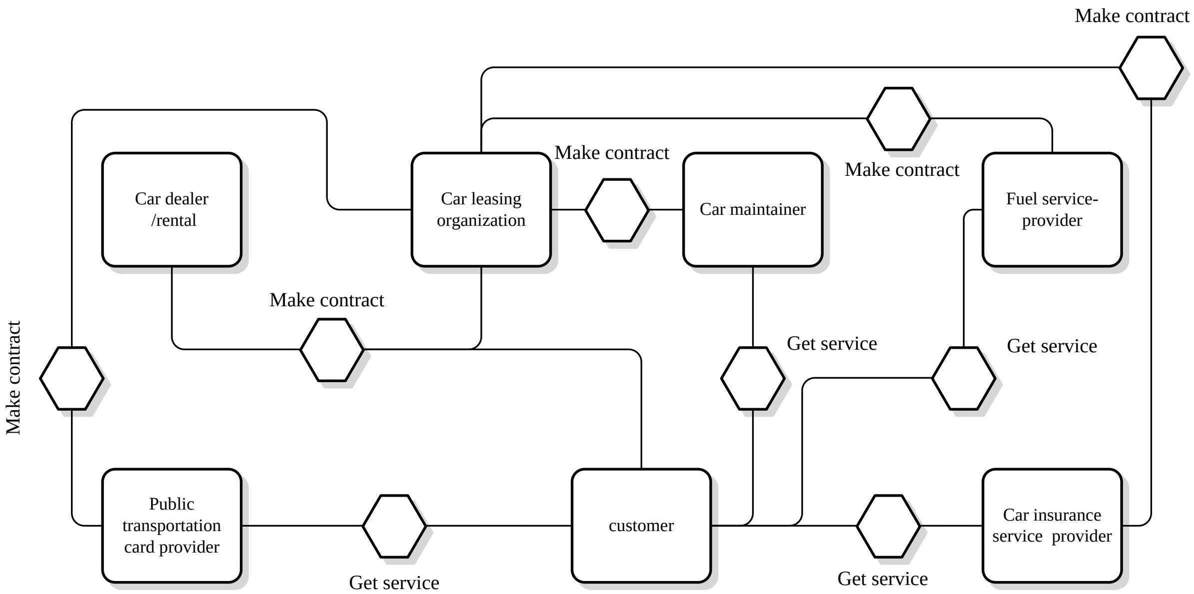

Figure 3.3- The BPMN scheme of case C; parties and interrelations

Table 3.2- The characterization of service orientation in the current state of the three BNs

	Value aspect		Networked interactions aspect		Network governance aspect	
	Value creation	Value production	Supplier-customer	Supplier-supplier	Network adaption	Network coordination
Case A	Co-developed certification schemes	Risks of employees' unsafe behaviors are undertaken by energy suppliers	Energy suppliers interact actively with the certification schema developer	Stable networked interactions	Adapting the certification schemas is based on energy suppliers' requirements	Centrally coordinated by the certification schema developers and the certification organizations
Case B	Semi-uniformed document management services	An integrated package of products and services relating to document management	Transactional interaction based on steady contracts	Stable collaborations within semi-fixed networked business processes	Scan/copy technology centered adaption	Central coordination by the document management service provider
Case C	Product oriented car lease	Risks of usage of car is handled by customers	CRM does not support customer-centric value propositions	Stable partnership	Lease rate centered adaption	Central coordination by the car lease organization

This BN has planned to develop new certification schemes to respond to energy suppliers' needs. Energy suppliers require more specific certification schemes to cover safety aspects for certain jobs. However, due to limitations of formal accreditation boards (Dutch Counsel for Accreditation), this BN has to aggregate similar certification schemes. This aggregation of certification schemes limits the possibilities for more customized certification schemes.

Value production: During a certification period of three years, certification holders need to keep track of any safety problems, faults, and risks. However, the responsibility for extra training and examination is undertaken by energy suppliers as customers of this BN. In this way, this BN is not directly responsible for providing added service during the certification life-cycle. In addition, the certification holders are employed by an energy supplier and all risks related to unsafe behavior of a certification holder are borne by energy suppliers. Therefore, it can be concluded that this BN is focused on a single service and has currently no plans to extend this service from the life-cycle or risk point of view (see Figure 3.4, Matrix a, the current and future position of case A within the horizontal axis).

Supplier-customer networked interactions: Energy suppliers as customers of this BN interact actively in the development of the certification schemes. However, the interaction during other stages of the certification processes (e.g. planning and examination) is limited. The certification organizations and the examination institutes aim to involve the energy suppliers in scheduling and delivering the examinations (See Figure 3.4, Matrix b, the current and future position of case A within the vertical axis).

Supplier-supplier networked interactions: Due to the established links between parties within this BN, many prefer to work together and so interactions are quite stable. There is no plan to expand this BN by adding new parties (See Figure 3.4, Matrix b, the current and future position of case A within the horizontal axis).

Network adaption: The adaption of the certification schemes is heavily based on energy suppliers' requirements. Energy suppliers do not have a considerable role in scheduling and holding of the exams. However, the certification organizations, together with the examination institutes, plan to involve the HR departments of energy suppliers in the scheduling of examinations (See Figure 3.4, Matrix c, the current and future position of case A within the vertical axis).

Networked coordination: The coordination role within this BN is shared between the certification scheme developers and the certification organizations. The certification scheme developers coordinate parties to develop and improve the certification schemes; while the certification organizations coordinate parties during the examination activities. This BN currently has no plans to change this coordination structure (See Figure 3.4, Matrix c, the current and future position of case A within the horizontal axis).

Case B.

Value creation: This BN provides semi-uniform document management services for customers from different domains. This means that this BN does not consider the specific characterization of documents in each domain. Although different customers ask this BN to manage different types of documents, the process of document management is approximately the same. The customization in this case is limited to some technical adjustments. Therefore this BN is not focused on the co-creation of value and the majority of what it delivers is pre-defined and uniform services. This BN also has no plan to focus specifically on customer requirements, because decision makers believe that the established uniformed service can respond effectively to the requirements of many customers (see Figure 3.4, Matrix a, the current and future position of case B within the vertical axis).

Value production: This BN is orchestrated by the document management service provider in order to fulfil integrated products and services for customers (see Figure 3.4, Matrix b, the current position of case B within the horizontal axis). The semi-uniformed integrated products and services for document management is interesting for many companies with a large amount of document circulations, because it reduces the risk of scan/copy device failure, missing and confounding documents, delay in document delivery, and avoids investment on storage. This BN is planned to enrich its package of integrated products and services by adding new services such as data analytical tools. Based on this plan, this BN intends to provide an information (i.e. the content of the document) management service rather than a document management service.

Supplier-customer networked interactions: The interaction between parties within this BN and its customers is transactional. Customers pay per document based on predefined contracts. This BN does not aim to change this type of interaction with customers, at least for the next five years (see Figure 3.4, Matrix b, the current and future position of case B within the vertical axis).

Supplier-supplier networked interactions: Parties within this BN have a long-term collaboration with each other and interactions between them are stable and highly standardized (see Figure 3.4, Matrix b, the current position of case B within the horizontal axis). However, there is a plan to interact with different providers of data analytics tools in order to provide an information management service. The reason is that each of these analytics tools is better suited to certain contexts. Since customers of this BN are from different contexts, they need to select analytics tools providers dynamically.

Networked adaption: Because offering semi-uniformed services is based on formal and pre-defined contracts, customers do not have many possibilities to adapt the BN (see Figure 3.4, Matrix c, the current position of case B within the vertical axis). The BN is adapted using new scan/copy technologies. However, the shift towards offering information management service necessitates deeper IS integration between this BN and customers.

Network coordination: This BN is coordinated centrally by a document management service provider. Because of the stable and highly standardized interactions between parties, this coordination is achieved by formal contracts (see Figure 3.4, Matrix c, the current position of case B within the horizontal axis). However, the change in the nature of the proposed value and the interactions can highlight the important role of data analytics tools providers in the BN coordination.

Case C

Value creation: This BN proposes an asset-oriented value (i.e. the car) for customers. The provision of this asset-oriented value is based on predefined contracts between customers and the car leasing organization. Due to the rigidity of this contractual relationship, there is limited possibility for customers to adjust the provided cars during the leasing period (see Figure 3.4, Matrix a, the current position of case C within the vertical axis). However, this BN plans to provide mobility solutions rather than cars. The provision of the mobility solution enables customers to arrange the best transportation experience for their requirements.

Value production: The car leasing organization organizes to provide relevant services that are required by customers during the usage of a car. These may include maintenance, fuel card, and tire change services. However, customers need to arrange these services personally and pay for each separately. The car is owned by customers during the leasing period and all risks associated with this ownership are their responsibility (see Figure 3.4, Matrix a, the current position of case C within the horizontal axis). The car leasing organization intends to integrate these current value-added services as well as some new services to provide a complete package of mobility solutions. In this way, customers will not need to arrange different services separately and the car leasing organization will orchestrate all of required services.

Supplier-customer networked interactions: The car leasing organization orchestrates this BN and interacts with customers during the car leasing contract period through a well-established CRM system. However, these interactions do not result in considerable adjustments of services during the usage of cars (see Figure 3.4, Matrix b, the current position of case C within the vertical axis)., The car leasing organization plans to integrate its CRM and contract management systems in order to provide mobility solutions. This integration enables the car leasing company to adjust provided products and services during the usage phase based on customer feedback.

Supplier-supplier networked interactions: The car leasing organization already has a stable partnership with car manufacturers and dealers. But it interacts with different maintainers and insurance companies dynamically on an on-going basis (see Figure 3.4, Matrix b, the current position of case C within the horizontal axis). In order to provide mobility solution, the car leasing organization also aims to dynamically collaborate with car providers such as car rental organizations.

Network adaption: The adaption of this BN is often triggered by a change in leasing rates. Also offers by car dealers can result in the need to adapt contracts with the customers. These adaptions are not necessarily in line with the customer requirements (see Figure 3.4, Matrix c, the current position of case c within the vertical axis). For the realization of a new business model within this BN, for the provision of a mobility solution, the car leasing organization plans to launch a customer agenda management system linked to the selling system. Based on this service, a customer can adapt the service provided by this BN.

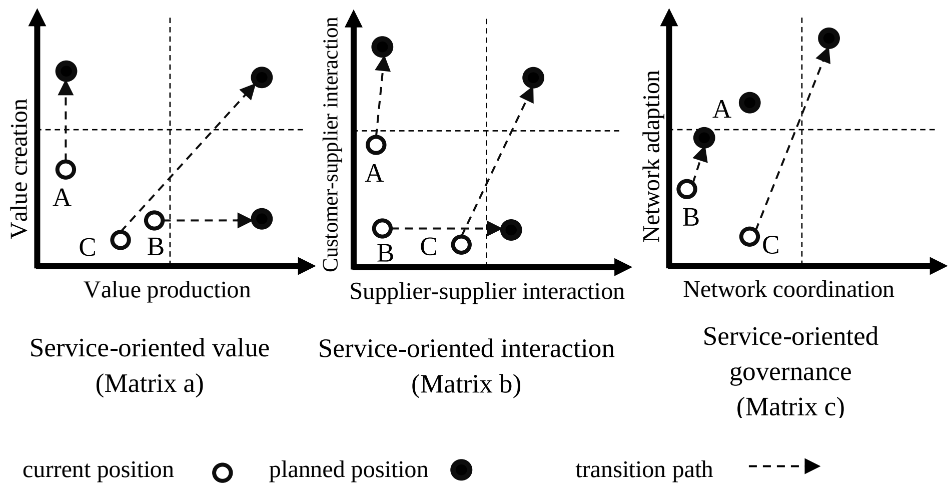

Figure 3.4- Positioning of the studied BNs from the service orientation point of view within the developed integrated framework

Network coordination: The car leasing organization and the car dealers coordinate the parties within this BN. However, coordinating parties who will participate in the provision of the mobility solution is challenging. The car leasing organization aims to do the coordination centrally. However, providers of navigation services and car dealers should also participate in the coordination of this BN particularly due to the distribution of customer related information, (see Figure 3.4, Matrix c, the current and future position of case C within the horizontal axis).

The results of the characterization of service orientation by using the developed integrated framework are shown to interviewees again. The goal of this representation is to investigate if the developed integrated framework reflects the real situation of the cases from service orientation point of view. In all three cases, interviewees agreed regarding the characterization of service orientation within their BNs as described in Figure 3.4.

This indicates that the integrated framework can be applied properly to characterize service orientation in real-life situations. Based on this research, the major difficulty in applying the developed integrated framework in real-life situations is identifying the boarder of BNs. This difficulty may arise because usually parties collaborate in different BNs. This difficulty can be addressed by the specifying the value that is proposed. In this way, the investigation of the other aspects can concentrate on networked interactions and governance mechanisms that support the provision of the specified value.

3.4.3 Evaluation of the usefulness of the integrated framework

The previous sub-section indicates that the integrated framework can be applied to characterize service orientation in real-life BNs. However, this characterization should also provide new and well-structured insights for decision makers. Therefore, we investigate if the developed integrated framework provides an inclusive insight for decision makers on service orientation in their BNs. We also probe the usefulness of the developed integrated framework to characterize service orientation transition in the BNs. In addition, we discuss how the developed integrated framework can align different decisions regarding the three aspects of service orientation in BNs. We organized two individual discussions for each of case A and case B and a group discussion in the form of a workshop for case C.

The discussion about characterizing service orientation triggers decision makers in case A to think deeply about the development of innovative business models. These models enable them to participate in handling risks relating to the certified personnel who are employed by the energy suppliers. This innovative business model would be quite interesting for energy suppliers, because it decreases their risks relate to unsafe behaviors of employees. However, the challenge of the realization of this business model is its conflict with necessity for the independence of certification related parties according to from the rules set by the Dutch Council for Accreditation. An initial idea is to add a new party to this BN who undertakes the HR management role, independent from the energy suppliers as well as certification parties.

Within the case B, by using the represented characterization of service orientation, neglecting the co-creation possibilities within the current business model is questioned. Meanwhile, a strategic discussion is triggered by positioning the main competitors of this BN within the framework.

We found that the main competitors mostly focused on the co-creation dimension of service orientation. This analytical insight enables decision makers to rethink their strategic direction. Also, regarding the governance aspect, there is consensus that centrally coordinating this BN may limit the opportunities to develop innovative analytics tools which are needed in the future business model.

The car leasing organization within the case C has already developed a clear road map for service orientation based on the provision of a mobility solution. Using the integrated framework to characterize this roadmap supported the participants in the workshop by offering new insights. This characterization clearly states that the developed road map requires two lines of activities to be conducted, that is, co-creation activities and product-service transition activities. This also triggered a strategic discussion about the possibility of distinguishing between actors in order to manage customer experience and coordinate suppliers.

Based on the resulting characterization, the best actor to adapt this BN is questioned by the participants in the workshop. Previously there was a consensus that this role should be filled by the car leasing organization. However, after examining the capabilities required for this role, which include access to customer experience during the usage of mobility solutions, it was decided that a new actor is required to act as an intermediary between different parties within the BN regarding customer experience. This intermediary should be able to integrate information related to customer experience that is distributed among all actors.

The findings from the discussions on the characterization of service orientation in the investigated BNs clearly state that the integrated framework gives decision makers an inclusive view of service orientation. This inclusive view from different inter-related aspects supports in-depth refinement of service orientation transitions in the BNs. The coherence of the three aspects clearly highlights the need for alignment between decisions in different functional units within the BNs. The integrated framework helps decision makers to recognize misaligned directions for service orientation in the BNs. For example, there is a misalignment of service orientation transition within the value and networked interactions and the network governance aspect in case B. This notifies decision makers that they need to concentrate on governance mechanisms that enable them to decentralized coordination of dynamic interactions that they will deal with in their future business model.

3.5 Discussion on the findings of the case study

The results of case studies clearly show the applicability and usefulness of the developed framework in real-life situations. The replication logic behind the conducted multiple- case study, in which cases are selected from different industries, can represent the applicability and usefulness of the developed integrated framework within other BNs.

In addition, the external validity of the findings from the case study is in line with previous authors can be supported by analytical generalization of the findings (see (Yin, 2013)). Indeed, since the development of the integrated framework is established on relevant theories in the context of service orientation, it can be applied in order to provide useful insight for decision makers on service orientation within other BNs.

However, although the conducted multiple case study highlight the applicability and usefulness of the developed integrated framework, its usage as a prescriptive tool in real-life BNs requires more empirical research. This research should examine the inter-relationships among decisions within different aspects. The most significant limitation of the conducted evolution is the lack of empirical validation of the corresponding inter-relationship among service orientation directions within the three aspects. In other words, although theoretical argumentations described in Chapter 2 sufficiently supports the corresponding inter-relationship among service orientation directions within different aspects, more empirical validation is required to enhance the findings from the case study based approach in this research. It can be said that the integrated framework developed here is generalizable across different BNs. The generalizability of the findings is supported by the replication logic and relevant theories. However, in future it should be applied in diverse BNs in order to confirm our findings in other contexts.

Finally, in this research, decisions on service orientation were not based on concrete tools such as collaborative products development, service architectural tools or networked interactions engineering models. Therefore the integrated framework may be limited in its ability to direct concrete service orientation related decisions. Therefore further research is needed in this area.

4

A Dynamic Capabilities Perspective on Service Orientation in Business Networking

Chapter 4

A Dynamic Capabilities Perspective on Service Orientation in Business Networking

In Chapter 2 and 3 an integrated framework for the characterization of SBNs was developed and evaluated. The developed framework inclusively and coherently describes the characteristics of BNs that aim to co-create integrated solutions with customers.

In this chapter we explore a set of dynamic capabilities that enable service orientation in BNs to support operationalization of the described characteristics. The clarification of capabilities required for service orientation in BNs bridges between the first part of the thesis concentrated on characterizing SBNs, while next parts address how IG, as a dynamic capability, can support and enable the described characteristics.

In this chapter we explain how dynamic inter-operations support service orientation in BNs. In Part two and three we concentrate on governance of information assets as supporters and enablers of dynamic inter-operations in SBNs. In this way, the research question addressed in this chapter is:

What are the capabilities that support co-creating integrated solutions with customers in SBNs?

To answer this research question we concentrate on a dynamic capabilities perspective (Teece et al., 1997) which highlights the required abilities to deal with highly changing environments (Dove, 2002; van Oosterhout, 2010). This perspective provides a well-established basis to explore the required capabilities for service orientation particularly regarding high dynamism within SBNs.

The dynamic capabilities perspective as a background concept of this chapter is elaborated in Section 4.1. Then the methodology for the exploration and validation of dynamic capabilities enabling the realization of the core characteristics of SBNs is represented in Section 4.2. In Section 4.3 the explored concrete dynamic capabilities in support of service orientation in BNs are described. The evaluation of the systematically explored concrete dynamic capabilities is reflected in Section 4.4. This chapter is concluded by a discussion on the findings about explored dynamic capabilities in Section 4.5.

4.1 Dynamic capabilities perspective

Within the strategic management literature, the capability view is supported by two main perspectives: the resource-based view (Rumelt, 1997) and the dynamic capabilities view (Teece et al., 1997). Whilst the resource-based view has a static view on a business environment, the dynamic capabilities perspective is more relevant in highly changing and dynamic environments (Winter, 2003). The resource-based view indicates the operational capabilities that support the current processes to achieve the current target of a system. However, the dynamic capabilities aim to align a system with respect to changes in an environment.

(Teece et al., 1997) define dynamic capabilities as 'the ability to integrate, build, and reconfigure internal and external competences to address rapidly-changing environments'. Dynamic capabilities as high-order abilities, govern the rate of change of operational capabilities to be aligned with the environmental changes (Collis, 1994). This is in comparison with operational (zero-level) capabilities.

Dynamic capabilities are more important in the highly dynamic and rapidly changing environments. SBNs embrace the high dynamism that originates from changes in supply chain and demand chain activities. The dynamism in the supply chain dimension can originate from the new suppliers who can provide new products and services within a value network. The dynamism in the demand chain dimension can result from the emerging needs of customers. Therefore it can be concluded that the dynamic capabilities perspective can provide a relevant basis to explore the required capabilities enabling the characteristics of a SBN.

The dynamic capabilities enabling the responsiveness and agility in supply chains have been explored in previous research (e.g. (Sambamurthy et al., 2003; Agarwal et al., 2007; Tseng and Lin, 2011)). The proposed frameworks for the dynamic capabilities in agile supply chains (e.g. (Sambamurthy et al., 2003)) provide a well-established basis for the identification of required dynamic capabilities in SBNs. The reason for the suitability of the

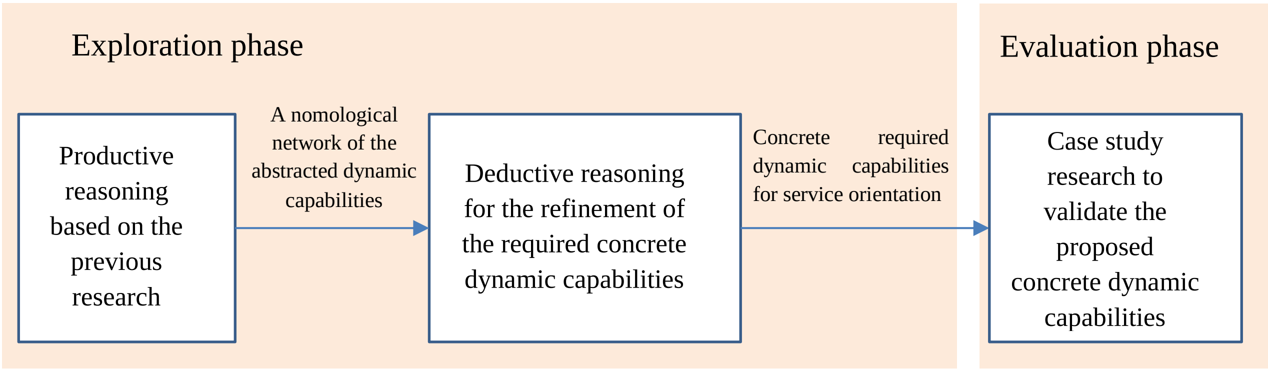

Figure 4.1- The approach to refine the required dynamic capabilities for the service orientation in demand-supply chains

proposed frameworks is that SBNs can be considered as agile demand-driven supply chains that co-create integrated solutions with customers. However, the proposed dynamic capabilities within these frameworks do not directly address the characteristics of SBNs. Previous research does not point out how the value co-creation and the integrated products and services provision can be by dynamic capabilities supporting agility in SCM.

In this chapter, we intend to explore and evaluate a set of concrete SBNs specific dynamic capabilities which enable the specific characteristics of SBNs. These concrete dynamic capabilities highlight in particular the required capabilities for value co-creation and integrated products and services provision.

4.2 Research Approach

We have two phases to identify the dynamic capabilities supporting service orientation in BNs: an exploration phase and an evaluation phase. We begin by systematically exploring the concrete dynamic capabilities that enable service orientation in BNs. We then evaluate the systematically explored concrete dynamic capabilities (see Figure 4.1).

Within the exploration phase we use productive and deductive reasoning. The productive reasoning relies on previous research to create a preliminary basis for the required dynamic capabilities. This preliminary basis provides a nomological network of relationships between the abstract dynamic capabilities and the SBN characteristics. The deductive reasoning aims to refine these abstract dynamic capabilities to a set of concrete dynamic capabilities for service orientation. This refinement is based on the two key characteristics of SBNs, which are the co-creation of the value-in-use (i.e. service orientation within demand chain dimension) and the provision of the integrated products and services (i.e. service orientation within supply chain dimension).

We conduct a case study research to evaluate the practical significance of the proposed concrete dynamic capabilities for service orientation. This approach enables us to investigate how the explored concrete dynamic capabilities support the characteristics of service orientation in a real-world situation. To do this case study analysis, we rely on the evidence from case C in Chapter 3.

4.3 Exploration of the concrete dynamic capabilities required for service orientation in BNs

In this section we firstly develop a nomological network of the abstracted dynamic capabilities. Then, these abstracted dynamic capabilities are refined based on two key characteristics of SBNs.

4.3.1 The nomological network of the abstracted dynamic capabilities

In this step, by using related literature, we intend to determine a preliminary set of dynamic capabilities that support the realization of the characteristics of SBNs. Much of the literature in this area focuses on the dynamic capabilities that shape agility in Supply Chain Management (SCM) (see (Sambamurthy et al., 2003; Yusuf et al., 2004; Agarwal and Selen, 2009)).

The dynamic capabilities that are indicated in these studies highlight the ability of SCM to sense changes in the environment and rapidly responding to these changes. These dynamic capabilities describe the required abilities to achieve strategic advantages in highly changing and dynamic environments. However, although these dynamic capabilities are relevant for the realization of the characteristics of SBNs, they do not directly focus on the realization of the specific characteristics of SBNs, as described in Chapter 2.

In other words, these research studies do not reflect how these dynamic capabilities enable value co-creation and integrated products and services provision. The dynamic capabilities proposed by these studies can be seen as abstracted dynamic capabilities for the realization of the required characteristics of SBNs. In other words, a SBN can be seen as an agile demand driven supply chain that provides a complete package of integrated products and services and intends to respond to customer expectations within whole products and services lifecycle. In this way, we elaborate how the dynamic capabilities supporting the agility in SCM can be refined as the SBNs specific concrete dynamic capabilities that support the realization of the characteristics of SBNs.

The conceptual model of the dynamic capabilities for shaping the agility in SCM that is proposed by (Sambamurthy et al., 2003) is a well-established framework in this context. This conceptual model rigorously integrates underpinning theories and has been referred

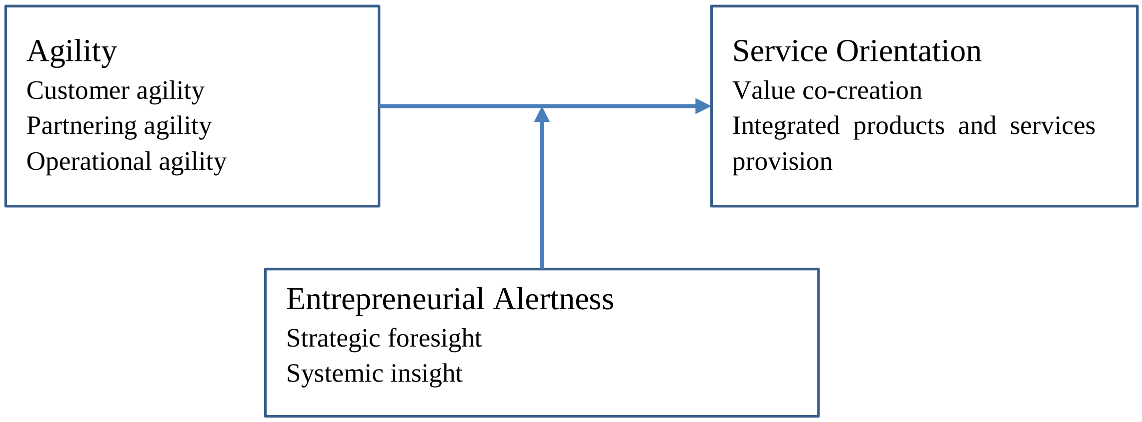

Figure 4.2- The Nomological Network of the Abstracted Dynamic Capabilities (Adapted from (Sambamurthy et al., 2003))

repeatedly by scholars as a basis for current research in this domain. Regarding the objective of this step of our research approach, to provide a well-established basis for abstracted dynamic capabilities for service orientation, we rely on this conceptual model. This conceptual model highlights three important dynamic capabilities including digital options, agility, and entrepreneurial alertness. Digital options are "a set of IT-enabled capabilities" that are based on process-oriented and knowledge-oriented information systems. Entrepreneurial alertness is "the ability of a system to explore its market place through preexisting knowledge and proactive experiments to detect an opportunity and to act upon that".

Entrepreneurial alertness comprises of two specific capabilities, namely strategic foresight and systemic insight. Strategic foresight is an ability to anticipate the opportunity in a value network through an in-depth understanding of customers' business concerns. Systemic insight is the ability of a system to architect competitive action through the investigation of possible benefits and risks related to a response to an opportunity. Agility is the ability to detect opportunities for innovation and to seize these opportunities by assembling the requisite assets. Agility includes three interrelated capabilities: the customer agility, the partnering agility, and operational agility (Sambamurthy et al., 2003).

We do not address the digital options in this chapter as we intend to concentrate on business related dynamic capabilities for the realization of the characteristics of SBN. In the third part of this thesis we describe how information governance as a dynamic capability can support and enable the required business characteristics. Considering the service orientation characteristics as most important competitive advantages in the context of SBNs, the adopted conceptual model in our research is exhibited within Figure 4.2. The abstracted dynamic capabilities reflected within this conceptual model are refined in the following subsection.

4.3.2 Refinement of the dynamic capabilities in the context of SBNs

To refine the abstract dynamic capabilities exhibited within Figure 4.2, we rely on two key characteristics of the SBN, namely value co-creation and integrated products and services provision. Indeed, we identify concrete SBN specific dynamic capabilities that support the co-creation of integrated solutions.

To refine the dynamic capabilities, we analyze how the dynamic capabilities within Figure 4.2 support each of these characteristics in SBNs using a deductive reasoning approach(see more details in (Fischer and Gregor, 2011)). This deductive reasoning is established using the logical distinction between the value co-creation and the integrated products and services provision.

This reasoning highlights how each of the abstract dynamic capabilities assists in value co-creation as well as the provision of the integrated products and services. Using this approach, each of abstract dynamic capabilities is divided into two concrete ones. This approach results in ten concrete dynamic capabilities that explain the required high-level routines to support the characteristics of SBNs (see Figure 4.3). These ten concrete dynamic capabilities are explained below.

Customer agility for value co-creation can be described as the ability to sense and seize opportunities to create better experience for a customer during their use of a product or service. The majority of these opportunities originate from the changes in customers preferences during the usage of a product or service (Payne et al., 2008). This dynamic capability addresses the ability of a business network to facilitate customer-supplier interactions during the entire period of usage of a product or service by a customer. This facilitated interaction enables a business network to identify the desired preferences of value-in-use by customers and to respond to them quickly.

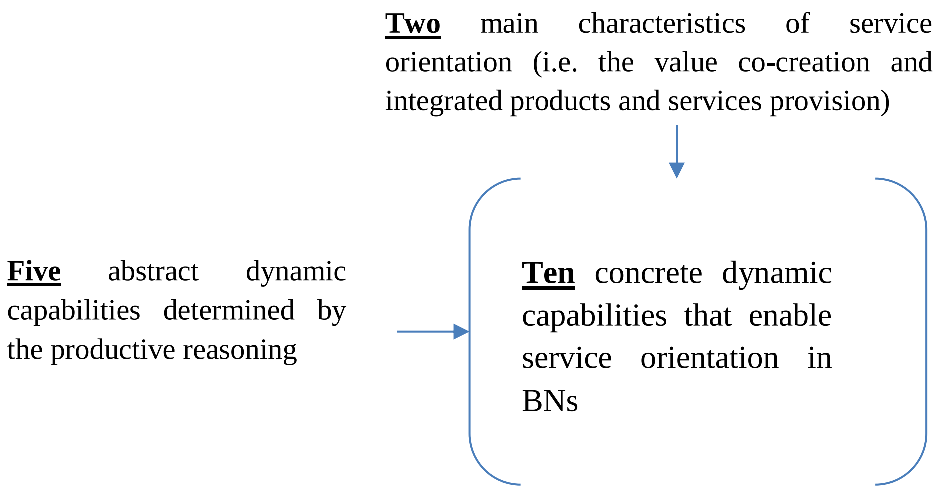

Figure 4.3- The logic of deductive reasoning for the refinement of the required dynamic capabilities in SBNs

Customer agility for co-production demonstrates the engagement of the customer as a resource in the supply processes (Grönroos, 2011). This dynamic capability reflects the ability of a business network to sense and facilitate customers' engagement opportunities in designing, procuring, manufacturing, and delivering processes. In other words, this dynamic capability is the ability to explore customer's competencies. Exploring customer's competencies provides a basis for exploiting from the business models encompassing the customer engagement in the form of co-innovation, co-manufacturing, and crowd-sourcing (Whitla, 2009).

Partnering agility for value co-creation reflects the ability of a BN to form a dynamic coalition of resources to support the value co-creation processes. This ability enables SBNs to use the best set of the value co-creation resources regarding the specifications of a customer. The value co-creation resources are the facilities provided by different suppliers within a value network to interact with customers during the usage of products or services. With respect to the nature of value networks, a customer can interact with all suppliers rather than a pre-determined supplier (Lusch, 2011). In this way, this dynamic capability the ability of a BN to exploit the interaction facilities provided by different suppliers dynamically in order to shape the most appropriate interaction experience for a customer.

Partnering agility for integrated products and services provision highlights the supplier-supplier interactions that enable a BN to provide the most complete package possible of the products and services that are required by customers.
Since the requirements of customers are quite different, this dynamic capability highlights the need for an adaptive partnership between suppliers. A SBN should be able to provide a high variety of integrated packages of products and services that allows a dynamic collaboration between suppliers. This dynamic capability means that a BN can sense opportunities for new collaborations between suppliers, in order to provide more interesting packages of products and services for customers.

Operating agility for value co-creation indicates the ability of a BN to manage dynamic processes that support value co-creation during the usage of a product or service by a customer. Value co-creation processes enable interaction between customers and suppliers through well-established activities. This may include value co-creation processes proposed by (Payne et al., 2008). Forming a value co-creation process depends on an individual customer's experience during the usage of a service or product (Arnould and Thompson, 2005). Therefore the processes supporting the value co-creation also need to be adaptive. This dynamic capability offers a business network the ability to identify the requirements needed to adapt the value co-creation processes based on the customer's experience and to redesign and re-implement these processes.

Operating agility for integrated products and services provision refers to the provision of the integrated products and services using the distributed resources within a business network. This requires integration of the intra and inter-organizational processes in a supply chain (Grefen et al., 2000). Due to the dynamic nature of the integrated products and services in a SBN, these processes need to be redesigned and re-implemented dynamically. This dynamic capability reflects the ability to explore the emerging requirements of business processes based on changes in the characteristics of the output (i.e. the integrated products and services) and to quickly respond to these requirements by implementing re-designed processes.

Strategic foresight for value co-creation reflects the ability of a business network to anticipate the expected experience of a customer from a product or service (i.e. value-in-use). This dynamic capability highlights the need for a BN to have an in-depth understanding of customers concerns. This ability is based on analysis of customers' experience through value co-creation processes during the usage of a product or service by customers.

Strategic foresight for integrated products and services provision is described as the ability to anticipate potential actors of a BN to develop collaborations to provide integrated products and services. This capability enables BNs to establish a strategic collaboration between actors within a value network. This strategic collaboration may be a basis to form instant virtual enterprises (Grefen et al., 2009b) supporting the provision of integrated products and services.

Systematic insight for value co-creation demonstrates the ability to investigate possible benefits and risks related to value co-creation. This capability addresses the inclusive view to align agility capabilities for value co-creation. This inclusive view enables a BN to investigate and develop particular value co-creation actions. Value co-creation actions embrace the three related agility capabilities (i.e. operating, partnering and customer agility) for value co-creation. Systematic insight reflects the alignment between these three dynamic capabilities regarding the possible benefits and risks.

Systematic insight for integrated products and services provision describes a BN ability to investigate different packages of products and services that are offered by collaborating parties. This capability aligns three agility capabilities to provide integrated products and services. This ability allows a BN to investigate the benefits and risks related to a value proposition in the form of integrated products and services. This investigation enables dynamic value proposition within a networked business (Kowalkowski, 2011).

4.4 Evaluating the Proposed Concrete Dynamic Capabilities for Service Orientation in BNs

In this section we evaluate the practical significance of the systematically explored ten concrete dynamic capabilities enabling service orientation in a real-life BN using a case study research approach. A case study is a relevant approach for this purpose because it enables us to describe "how" the explored dynamic capabilities support the realization of the service orientation characteristics in a real-life situation (please also see the discussion on the selection of the case study research in Chapter 3 in the context of SBNs).

Using case study approach we aim to investigate how the concrete dynamic capabilities can enable service orientation in BNs. To do this, we need to select a BN that already is within service orientation transition. In this way, we can describe how the dynamic capabilities support this transition.

For this purpose we rely on the evidence gathered from case C (see Section 3.2). This case is a BN formed by a car leasing organization in the Netherlands with branches located in ten European countries. This BN currently focuses on car provision that is quite asset-based. As a strategic transition, this BN has decided to move from its asset-based business towards a SBN. As a vision of this strategic transition, the parties within this BN intend to provide an integrated mobility solution for their customers. The provision of the integrated mobility solution requires offering a complete package of products and services relating to the mobility experience of customers.

To gather relevant evidence we use data that have been collected from in-depth interviews (see Section 3.3). These data are relevant as they examine the service orientation transition in this BN. We aim to investigate how the concrete dynamic capabilities can support the service orientation transition described in Section 3.4.

For this purpose, we also use the findings of the "CoProFind[1]" project (Lüftenegger, 2014). The findings from this project are relevant, because the artifacts that have been developed in this project show how the network formed by the car leasing organization can shift towards a service-oriented BN. In this project three relevant artifacts were developed to reflect the service orientation transition in this BN: the business strategy, the business model, and the service composition model. The service-oriented strategy defines the new identity of the BN as a mobility solution co-creator. The developed business model describes the interactions between different partners in the form of a BN aiming to provide the defined integrated mobility solution. The service composition artefact highlights the intra and inter-organizational processes that support the provision of the mobility solution. Based on the delineated strategic transition, the car leasing organization aims to be an orchestrator within the mobility BN.

To evaluate the significance of the concrete dynamic capabilities, we investigate how they

[1] A collaborative research by TU/e and a financial service corporation to design innovative business models in a service-oriented business context

can support the delineated service orientation transition that is represented within the business strategy, the business model, and the service composition model. To do this, we rely on the evidence gathered in two workshops that have been conducted to delineate the service orientation artefacts.

These two workshops, from the CoProFind project, include all of the business executives from the car leasing organization and representatives from key parties. To gather data from these workshops a pre-defined format of the artefacts was prepared and each part of these artefacts was discussed during the workshop. The discussion continued until a consensus was achieved among all participants regarding each part of artefacts. The discussion was facilitated by research team, who clarified the scientific terms used within artefacts. To triangulate the evidence found in the workshops organized in CoProFind project, we also conducted two in-depth interviews with a practitioner and a researcher involved in the workshops. Within these two in-depth interviews we test the correctness of the interpretation of the empirical evidence gathered within the two workshops. The evidence resulting from this case study research is described below.

In order to form a customer-centric value (i.e. the value-in-use), the mobility solution that is going to be offered by this BN is characterized as "a seamless experience for a customer that embraces being at the right place, at the right time, by the right cost". To be able to facilitate this experience, strategic decision makers in this BN require a preliminary mindset about the expected experience of each segment of customers. This need in the BN has been addressed by trying to develop a service orientation strategy. The need for a preliminary mindset about the expected co-created value-in-use and trying to formulate the mindset through a service orientation strategy reflects the practical significance of the "strategic foresight for value co-creation". The heart of this preliminary mindset is the anticipation of the expected experience by each segment of customers. For this, we need to characterize the mobility service needed for different segments of customers within the service orientation strategy. This need is addressed by the "strategic foresight for value co-creation".

Within the service-oriented business model artifact, a service ecosystem has been delineated that supports offering the expected experiences. This service ecosystem delineation embraces the core and enriching services as well as the core and enriching partners. The delineated business model artifact highlights the need for the "strategic foresight for integrated products and services" as well as the "systematic insight for integrated products and services provision".

In the developed service-oriented business models the required interactions with customers for the co-creation of a certain experience also have been addressed. The anticipation of these interactions relating to different customer experiences needs a deep insight about the abilities as well as the expectations of customers. This need reflects the significance of the systematic insight for value co-creation.

For the realization of the service orientation strategy, the car leasing organization as the orchestrator of the mobility solution value network, has developed different service-dominant business models (see (Lüftenegger, 2014) for more details). Each of the developed business models focuses on the co-creation of a certain expected customer experience (i.e. the necessity for “customer agility for value co-creation”). The role of customers, as creators of the mobility experience, has been identified within each of the developed service-dominant business models (i.e. the significance of “customer agility for co-production”).

Within each of the developed service-dominant business models a complete package of relevant products and services that can enhance the expected customer experience have been considered. Because these products and services are provided by different parties, each of the developed service-dominant business models highlights the collaboration among specific sets of parties within the mobility value network (i.e. the necessity for “partnering agility for value co-creation and integrated products and services provision”).

According to the developed service-dominant business models, the car leasing organization has developed business process choreography models (like the business process choreography models represented in Chapter 6). Each of these developed business process choreography models supports the realization of a specific service-dominant business model. The car leasing organization needs to support different business models simultaneously in order to be able to co-create customer-centric mobility solutions. To support the realization of these different business models, the car leasing organization requires handling dynamic inter-organizational business processes (i.e. the necessity for “operating agility for value co-creation and integrated products and services provision”.

4.5 Discussion

In this chapter we identified and evaluated a set of ten concrete dynamic capabilities supporting the characteristics of SBNs. These concrete dynamic capabilities support the realization of the service orientation characteristics. It is particularly useful for realizing those characteristics related to value co-creation and integrated products and services provision. The proposed concrete dynamic capabilities can enable BNs to provide customer-centric integrated solutions through highly distributed and dynamic suppliers. This chapter bridges the first part of the dissertation and the next parts by the clarification of the role of dynamic partnering and dynamic operating, which are addressed by dynamic networked business processes in the next parts, for service orientation in BNs.

Part 2

Information Governance Issues in Service-Oriented Business Networking

Service orientation in BNs, as characterized in Part One of this thesis, involves handling dynamic inter-organizational interactions in order to rapidly respond to environmental changes. This situation stresses information-intensity in networked business processes, where information is exchanged among parties to enable composing and executing networked business processes. Information-intensity highlights the need for high-quality and secure information exchanges among collaborating parties. IG addresses different mechanisms to ensure high quality and secure information exchanges. Service orientation in BNs results in emerging IG issues. This part addresses the second research question within the dissertation that states:

RQ2- What IG issues need to be addressed to ensure high quality and secure information exchanges in dynamic networked business processes within SBNs?

This part is organized into two chapters. Chapter 5 addresses the identification of a comprehensive list of the IG issues in dynamic networked business processes within SBNs. Chapter 6 evaluates the practical relevance of the IG issues that have been identified. A case study is conducted in a SBN that provides integrated mobility solutions for customers (i.e. Case C in Chapter 3).

5

Identifying Information Governance Issues in Dynamic Networked Business Processes

Chapter 5

Identifying Information Governance Issues in Dynamic Networked Business Processes

In this chapter we intend to identify information governance (IG) issues in the context of service-oriented business networking. A systematic literature review is conducted to identify IG issues. In this way, we identify a comprehensive list of the IG issues in dynamic inter-organizational interactions among parties within service-oriented business networks (SBNs). These issues are classified into information quality, information security, and metadata domains.

To do so, the introduction of the research for the identification of the IG issues is addressed in Section 5.1. In Section 5.2 the research question is specified precisely. The methodology for answering the specified research question is described in Section 5.3. In Section 5.4 the identified IG issues are illustrated. This chapter is concluded by discussions about the identified IG issues in Section 5.5.

5.1 Introduction

Competition in today's globalized markets increasingly forces BNs to provide mass-customized integrated solutions for their customers (Vargo and Lusch, 2004; Tukker and Tischner, 2006). This situation stresses the importance of service-oriented business networking to respond to emerging customer requirements (Mehandjiev and Grefen, 2010). As discussed in Chapter 4, SBNs need to sense customer needs and rapidly respond to these needs by agile orchestration of resources distributed among parties (Sambamurthy et al., 2003). This highlights the importance of information-intensity in inter-organizational business processes (Aarikka-Stenroos and Jaakkola, 2012). Information-intensity refers to dynamic evolution of inter-organizational business processes in order to respond to environmental requirements (Grefen et al., 2009b). The property of information-intensity is further increased by emerging paradigms such as big data (Manyika et al., 2011), cloud computing (Armbrust et al., 2010), and internet of things (Atzori et al., 2010) which enable BNS to generate , store, access, and use globally distributed information. Information can be generated by suppliers, (such as logistics related information) or by customers (such as information implying customers' experience in social media).

Although the access to globally distributed information enables a BN to exploit environmental opportunities, it also can result in emerging issues such as unsecured information access and low quality information products (Silvola et al., 2011; Tallon, 2013; Haug et al., 2013; Rasouli et al., 2015c). These issues can significantly disrupt the performance of a BN. Therefore, they need to be clearly recognized and responded to by information governance (IG) mechanisms (Tallon, 2013).

IG is an holistic approach to different mechanisms that are required to enable high quality information exchange (Kooper et al., 2011; Hulme, 2012). It should maximize value of information for all stakeholders and safeguard information as an asset within its whole lifecycle (Tallon et al., 2013). In this way, IG addresses information quality (IQ), information security, and metadata domains (Khatri and Brown, 2010; Young and McConkey, 2012). Although IG within organizational boundaries has increasingly been considered in recent literature, the research on IG in the context of BNs is lacking (Otto et al., 2011). The majority of research on IG in the context of BNs has concentrated on architectural solutions enabling quality information exchange (like (Scannapieco et al., 2004; Dustdar et al., 2012)). However, these architectural solutions do not offer a comprehensive view on different aspects of IG including information service quality, information product quality, security, and metadata (see (Rasouli et al., 2015a)).

On the other hand, IG in SBNs encounters various emerging issues such as context-aware semantic information exchange or collaboratively created information ownership. Therefore in this chapter we concentrate on the identification of these issues that arise from service orientation in BNs within a structured way.

Based on BN engineering approaches (e.g. (Alt et al., 2000; Camarinha-Matos and Afsarmanesh, 2007; Grefen, 2015a), operational interactions among parties are seen within networked business processes that are composed and enacted by collaborating parties. Networked business processes are enacted by two or more autonomous organizations, where at least one organization exposes a transparent projection of the explicit control flow structure of an internal process to the other organization(s) (Grefen, 2013). The definition of networked business process implies that a networked business process is formed when a party makes a process structure accessible for its partner(s). This process structure is referred as a process view (Eshuis and Grefen, 2008) or external process (Grefen et al., 2000). An external process is public and a projection of an intra-organizational business process, which contains additional private details not shown in the external process. Based on the BN engineering approach, in this research we focus on the identification of IG issues within networked business processes in the context of SBNs. In this way, the research question addressed in this chapter is:

What IG issues need to be addressed to ensure high quality and secure information exchanges in dynamic networked business processes within SBNs?

This research question is specified in the next section.

5.2 Research Question Specification

To answer the research question precisely, it needs to be specified in a structured way. This specification is particularly needed because we intend to explore IG issues within a specific context (i.e. SBNs), at a specific level (i.e. operational interactions that are handled by networked business processes), and originating from the dynamism of networked business processes. A precise specification of the research question prevents biased answers. We frame the research question within four facets: the context, the intervention, the population, and the outcomes (Petticrew and Roberts, 2008) (see Figure 5.1).

5.2.1 Networked Business Processes within SBNs

SBNs as the context of this research are characterized in Part one. Using a business engineering view (Alt et al., 2000; Grefen, 2013), three different layers can be recognized within a BN: the strategy layer, the business process layer, and the information system layer. The strategy layer requires a BN to respond to environmental needs effectively (e.g. capabilities discussed in Chapter 4 and also proposed by (Otto et al., 2011; Rasouli, 2015a)).

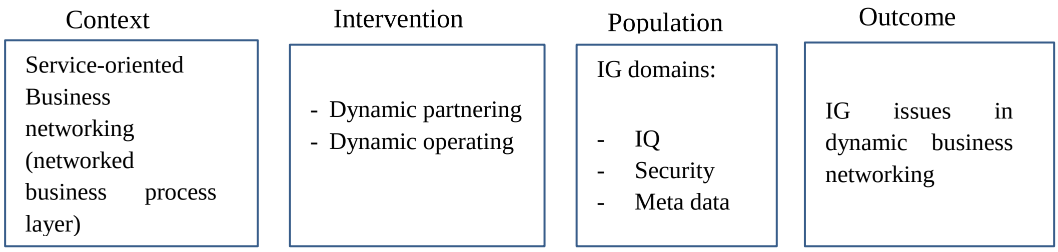

Figure 5.1- The specification of the research question

The business process layer points out interactions among parties in the form of inter-organizational business processes that support realization of required capabilities (Grefen, 2013). The information system layer enables inter-organizational business processes to use different IT facilities, especially supporting software services. In this research we concentrate on the business process layer. We do this for a number of reasons:

- In this research we see inter-organizational interactions from an operational point of view, rather than strategic perspective. Interactions from a strategic view mainly support strategic alignment between different collaborating parties through the formation of joint visions in order to form service ecosystem (Afsarmanesh and Camarinha-Matos, 2005; Lüftenegger, 2014)). Strategic interactions are important for long-term collaborations (e.g. in the form of virtual enterprise breeding environments (see (Camarinha-Matos and Afsarmanesh, 2007)). However, since our focus is on SBNs that can be seen as short term collaborations to respond emerging market opportunities rapidly (e.g. in the form of instant virtual enterprises (see (Mehandjiev and Grefen, 2010)), operational view can be more relevant.
- In a complex situations, like SBNs, interactions among information systems (like software services) need to be handled through networked business processes (Grefen et al., 2000; Grefen, 2013). In this way, information system layer interactions issues (like services interoperability) need to be considered in composing and enacting networked business processes (see e.g. (Grefen et al., 2009a)).

Moreover, regarding the distinction between supply chain and demand chain dimensions within BNs (as described in Chapter 2), in this research our main focus is on a supply chain dimension, which concentrates on supplier-supplier interactions. Therefore customer processes (e.g. processes for the co-creation of the value proposed by (Payne et al., 2008)) are not directly considered in this chapter. However, the IG issues identified here indirectly address issues relating to customer processes. The reason is that from information-centered point of view, customers information are mainly gathered through social media (Ang, 2011). Customer information is increasingly handled by third parties who provide services that involve wrapped big data analytics to gather information via social media (Gantz and Reinsel, 2012). We can consider that customer information is handled by these third parties. These third parties can be seen as customer information suppliers. In this way, IG in SBNs needs to care about information exchanges within supplier-supplier interaction. Based on this view, customer-centric aspects of IG, such as information privacy, need to be addressed by these third parties.

5.2.2 Dynamisms

As described in Chapter 2 and Chapter 4, networked business processes in SBNs need to be dynamic. This is due to the market forces for mass customization of products and services regarding customers' unique needs (Gunasekaran et al., 2008; Hilletofth, 2012). Considering different abstraction levels (see (Lankhorst et al., 2009)), dynamisms of networked business processes can be investigated within abstract or concrete levels.

The abstract level refers to the conceptualization of networked business process in order to respond to business requirements. In the context of SBNs, conceptualization of networked business processes can be seen as composing and global enacting of distributed business processes in order to provide integrated solution for customers (see (Grefen et al., 2009b; Mehandjiev and Grefen, 2010)). Conceptualized networked business processes enable BNS respond to an emerging environmental requirement using distributed resources provided by collaborating parties (see Chapter 4).

The concrete level refers to detailed specification of conceptualized business processes. Investigating dynamisms in networked business processes from a concrete level concentrates on different flexibilities that need to be handled in order to support changes in conceptualized networked business process (e.g. see (Schonenberg et al., 2008; Reichert and Weber, 2012)). In this chapter, we address dynamisms of networked business processes from an abstract level. We have chosen this level because we aim to concentrate on dynamisms resulting from service orientation in BNs.

The dynamic capabilities perspective implies high order routines to sense and respond to environmental changes (Teece et al., 1997; Winter, 2003). This approach is a well-regarded basis to explore dynamisms of business networks (Sambamurthy et al., 2003; Benner and Tushman, 2003). Based on this perspective, the dynamism of business networks is due to the need to respond to sensed environmental changes (i.e. customer dynamisms/agility). The sensed environmental changes need to be responded to by adapting internal resources within a business network. The adaption of internal resources within a business network is achieved by operating dynamisms and partnering dynamisms (Sambamurthy et al., 2003).
Operating dynamisms refers to the need to change in business processes to respond to environmental requirements. Regarding the inter-organizational nature of business processes within BNs, this change can be made at the internal or external level of a networked business process(see (Eshuis and Grefen, 2008)). The internal level is of an intra-organizational nature and refers to resources of a certain party (especially technological resources like workflow management systems or process-aware information systems). The change in the internal level occurs within the borders of a party. Based on the BPEL

standard (Anders, 2002) this change can be reflected in the business orchestration model of a party. However, the external level is of an inter-organizational nature and specifies interactions with external parties within BNs.

At this level, process models need to be aligned with arrangements within a BN. This means that business processes at the external level must conform to standards and/or technology used by a specific network. Based on the BPEL standard, the external level of an inter-organizational process can be addressed by a network choreography diagram. Changes in internal and external processes can be refined into different flexibility types (e.g. see (Schonenberg et al., 2008; Reichert and Weber, 2012; Fdhila et al., 2015)).

On the other hand, dynamisms in networked business processes can also result from dynamic partnering. This dynamism can be viewed as dynamic collaboration between interdependent parties in the form of instant virtual organizations who respond to an emerging opportunity in the environment. This dynamism originates from the independence of parties within a networked business who decide about the participation in the collaboration.

According to the aforementioned description of the dynamic operating, to be able to investigate different sources of dynamisms in dynamic networked business processes, we distinguish between dynamisms in internal processes and dynamisms in external processes. In this way, in this chapter we characterize the dynamism in networked business process within three levels as below.

- Dynamic partnership that reflects adding a new party, removing an existing party, or switching a party with another. This dynamism can result from the autonomy of parties, the change in the requirements of customers, and failure of an existing party.
- Dynamic external processes that address the change of an external process by a party. This change may be due to the decision of a party to participate in a new network, business process reengineering, or the change in standards or technologies used within a network.
- Dynamic internal processes that highlight the alteration of an intra-organizational process by a party. This change may result from the need to align internal processes within a party with environmental requirements or the emergence of new technologies that can be used by a party.

5.2.3 Information Governance Domains

The importance of information as a strategic asset highlights the need to use mechanisms to enhance information quality in order to create business value and safeguard it from opportunistic behaviors (Tallon et al., 2013). In this way, IG can be characterized as an holistic approach to different mechanisms that are required to enable high quality and secure information exchange (Kooper et al., 2011; Hulme, 2012). IG should maximize the value of information for all stakeholders and safeguard information as an asset within its whole lifecycle (Tallon et al., 2013).

Previous research has focused on IG within organizational boundaries. In this research we consider IG in the context of BNs. In this context, IG addresses information exchanges within inter-organizational interactions. As discussed in Section 5.2.2, we see inter-organizational interactions within networked business processes. In this way, in this research we concentrate on governing information that is exchanged within networked business processes. Therefore, regarding the intervention facet of the research question (i.e. dynamisms), we intend to investigate emerging IG issues resulting from dynamisms of networked business processes within SBNs.

To characterize IG in the aforementioned context, its relationship with network governance and IT governance needs to be clarified. Based on (Jones et al., 1997), network governance can be defined as:

"Network governance involves a select, persistent, and structured set of autonomous firms (as well as nonprofit agencies) engaged in creating products or services based on implicit and open-ended contracts to adapt to environmental contingencies and to coordinate and safeguard exchanges. These contracts are socially -not legally-binding."

Based on this definition, and regarding the networked business process view on inter-organizational interactions, IG focuses on information exchange within the context of BNs. Other types of inter-organizational exchanges may be addressed by other types of governance. For instance, coordination of physical assets exchanges can be addressed by supply chain governance mechanisms (see (Wilding et al., 2012)). In this way, IG can be considered as an integral part of network governance in the context of BNs. This is in line with (Lajara and Maçada, 2013) that sees IG as a part of corporate governance.

On the other hand, IT governance refers to different mechanisms that support alignment between business and IT (De Haes and Van Grembergen, 2004). Business/IT alignment indicates that an organization's IT sustains and extends organizational strategies and objectives (De Haes and Van Grembergen, 2009).

Previous research in the area of IT governance has mainly focused on organizational boundaries. In this way, IT governance is seen as subset discipline of corporate governance which focuses on IT and its performance and risk management (Kooper et al., 2011). IT governance in some recent literature has been considered as a part of network governance (Grant et al., 2007; Croteau and Bergeron, 2009). According to (Tallon et al., 2013; Lajara and Maçada, 2013), IG and IT governance are seen as integral parts of network governance; see Figure 5.2.

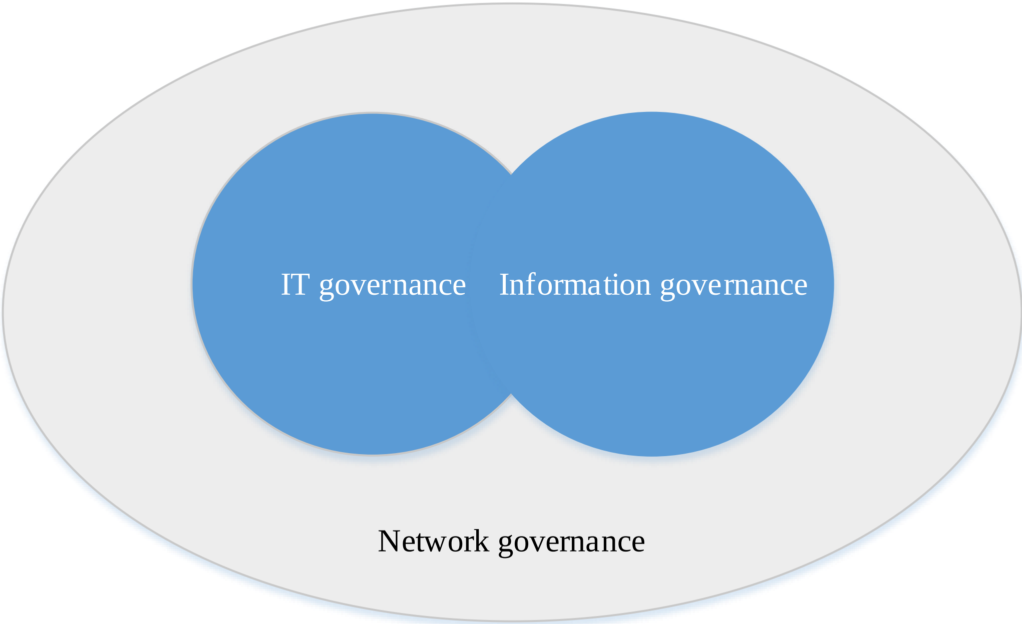

Figure 5.2- The relationship between network governance, IT governance, and IG

The difference between IT governance and IG is clearly described in (Kooper et al., 2011; Tallon et al., 2013). The most important difference between IT governance and IG is that IT governance focuses on governing physical artifacts (like hardware, software, and network), while IG concentrates on governing information as the content that is gathered, stored, processed, and exchanged through IT assets.

From a structural point of view, governance can be applied within centralized, decentralized, and hybrid structures. In centralized structures, such as OEM based supply chains, a party has the responsibility and authority to apply governance mechanisms. In decentralized structures, such as ad-hoc BNs, the related responsibilities and authorities are distributed among all parties. In hybrid structures, some responsibilities and authorities are centralized, for example within intermediaries that enable business networking (see (Chituc et al., 2009). However others are distributed among all parties. In this chapter, we do not consider the differences among these different governance structures. This difference is discussed in the architectural solution enhancing IG in SBNs in Chapter 7.

Based on the characterization of IG, in the determined context for this research (i.e. dynamic networked business processes within SBNs), the relevant domains that need to be considered are information quality (IQ), information security, and metadata domains (see (Khatri and Brown, 2010; Young and McConkey, 2012)). In this research, information privacy is not considered as a different domain for IG. This is due to the fact that we concentrate on B2B interactions where information privacy is more important in customer-related information that exchanged within customer processes. These IG domains are elaborated further.

Information quality

IQ typically is defined by information “fitness for use” (Wang, 1998). This definition of IQ states that the quality of information can be measured by the value which information provides to the user of that information. The user of information might be an automated application, an organization, or any other entity that uses information (Sadiq, 2013). The concept of quality is closely related to the determination of relevant metrics to assess and improve it. This has been reflected in the context of IQ research by the characterization of IQ dimensions, which generally rely on empirical methods to explore IQ dimensions (see e.g. (Wang and Strong, 1996; Strong et al., 1997; Kahn et al., 2002)). Although there are a number of differences between these different representations of IQ dimensions due to the contextual nature of quality, they are broadly consistent (Batini et al., 2009). An overview of IQ dimensions based on (Kahn et al., 2002) is represented in Table 5.1.

Table 5.1- IQ dimensions based on (Kahn et al., 2002)

	Conforms to Specifications	Meets or Exceeds Consumer Expectations
Product Quality	Sound Information The characteristics of the information supplied meet IQ standards.	Useful Information The information supplied meets information consumer task needs.
Service Quality	Dependable Information The process of converting data into information meets standards.	Usable Information The process of converting data into information exceeds information customer needs.

Information security

The Information security domain is concerned with the protection of information confidentiality, integrity and availability (Bishop, 2003). Safeguarding information as an asset involves effective risk analysis to ensure that information is only accessed by authorized parties. Traditional security mechanisms such as identity, authentication, and authorization cannot sufficiently respond to security issues in dynamic BNs (Camarinha-Matos and Afsarmanesh, 2003). IG in this context needs to align inconsistent security policies used by different parties, manage collaboratively created information ownership, and monitor the compliance with industry standards.

Metadata

Metadata domain within IG refers to information about information that enhances the usability and understandability of an information service (Khatri and Brown, 2010). Metadata enhances the semantics of information services that are exchanged among parties. IG uses related mechanisms such as collaborative ontology management (Sure et al., 2002) or domain specific standardization (Singh et al., 2003). This ensures consistent understanding and interpretation of information by different parties.

5.2.4 Information governance issues

Regarding the specified research question, the aim is to identify the IG issues in dynamic networked business processes within SBNs (i.e. the outcome facet; see Figure 5.1). We focus specifically on IG issues that emerge due to dynamisms in networked business processes. In this chapter the emerging IG issues are addressed within problem domain. This means that these identified IG issues should be countered by relevant solutions. We shift towards the solution domain in Part three.

Based on the aforementioned specification of the research question, the focus of the research to identify the IG issues is represented within in a broader relevant context in Figure 5.3. This representation states that:

- To identify IG issues we concentrate on B2B (i.e. supplier-supplier) interactions in SBNs.
- These interactions are seen from a business process layer (i.e. networked business processes).
- Dynamisms of networked business processes are considered at an abstract level.

The approach for the identification of the IG issues regarding the specified research question is elaborated in the next section.

5.3 Approach used to identify IG issues

In this section the approach for answering the specified research question is represented. To do so, in this section we firstly discuss the requirements needed from the approach. Based on these requirements, different potential research approaches are compared. We then discuss the selected research approach in detail.

In order to identify IG issues dynamic in networked business processes within SBNs, the approach used must conform to three key requirements:

- *Req 1*. Regarding the focus of the research, as elaborated in Section 5.1 and shown in Figure 5.3, the approach should adequately consider contextual situations (i.e. service orientation in B2B interactions within dynamic networked business processes). If it does not, the contextual relevance of the identified IG issues cannot be confirmed.
- *Req 2*. The approach should support the comprehensiveness of results. This means that it should sufficiently explores relevant evidence to identify the IG issues.

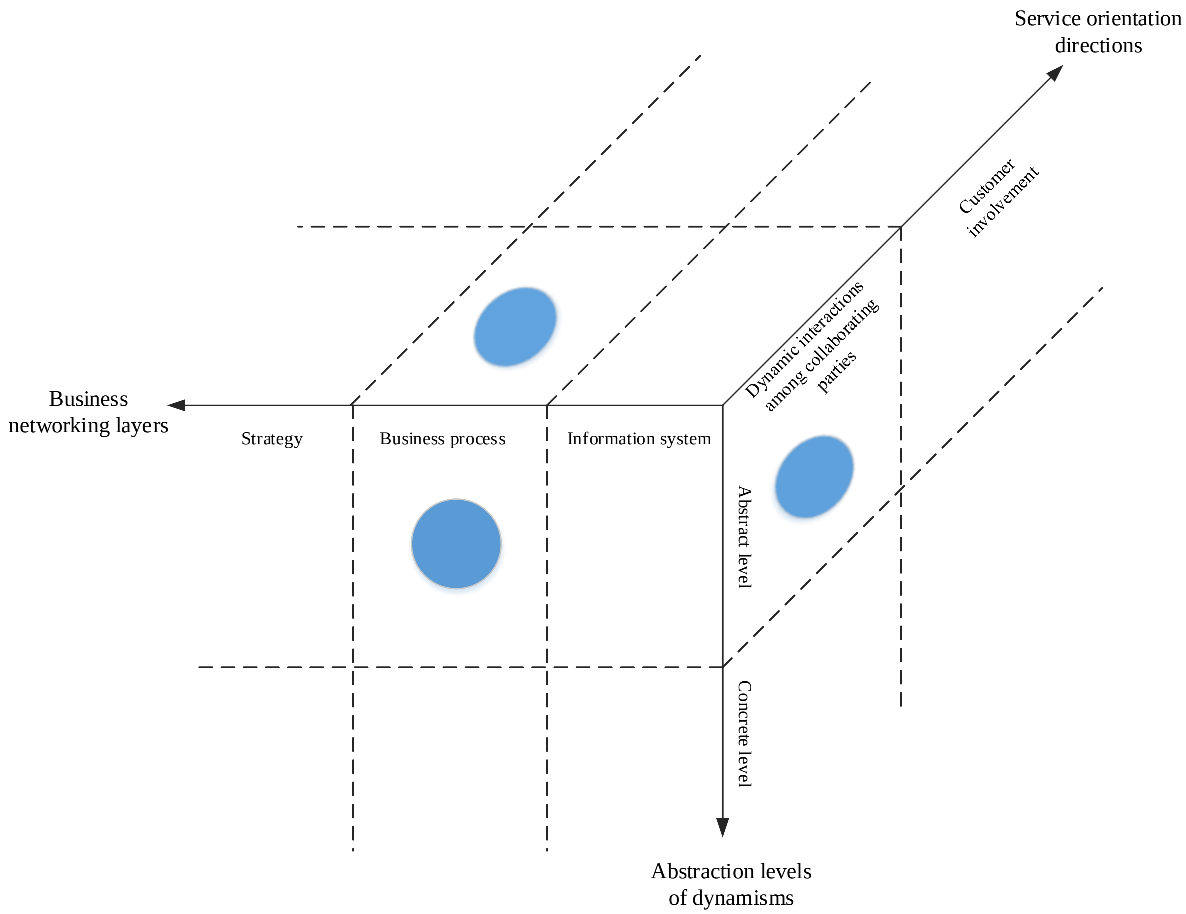

Figure 5.3- Positioning research focus within a broader relevant context based on the specified research question

- *Req 3*. The approach needs to be feasible regarding limitations. The main limitations to be considered are:
  - To date, SBNs in real-life situations are rare which makes gathering real-life empirical evidence difficult and time-consuming.
  - The investigation of interactions requires data to be gathered from different parties that may be geographically dispersed.

In order to select the most appropriate research approach, we investigate five potential research approaches: a survey, a case study, a systematic literature review (SLR), an action research, and a grounded theory. The comparison between these alternative approaches is reported in Table 5.2. We discuss the comparison in the following of this section.

A survey research can be directed as an exploratory approach in order to answer "*what*" questions (Pinsonneault and Kraemer, 1993). Therefore it is consistent in its nature with the research question described in the previous section. A survey research approach also can support a comprehensive view on intended issues. Therefore it conforms to the requirement 2. However, a survey is limited in its consideration of contextual factors (Yin, 2013). This means that for our research, a survey approach may not sufficiently consider the context,

Table 5.2- A comparison of alternative research approaches

Requirements \ Alternative research approaches	Survey	Case study	SLR	Action research	Grounded theory
Consideration to contextual situations	no	yes	yes	yes	yes
Ability to support comprehensiveness	yes	no	yes	no	yes
Feasibility	no	yes	yes	yes	yes

which is service orientation in BNs, in order to identify IG issues. Therefore it does not conform to requirement 1. This limitation is due to its use of structured questionnaires to gather data. In addition, regarding the requirement 3, gathering relevant data through structured questionnaires is difficult to be handled in the context of this research. The reason is that due to the complex concepts used, gathering data needs to be conducted via in-depth interviews. Conducting in-depth interviews to gather data within structured questionnaires conflicts with the limitations that are addressed in the requirement 3.

A case study research approach is appropriate to answer how/why questions. However it also can be used in exploratory research in order to answer what questions (Yin, 2013). With respect to the requirements described above in this section, the main limitation of a case study approach is that the comprehensive view in a case study research cannot be easily handled. Therefore it does not conform to the requirement 2. This limitation can be addressed by conducting multiple case studies (i.e. shift towards a mixed method as survey on related cases). However this conflicts with the requirement 3.

An SLR approach follows a survey logic (Tranfield et al., 2003). In this way, it meets advantages that are described for a survey research approach. Therefore, this approach can support a comprehensive view on the IG issue in the desired context, and so conforms to the requirement 1. It is also possible to manage gathering evidence that is related to the intended context. This can be conducted by a precise identification of search terms (within research identification step) and also by evaluating the relevance of the extracted evidence. In addition, because data gathering in this approach is based on literature review, it meets the limitations that are represented in the requirement 3.

An action research regarding its ability to investigate changes in real-life situations (Reason and Bradbury, 2001) can be an appreciate approach for the exploration of IG issues in real-life SBNs. However, according to the arguments that are stated about a case study research approach, an action research also cannot conform to the requirements for comprehensiveness (i.e. the requirement 2).

A grounded theory research approach, like a SLR, can support the analysis of relevant evidence within the specified context (Martin and Turner, 1986). Therefore it conforms to the requirement 1. Due to the same argument that is stated about a SLR, this approach also is feasible in the context of this research (i.e. it conforms to the requirement 3). A grounded theory approach also covers related evidence sufficiently therefore it conforms to Requirement 2.

A summary of the investigation of the relevant research approaches for the identification of the IG issues in the desired context is represented in Table 5.2. Based on this comparison, SLR and grounded theory approaches are preferred. From these two, we use an SLR approach. This is due to its systematic approach for gathering related evidence. Therefore, covering relevant evidence in support of the comprehensiveness of results can be guaranteed in a more reliable way. In this way, we rely on an SLR approach as a main method to identify IG issues. To exploit advantages of grounded theory approach, we use this approach to synthesize extracted evidences.

The main limitation of the SLR approach is that systematically reviewed evidences are gathered from relevant theories. This means that the SLR approach does not guarantee the practical relevance of the identified IG issues in real-life SBNs. In order to counter this limitation of the conducted SLR, we empirically investigate the practical relevance of the identified IG issues in Chapter 6.

On the basis of (Tranfield et al., 2003; Keele, 2007), to conduct the SLR for the identification of the IG issues within the desired context, the subsequent steps are followed:

1. Plan the review
2. Identify research
3. Practical screening
4. Extract quality evidences
5. Synthesize and report evidences

These steps are illustrated in in the following sections.

5.3.1 Planning the review

After we specify the research question (see Section 5.2) and select SLR as the most appropriate approach, a review protocol is developed and submitted to three reviewers. These three reviewers, who are the supervisors of this PhD dissertation, investigate the

Table 5.3- keywords and query strings used in the systematic review

Intervention			Context			IG domains		Not related terms
Dynamic OR Flexible OR Agile	And	Network OR Collab (oration) OR Inter organization	And	Process OR Service composition	And	Information/ data quality OR Information/ data security OR Meta data / ontology	And NOT	Wireless Sensor Agent Grid Bandwidth Routing Routing

review protocol from three different relevant perspectives: dynamic BN, business process management and IT governance. Based on this protocol, activities that need to be conducted are scheduled. Based on this schedule, the SLR was conducted from February 2015 to October 2015.

5.3.2 Identifying research

According to (Keele, 2007), to identify the research we clarify search terms, develop a search strategy, and search relevant databases. These three required elements for the identification of the research are elaborated in the following of this section.

To clarify search terms we rely on the specified research question, see Figure 5.1. Relevant key words within each of the determined facets of the research question are listed (see Table 5.3). We aim to generate a list of keywords that is "both wide enough to recall a sufficient quantity of references and precise enough, in the light of information explosion, to eliminate unnecessary material" (Duff, 1996). To evaluate the relevance of the identified keywords, we refer to the aforementioned three reviewers with expertise in related domains. The search terms are shown in Table 5.3.

The identified keywords are repeatedly used in the context of networked communication related to the infrastructural technologies supporting communication between devices. The networked communication domain is out of scope of this research therefore we determine some terms to exclude these irrelevant sources, see Table 5.3 (not related terms).

In order to develop a complete framework, we need to select a search strategy that allows us to identify sufficient relevant evidences. This means that the selected search strategy should support the comprehensiveness of the results. To do this, two alternative search strategies are considered:

- **Strategy 1**. Select multiple related sources (i.e. bibliography databases) and search for the determined research terms in multiple sources. In this strategy, we need to ensure that the selected sources sufficiently cover related evidences.

- **Strategy 2.** Conduct the search using Google Scholar search engine which has access to the content from many databases, conference proceedings, and technical reports.

Each of these strategies has advantages and disadvantages (see Table 5.4). From the strategies presented above strategy 1 is more suitable in this context. The main reason is its efficiency. Using this strategy we do not have to investigate a large number of irrelevant sources, because we concentrate on relevant databases. However, the disadvantages of this strategy need to be handled properly. To address these issues, we:

- Select multiple bibliography databases in order to broaden the coverage of relevant evidences.
- Determine the most cited scholars in the area and include their publications. This also checks the coverage of relevant evidences within the selected bibliography databases.
- Include relevant conferences proceedings. This is due to avoid publication bias, which refers to the problem that positive results are more likely to be published than negative results.

Table 5.4- advantages and disadvantages of the alternative search strategies

Search strategy	Advantages	Disadvantages
Strategy 1	• Access to high quality evidences (scientific and peer-reviewed). • The search concentrates on the required context because only the databases relating to the research context are selected.	• To cover relevant sources sufficiently, the search needs to be conducted in multiple bibliography databases. • Publication bias.
Strategy 2	• Access to content from different scientific databases, conference proceedings, white papers, and technical reports. Therefore, this strategy can ensure a full coverage of relevant evidence.	• Relevant high-quality sources may be ranked lower and therefore neglected, due to search engine algorithms. • The inclusion of a large amount of irrelevant sources from other contexts results in many search items. Analyzing all these irrelevant findings (even by title) is not feasible and the stop point issue might occur.

Based on the identified research terms, the search strings are set. The identified search terms result in 54 query strings (i.e. 3*3*2*3). The query strings are used to search for full-text publications in related bibliography databases. The bibliography databases containing sources related to IG, business networking, and business process management were identified as potentially relevant. Based on previous reviews conducted in this subject area (e.g. (Otto et al., 2011; Xiao et al., 2014)) we chose five bibliography databases:

- EBSCO online
- Emerald
- AIS electronic library
- ACM electronic library
- IEEE

We also search for publications by key authors. These key authors are recognized based on their high citation in the relevant domains. The list of selected key authors was confirmed by the aforementioned reviewers as domain experts. Comparison between the publications from key authors and the sources found from the selected bibliography databases shows more than 90% coverage of the selected databases.

We also search publications from conference proceedings. The list of conferences proceedings is found by searching the query strings in Google Scholar. The relevance and completeness of the resulting list is confirmed by the reviewers.

The resulting list of the conferences is:

- BPM
- CIKM
- DASFAA
- ECOOP
- EDBT
- PODS
- SIGIR
- SIGMOD
- VLDB
- WIDM
- WISE
- ACIS
- AMCIS
- CAiSE
- CooPIS
- ECIS
- ER

- HICSS
- ICIQ
- ICIS
- EDOC
- PRO-VE
- IRMA
- PACIS

Many of these conference proceedings are indexed by the selected bibliographies. Therefore it is not necessary to conduct the search for this group of conference proceedings again. However, other conference proceedings are explored independently.

The search for relevant evidence, based on the search queries within the selected databases, was conducted during the spring of 2015. These queries resulted in 4960 sources. These sources were managed by EndNote software.

5.3.3 Practical screening

The selection of primary studies is based on the determined inclusion and exclusion criteria. Regarding the research question in this review we apply the following inclusion criteria:

- All studies within the selected databases relating to IG and dynamic processes in the context of BNs are included. We also include all types of BNs since business networking can be found in different forms (such as supply chain, collaborative network, and B2B e-marketing).
- No limit on publication date is considered.
- All types of publications, including conceptual, research, and literature study, as well as conference proceedings, are included.

The exclusion criteria are as follows:

- Studies relating to IT infrastructure, such as network communication, are excluded.
- Studies that are not focused on BNs context.
- Studies that focus on technical solutions for data integration.
- Studies focusing on social media and customer information management.
- Studies that do not clearly address an IG domain.

To ensure the reliability of inclusion and exclusion decisions, a randomized set of sources are independently assessed by two reviewers. A high consistency in the decisions of these reviewers reflects the reliability of the inclusion and exclusion criteria.

The selection of primary studies is conducted using three steps based on the inclusion and exclusion criteria:

- **Assessment based on the title**: Sources that are found by conducted queries were added to the databases if their title satisfies the inclusion criteria. This step resulted in the selection of 358 sources.
- **Remove repeated sources**: the research queries return many repeated sources. In this step we removed repeated sources: this resulted in 267 sources.
- **Assessment based on abstracts and conclusions:** since in the domain of our research, the abstracts are not qualified sufficiently (Keele, 2007), we investigate the conclusions of the selected sources as well. This step resulted in a final set of 87 sources.

5.3.4 Extracting quality evidences

We conducted the quality assessment and data extraction steps in parallel. To do this, we extract evidence from the 87 selected sources. We rely on their relevance to the research question as well as their scientific rigor to assess the quality of evidence. Investigation of the relevance of extracted evidence is based on the research question facets (see Figure 5.1). In this way, extracted evidence is relevant if it addresses an IG domain in the context of dynamic business networking, particularly within the business process layer.

To assess the scientific rigor of the extracted evidence, we rely on the hierarchy of evidence quality proposed by (Keele, 2007). Using this hierarchy, evidence can be accepted as sufficiently high quality if it has been peer-reviewed by experts. We then designed a form to conduct the data extraction and quality assessment (see Appendix C). The data gathered within the designed form are stored in a database. The database is designed by using Microsoft Access; see Appendix D.

A set of randomized publications are extracted and evaluated by the reviewers independently in order to test the reliability of the extraction and quality assessment process. The consistency of the results indicates the reliability of the process.

The extraction of quality evidence from 87 selected sources led to 163 pieces of evidence. These pieces of evidence were extracted from 51 publications. This means that we did not find any quality evidence in the other 36 sources. (See the extracted quality evidences listed in Appendix E).

5.3.5 Synthesizing and reporting evidences

Different synthesis strategies can be used to analyze extracted evidence (Tranfield et al., 2003). The main synthesis strategies are:

- Narrative strategy of the extracted evidence which does not generalize findings.
- Realistic synthesis strategy, which lists the vital ingredients of a desired phenomenon.

- Meta synthesis strategy which qualitatively interprets findings.
- Meta-analysis, which statistically analyses evidence from other studies to present a cohesive summary of findings.

From these strategies, we follow the realist synthesis strategy. This strategy captures a list of vital ingredients that underpin each aspect of the research question (Pawson, 2002). Our intent in this research is to identify IG issues; therefore this strategy is the most appropriate.
In order to synthesize the evidence in a systematic and reliable way, we use grounded theory approach. We follow three steps: open coding, axial coding, and selective coding (Corbin and Strauss, 2014).

Within the first step, open coding, 163 pieces of evidence were labeled (as reported in Appendix E). The same label is given to similar evidence. The terms used to label evidence originates from the reviewed literature. The aim is to gather evidence and generate meaningful categories from it. Categories derived from the extracted evidence indicate theoretically significant IG issues in the context of dynamic networked business processes within SBNs. This step results in 39 categories of IG issues.

The second step (i.e. axial coding) refers to the process of looking for relationships between the derived categories. As these relationships are recognized, they are re-arranged into a hierarchical form. In this way, we analyze the relationship between the 39 derived IG issues. In this step we re-arrange the derived categories in a way that represent the IG issues on a same aggregation level. In doing so, 11 of the derived categories are merged with other categories. In this way, this step results in 28 IG issues that are derived from the evidence.

The extracted evidence is mapped within the derived categories independently by two reviewers to ensure the reliability of the conducted open and axial coding. If the reviewers map the evidence within the same categories as the author, then it can be concluded that the steps are reliable. In this research, more than 90% of the derived evidence is mapped consistently by the reviewers. The main reason for inconsistency (10%) is the different interpretation of the meaning of the terms that are used. This inconsistent interpretation is addressed with a joint discussion about the meaning of the terms. This results in consistent mapping of all extracted evidence within the derived 28 IG issues.

The third step, selective coding, integrates the derived 28 IG issues within principal categories. In this research, we categorize the derived 28 IG issues within the determined domains for IG. These include IQ, information security, and metadata. However, the derived categories reflect clear differences regarding the issues relating to information product quality and information service quality. Therefore we categorize IQ related issues within these two sub-categories. The results are elaborated in the next section.

5.4 Identified IG issues

The identified IG issues based on the conducted SLR and their relating sources are listed in Table 5.5. These IG issues are categorized into four domains: information product quality, information service quality, information security, and metadata domain. IQ indicates the extent to which information provided within a BN fits with stakeholders' needs (Wang, 1998; Otto et al., 2011). IQ is addressed within information product quality and information service quality (Kahn et al., 2002). Information product quality addresses information as a product that needs to be produced by a manufacturing process with an end-product of information stored in a database. However, information service quality focuses on the activities which occur after information is stored as an end-product in a database, i.e. to enable consumers to obtain and use information. The information security domain underlines the protection of information confidentiality, integrity and availability (Bishop, 2003). The metadata domain reflects information about information which enhances the usability and understandability of an information service (Khatri and Brown, 2010).

Modification of information product syntactic and semantic inconsistency. Certain information products can be produced by different parties using different rules (syntactic) and different language and norms (semantic). This is due to the independence and autonomy of parties in BNs. This is further highlighted in SBNs, where parties can switch repeatedly. Moreover, the presence of parties from different contexts, each with different norms and languages, is a major issue particularly in SBNs who aim to provide integrated solutions for customers. The governor of a SBN must ensure the consistency of syntactic and semantic information products to enable information exchange between parties.

Aligning information production processes: Because parties collaborating in SBNs are loosely linked, each party needs to produce and maintain critical information regarding its environmental entities (e.g. information on customers' experience). This independent view on producing information about related objects within business environment can result in repetitive information products relating to the same objects. Representation of same objects within business environment by different information products that are produced from different points of view can cause to garbling information products. It also leads to unnecessary information production costs and repetition of information entries (e.g. by customers). To avoid these issues, SBN governors need to align different information production processes handled by collaborating parties.

Table 5.5- The identified IG issues in dynamic networked business processes within SBNs

	Identified IG issue	Sources
Information product quality issues		
1	Modification of information product syntactic inconsistency	(Hassine-Guetari, 2009; Lu and Xu, 2014; Hüner et al., 2011b; Botha et al., 2014; Dawyndt et al., 2005; Song and Xiongying, 2010; Hsu and Rubenstein, 1994; Nakatani et al., 2006; Falge et al., 2012a; Rasouli et al., 2015b)
2	Modification of information product semantic inconsistency	(Mecella et al., 2002; Barnickel et al., 2010; Botha et al., 2014; Finin and Joshi, 2002; Dawyndt et al., 2005; Song and Xiongying, 2010; Guo et al., 2003; Bizer et al., 2012; Hsu and Rubenstein, 1994; Batini, 2004; Liu et al., 2011)
3	Aligning information production processes	(Mecella et al., 2002; Botha et al., 2014; Dawyndt et al., 2005; Ofner et al., 2012; Nakatani et al., 2006; Batini, 2004; Haug et al., 2013; Xu et al., 2002; Rasouli et al., 2015b)
4	Linkage of relevant information products that are distributed among loosely linked collaborating parties	(Afsarmanesh et al., 1998; Lu and Xu, 2014; Falge et al., 2012a)
5	dismission of not added value information products	(Botha et al., 2014; Rasouli et al., 2015b)
6	Information product synchronization	(Lu and Xu, 2014; Nakatani et al., 2006; Schemm and Legner, 2008b; Hoellrigl et al., 2010; Demeter et al., 2007)
7	Evolution of pooled master information products in support of emerging requirements	(Schemm and Legner, 2008a; Yang, 2012; de Corbiere, 2009; Haug and Stentoft Arlbjørn, 2011)
Information service quality issues		
8	Clarifying garbling information services	(Felici et al., 2013; Lotz et al., 2012)
9	Information service quality certification	(de Corbiere, 2009; Nakatani et al., 2006; Batini, 2004; Falge et al., 2012a; Haug and Stentoft Arlbjørn, 2011; Hüner et al., 2011b)
10	Quality aware information service brokery	(Haug et al., 2013; Xu et al., 2002; Felici et al., 2013; Haug and Stentoft Arlbjørn, 2011; Mecella et al., 2002; Missier and Batini, 2003)
11	Handling information networkability	(Hu and Grefen, 2002; Hoellrigl et al., 2010; Hüner et al., 2011a; Shankaranarayanan and Cai, 2005; Nakatani et al., 2006; Falge et al., 2012a)
12	Continuity of information service	(Felici et al., 2013; Lu and Xu, 2014)
Information security issues		
13	Prevention of information leakage and misappropriation	(Roy et al., 2012; Sathyanarayana and Sheela, 2013; Rasouli et al., 2015b)
14	Information asset ownership management	(Lu and Xu, 2014; Miseldine et al., 2008; Haug and Stentoft Arlbjørn, 2011; Steinke and Leamon, 1996)
15	Prevention of data remanence	(Sathyanarayana and Sheela, 2013)
16	Preserving added value information	(Roy et al., 2012; Lu and Xu, 2014; Hüner et al., 2011b; Ofner et al., 2012; Tallon, 2013)

17	Traceability of information provenance	(Hassine-Guetari, 2009; Handel and Wang, 2011; Velikova et al., 2009; Sathyanarayana and Sheela, 2013)
18	Dynamic trust management	(Velikova et al., 2009; Roy et al., 2013; Msanjila and Afsarmanesh, 2007; Xu et al., 2002; Qi et al., 2012)
19	Aligning diversified security ontologies	(Lu and Xu, 2014)
20	Creation of trustworthy information exchange environment	(Msanjila and Afsarmanesh, 2010; Yang, 2012; Lotz et al., 2012)
21	Modification of inconsistent security policies	(Teo and Ahn, 2007)
22	Identity federation	(Hoellrigl et al., 2010; Seigneur, 2005)
Metadata requirements		
23	Metadata collaborative repository	(Schemm and Legner, 2008a; Afsarmanesh and Ermilova, 2010; Hüner et al., 2011a)
24	Metadata traceability	(Myrseth et al., 2011)
25	Modification of collaborative metadata inconsistency	(Barnickel et al., 2010; Becker et al., 2008; Hüner et al., 2011a)
26	Metadata evolution	(Schemm and Legner, 2008a; Myrseth et al., 2011; Barnickel et al., 2010)
27	Collaborative metadata robustness	(Batini, 2004)
28	Metadata context awareness	(Schemm and Legner, 2008b; Falge et al., 2012a; Shankaranarayanan and Cai, 2005)

Linkage of relevant information products that are distributed among loosely linked collaborating parties: Because of the independent view on facts by parties, information about similar facts can be distributed among different parties. This distributed information may be biased due to a party's interest or perspective. However, providing integrated solutions in SBNs necessitates a comprehensive view on related objects (e.g. customers, as well as products and services provided by parties within value network). This comprehensive view enables decision makers in SBNs to make well-established decisions when modifying value propositions for customers and composing global networked business processes to co-create proposed value. This necessity for a comprehensive view on related objects states the need for linkage of relevant information products that are distributed by loosely linked collaborating parties.

Dismission of not added value information products: The change of information needs in SBNs can result in disutility of an information product. To avoid production and storage costs associated with information that does not add value, governors of SBNs need polices in place to recognize and remove information products that do not add value.

Information product synchronization: Because of the distributed nature of a BN, a change in the environment can be recognized by a party. To keep information products consistent and updated, the recognized change needs to be disseminated to all relevant information products distributed among different parties.

Evolution of pooled master information products to support emerging requirements: Bilateral information exchange between parties has proven to be costly and complex. Therefore centralization of critical information products is inevitable. This includes master information that is repeatedly used by parties. In a SBN context, the master information needs to be evolved to conform with changes to information requirements.

Clarifying garbling information services: Information services in SBNs are easier to govern if they are transparent. Exposing the information service interface without sufficient visibility of its internal view (e.g. related to the information production process) can limit its usability.

Information service quality certification: information services provided by parties within SBNs vary from a quality point of view. To ensure that an information service is of sufficient quality to be used by another party, a quality certification is required. In the context of SBNs, this certification should be based on standards that are globally recognized. However, these standards need to be flexible to deal with changing requirements within SBNs.

Quality aware information service brokery: Within an SBN, the information needs of collaborating parties can be responded to by different information services. For example, information on customer experience can be provided by different parties that analyze customer information gathered by social media. Well-established decision-making in SBNs (e.g. to propose tailored solutions for customers) necessitates ensuring that the best matched quality information service is selected and used by an information consumer (e.g. a decision support system that uses customer information). An information service brokerage can facilitate this quality match-making in SBNs. The brokerage can also handle quality notifications in order to enhance the quality of information services that are distributed among collaborating parties.

Handling information networkability: Information networkability refers to how usable and understandable an information service is. Improving information networkability involves applying syntactic and semantic information interoperability mechanisms. These may include standardizing information services and interaction protocol adaptions. IG in SBNs must ensure that these information interoperability mechanisms are used properly within interactions among parties. It must also evolve these mechanisms in response to dynamisms resulting from service orientation.

Continuity of the information service: In the context BNs, due to the distribution of information assets, different information services are composed to support a work process or decision making needs. In SBNs, this composition may be dynamic because of the switching information sources. To avoid interrupting work processes and poor decision-making, IG should ensure the continuity of information services.

Prevention of information leakage and misappropriation: Sharing information assets among parties within a BN is usually based on trust. However, trust based information sharing can be threatened by opportunistic behaviors. This issue can be further highlighted in SBNs due to the dynamisms resulting from service orientation. IG in SBNs must ensure that these threats are recognized and ideally, prevented.

Information asset ownership management: In a BN, many valuable information assets are created collaboratively. In SBNs collaborations are based on momentary opportunities (i.e. a sensed expected customer experience that can be responded by an integrated solution). Therefore, IG must distribute collaboratively created information assets after the dissolution of certain collaborations. However, within SBNs that are formed and disbanded rapidly, there is often little clarity as to each individual's responsibilities. This means that ownerships of collaboratively created information assets cannot be easily determined using conventional formal and structural ownership mechanisms.

Prevention of data remanence within departed parties: Collaboratively created information assets are distributed among parties within a BN. In a dynamic BN where parties can easily be switched, IG must ensure that information assets have not been used illegally by a party that has already left the BN.

Preserving added value information: When a party leaves the collaboration, some important information assets can be lost. To avoid the interruption of BN operations due to this dynamism, a well-established policy is required to preserve added value information.

Traceability of information provenance: providing the source or provenance of information improves the reliability of the IQ, particularly when this information comes from multiple information sources. In this way, traceability of information provenance is required in order to be able to respond to different IG issues such as information service certification and quality-aware information service brokerage. On the other hand, proposing value via integrated solutions and providing these solutions through enacting networked business processes means using composite information services. Dynamic partnering in SBNs makes it difficult to trace provenances of composite information services that are used for decision making or enactment of networked business processes.

Dynamic trust management: Access to information assets in a dynamic BN is based on trust between parties. To secure information assets within a BN, a well-established policy is required to determine the trust value for parties and manage access to information assets based on this trust value. In a dynamic BN, this trust value needs to be updated continuously. However, conventional trust management approaches in SBNs, in which collaborating parties may collaborate together only once, may not completely prevent opportunistic behaviors.

Aligning diversified security ontologies: Each local security system, which is used by a party, understands its own vulnerabilities and threats which are addressed by security ontology. In BNs in which parties are loosely linked, these diversified security ontologies need to be aligned. This aligned security ontology supports a shared understanding of threats and vulnerabilities. However, dynamic partnering within SBNs can mean difficulties achieving a shared understanding of these threats and vulnerabilities.

Creation of trustworthy information exchange environment: The role of trust as a basis to form a BN has been proven. However, the loose linkage between parties in SBNs encounters trust. To deal with this issue, in addition to mechanisms ensuring the prevention of opportunistic behaviors, information governance within SBNs needs to create a trustworthy environment. This trustworthy environment can be based on legal foundations as well as on the reputation of BN orchestrators.

Modification of inconsistent security policies: Autonomous parties within SBNs may have inconsistent security policies. Therefore, a coherent security policy must be agreed on by all parties to ensure secure access to information distributed among parties. However, informal governance mechanisms used in SBNs (as described in Chapter 2) cannot guarantee consistency of security policies among all collaborating parties.

Identity federation: Autonomous parties collaborating within a BN store identity-related information locally. The heterogeneity and distribution of identity-related information, which can be intensified in SBNs, can result in unauthorized and incorrect service delivery. To prevent this, identity related information must be federated. The federation of identities, however, should consider privacy of actors (particularly customers). Regarding governance mechanisms that are used in SBNs (as described in Chapter 2), balancing between actors privacy and identity federation seems to be tough.

Metadata collaborative repository: Each party within a BN has a particular ontological view due to independent views on objects by collaborating parties. Each ontological view corresponds to a metadata, which represents meanings of related objects. The independent ontological views and resulting diversified metadata can be handled through ontological alignments and shared metadata. Regarding the dynamic nature of interactions among parties in SBNs (as described in Chapter 2), ontological alignments and sharing related metadata needs to be handled for any collaboration that is formed to provide an integrated solution for a customer. IG needs to ensure that ontological alignments and sharing relevant metadata is conducted accurately within interactions among parties. To do so, information governance in SBNs need to recognize ontological bases and related metadata that are used by each collaborating party via a collaborative metadata repository.

Metadata traceability: The metadata used by an information service provider needs to be traceable in order to prevent semantic inconsistency in SBNs. IG in SBNs involves ensuring the traceability of metadata related to information services. Metadata traceability is particularly important in SBNs, as parties are collaborating from different contexts. This is due to the need to provide a complete package of related products and services supporting the whole lifecycle of provided products and services.

Modification of collaborative metadata: Collaborative metadata needs to be modified to correspond to dynamisms of collaborating parties within a SBN. This will enhance a shared ontological understanding of reality among parties. Due to dynamic partnering in SBNs, this collaborative metadata needs to be modified to support understandability and interpretability of exchanged information among a SBN. IG in SBNs needs to ensure that the modification of collaborative metadata is conducted properly within a formed SBN.

Collaborative metadata evolution: Dynamism in SBNs, like switching parties or emerging environmental needs, can result in adaptions of ontologies and metadata used by collaborating parties. Collaborative metadata must evolve to keep aligned with these on-going changes.

Collaborative metadata robustness: Because collaborative metadata is regarded as a semantic foundation for all parties within a BN, it needs to be sufficiently robust. Otherwise, unceasing change will be loaded to all parties, which can then disturb a BN. This issue conflicts with the need for dynamisms in SBNs and also autonomy of collaborating parties. Therefore, IG in SBNs must balance between the need for dynamisms in SBNs (to provide mass-customized integrated solutions) and the need for robustness (to prevent network-level and party level operations disruptions).

Metadata context awareness: Parties collaborate from diverse contexts within a SBN to provide integrated solutions. Standardization of metadata is usually context-specific. Therefore, parties need to be aware of context when carrying out semantic information exchanges between parties from different contexts.

The findings of the conducted SLR, which are synthesized within 28 concrete IG issues, provide a thorough view of the issues that should be addressed by IG in SBNs. However, these theoretically originated findings need to be evaluated in a real-life situation. The evaluation of the practical relevance of the identified IG issues is addressed in the next chapter.

5.5 Conclusions

In this chapter we identified a comprehensive list of 28 concrete IG issues in SBNs with a focus on inter-organizational interactions. . These identified IG issues are classified within IQ, information security, and metadata domain. In this section we firstly discuss about the identified IG issues regarding related works. Then the implications on service orientation in BNs regarding the identified IG issues are addressed. This section concludes by the limitations of the research.

5.5.1 Discussion on related research.

Research on IG in the context of BNs can be categorized as business-oriented and IT-oriented studies. Business orientated research has focused on the characterization of information exchange in BN (e.g. (Rai et al., 2006; Croom et al., 2007; Prajogo and Olhager, 2012)). IT orientated research has concentrated on solutions that support information exchange in BN (e.g. (Afsarmanesh et al., 1998; Scannapieco et al., 2004; Dustdar et al., 2012)). This research in this thesis is situated in the intersection of these two related areas.. This chapter, based on the characteristics of SBNs, addresses concrete issues that need to be addressed by IG solutions. In this way, although this chapter does not demonstrate a concrete solution for IG in SBNs, it provides a well-established basis, as well as a comprehensive view, to develop and integrate different relevant solutions.

Much of the related work in the context of BNs have focused on the syntactic aspect of IG issues (Izza, 2009) while the semantic issues have not been sufficiently addressed in this context. Meanwhile, due to the dominance of service-oriented architectures in this context, much of the previous research has focused on information service quality issues, including availability and usability (Dustdar et al., 2012). While, Information product quality issues such as how to address information product repetition or information product synchronization have not been sufficiently considered (Rasouli et al., 2015a). The implicit assumption in many of the related studies is that information product quality issues need to be handled by each party and the network governor should only be involved in information service quality issues. However, our findings demonstrate that many of the information product quality issues resulting from dynamisms for service orientation in business networking cannot be addressed by parties separately and need to be considered by information governors at a network level.

Many solutions have been developed to support information security requirements in the context of BN (Blaze et al., 2009; Takabi et al., 2010)). However, a comprehensive view on the issues resulting from a dynamic BN has not been developed. For instance, modifying inconsistent security policies established by autonomous parties cannot be easily addressed by conventional dynamic trust management mechanisms. Meanwhile, the management of the information asset ownership can be quite challenging because of the co-creation of information assets in SBNs. This issue is intensified by the dynamic partnering and most of the proposed solutions (e.g. (Rosenbaum, 2010)) dramatically limit the agility of BN.

Previous research regarding the metadata domain of the IG requirements can be categorized into studies that address semantic business process management and studies that focus on collaborative ontology management. The research on semantic inter-organizational business process management (e.g. (Hoang et al., 2014) focuses on the gap between business experts and IT experts in the business process management lifecycle. However, the identified issues in this research address a different aspect, related to misalignment of the semantics between parties within a networked business. In this way, the identified metadata related IG issues highlight the alignment between heterogeneous information services among different parties participating in networked business processes, rather than the semantic alignment between business and IT experts within business processes.

Meanwhile, research on the technologies supporting the semantics-aware interactions are principally related to ontology technologies like WSMO, METERO-S, and OWL-S (see (Fensel et al., 2011)). These technologies enable semantic modeling, configuration, and execution of networked business processes (Karastoyanova et al., 2008). However, the semantics-aware conceptualization of inter-organizational business processes is not addressed by these ontology technologies. The identified metadata related IG issues stress the need to develop and evolve a collaborative ontology to support the conceptualization of the inter-organizational business processes in SBNs.

A deep view on the relevant solutions supporting IG requirements shows that some IG issues can be addressed using well-established solutions focusing on the structural, procedural, and relational mechanisms (De Haes and Van Grembergen, 2009). However, others cannot be handled as easily. For instance, dynamic semantic interactions between parties collaborating from different contexts are difficult to address using state-of-the-art solutions such as semantic interoperability technologies, or domain specific standardizations (Izza, 2009). Meanwhile, some IG issues are conflicting. For instance, information service clarification (i.e. the 8^{th} requirement in Table 5.5), insists on accessibility and visibility of internal information production by a party. However, this conflicts with information privacy and ownership (i.e. the 14^{th} requirement in Table 5.5).

In addition, many semantic interaction solutions, which are based on standardization, conflict with business flexibility and dynamism. This may cause conflict between IG and business requirements, which in turn, may mean that an IG program cannot respond to all emerging issues in SBNs. Consequently, a BN must make a trade-of between business value, which arises from service orientation, and risks, which emerge from information exchange in SBNs.

5.5.2 Implications

The identified IG issues clearly demonstrate that the theories in the marketing as well as in the operations management, that state the necessity for the co-creation of mass-customized integrated solutions (Hakanen, 2014), need to focus on information artefact exchange issues among parties. Particularly, BN engineering approaches (e.g. (Alt et al., 2000; Grefen, 2015a)) should focus on IG by developing relevant methods and tools to support quality-aware information exchanges. IG theories (e.g. (Khatri and Brown, 2010; Young and McConkey, 2012; Tallon et al., 2013) should go beyond organizational boundaries to be able to support issues within business networking environments.

From a practical point of view, the findings of the research indicate that a strategic transition plan for service orientation needs to be aligned with a well-established IG program in order to move from a stable product-centered BN towards a dynamic customer-centric BN. This IG program should identify emerging information exchange issues in the context of SBNs and recognize relevant solutions to respond to these issues effectively.

The business ambitions for radical change from a stable supply chain towards highly dynamic BNs need to be lessened regarding emerging information exchange risks. Misalignment between business ambitions and IG capabilities can result loss of competitive strategic position in the market. It can also interrupt operations due to low-quality and unsecure information.

Finally, the multidisciplinary nature of an IG program makes it difficult to be developed and realized properly. An IG program needs to be developed and implemented with input from experts from different domains, such as strategy, marketing, business architecture, system architecture, and technical IT solutions. An IG program also needs to be shared and evaluated by all parties within a BN. This need for multidisciplinary, multi-organizational input when developing and implementing an IG program makes it difficult to be developed successfully.

5.5.3 Limitations

In this research, to identify IG issues, we concentrated on interactions between business parties. However, the co-creation of integrated solutions with customers also requires attention to customer-supplier interactions. The identification of IG requirements, concerning the value co-creation processes that underline interactions between customers and suppliers during the usage of a product or service, needs to be addressed in future research.

6

Evaluating the Identified Information Governance Issues in Dynamic Networked Business Processes

Chapter 6

Evaluating the Identified Information Governance Issues in Dynamic Networked Business Processes

In Chapter 5 we conducted a comprehensive literature review and identified a comprehensive list of the IG issues in relation to the management of dynamic networked business processes. Regarding the conducted methodology, the theoretical relevance of the identified IG issues is evident. However, we also need to investigate the practical relevance of the identified IG issues within dynamic networked business processes in real-life situations. We need to investigate if the theoretically predicted IG issues resulting from dynamism of networked business processes are also recognized in practice. This question will be empirically tested in this chapter.

Within this chapter we first describe the objectives and approach used to conduct the desired evaluation; see Section 6.1. We then outline the empirical research design used to evaluate the practical relevance of the identified IG issues; See Section 6.2. In Section 6.3 we describe the logic models that are developed in order to support the internal and the external validity of the empirical research. Next, in Section 6.4 and Section 6.5, we present how the empirical evidence was gathered and its analysis in relation to the developed logic models. The findings of the conducted empirical research are reported in Section 6.6. The chapter is concluded by discussions in Section 6.7.

6.1 Introduction

The purpose of this chapter is to evaluate the practical significance of the identified IG issues within dynamic networked business processes in SBNs. This evaluation is necessary because until now the identification of the IG issues has been based on surveyed literature. The logic behind the conducted SLR supports the theoretical relevance of the identified IG issues. It also ensured that the derived list of the IG issues within the desired context is comprehensive. However, we need to evaluate if this comprehensive list of the identified IG issues is also relevant in real-life situations. In this way, the purpose of the evaluation can be stated as "the investigation of the practical relevance of the theoretically identified IG issues within dynamic networked business processes in real-life SBNs."

To evaluate the practical relevance of the identified IG issues, we need to investigate if the identified issues that threaten high quality and secure information exchanges are recognized by parties collaborating within dynamic networked business processes in SBNs. This investigation can be realized through an empirical exploration of IG issues within a relevant real-life environment.

This empirical exploration for the investigation of the practical relevance of the identified IG issues can be conducted in two ways, a non-directed or a directed exploration. A non-directed exploration addresses an exploratory empirical research approach, in which different observations are planned to sufficiently observe IG issues within the desired context. These observations should be designed in a way that supports all relevant issues sufficiently. The research question here can be considered as: "What are the IG issues in dynamic inter-organizational business processes?" Results of this non-directed exploratory research can be mapped onto the IG issues identified in Chapter 5 to determine which IG issues are practically relevant.

The directed exploration, on the other hand, starts the exploration using the theoretically identified IG issues. This means that this research direction does not follow a coherent exploratory research and observations are directed by the predicted list of the IG issues. The research question within this type of exploration can be stated as "Are the theoretically predicted IG issues observed in a real-life dynamic inter-organizational business process?"

Within these two alternatives for conducting the empirical investigation of the identified IG issues, we select the directed exploration. The reasons for this selection are:

- We have already conducted a comprehensive exploratory research through the SLR. Although conducting a new exploratory research by using another approach (e.g. a survey research) can enhance the comprehensiveness of the identified list of IG issue, it is not an efficient research direction. In other words, the main issue of a non-directed exploratory research can be its lack of exploration of related observations comprehensively. However, we have already supported the comprehensiveness of the identified IG requirements and in this section we only need to focus on the practical relevance of the identified IG issues.

- Regarding the nature of the characterized research question within the first direction (i.e. what question), the possible approach for conducting an exploratory research can be a survey research (Yin, 2013). However, as described further in more details, a survey is not an appropriate approach in the context of our research.

In this way, to investigate the practical relevance of the identified IG issues we follow a directed empirical exploration. However, this research direction can encounter a biased observations issue. A biased observation issue in the context of this research reflects the reporting of an observation (i.e. an IG issue) that has not originated from the dynamism of networked business processes.

Using the directed empirical exploration method, we look for specific observations (rather than a global exploration). Therefore it is likely that we observe an intended observation that in its nature is an irrelevant observation. This biased observation issue is highlighted in the context of our research, because it is likely that the identified IG issues be observed in conventional business networks (and not dynamic business networks) due to other factors rather than dynamism. These biased observations issue can strongly threaten the internal validity of findings in the directed empirical exploration. To counter this issue, we need to ensure the relevance of the observed IG issues to the dynamism of the networked business processes. The relevance of an observed IG issue in the context of this research means that it originates from the dynamic nature of networked business processes. To ensure this, we complement the aforementioned research question in this way:

"Are theoretically predicted IG issues observed in a real-life dynamic inter-organizational business process? If so, <u>**how**</u> does the dynamism of a dynamic inter-organizational business process results in the emergence of the observed IG issue?"

The added part of the research question ensures that the evidence gathered on IG issues within the empirical exploration relates to the dynamism of networked business processes. The design of the empirical research to answer this research question is elaborated in the next section.

6.2 Empirical research design

The main research approaches that can be used for conducting an empirical investigation in order to evaluate the identified IG issues found in real-life dynamic networked business processes are a survey research approach and a case-study research approach. Within these two alternative research approaches, a case study is preferred for the following reasons:

- Firstly, a case study is more appropriate to answer how questions based on empirical evidence (Yin, 2013). This is because a case study enables us to investigate a chain of relevant evidence that clearly describe how a desired phenomenon, which is an IG issue in the context of our research, has arisen. In this empirical study, we investigate "how dynamisms of networked business processes in real-life situations result in the identified IG issues". Therefore, a case study provides a more well-established basis to investigate the chain of relevant empirical evidence to answer this research question.
- Secondly, a case study is the most appropriate approach for in-depth consideration of the context of a phenomenon, for example by in-depth interviews or direct observations. In this context, survey research is quite limited because of the need to use a structured questionnaire. Therefore it is limited in its ability to offer a deep analysis of a phenomenon within a complex context (Yin, 2013).

For these reasons we establish the empirical investigation of the practical relevance of the identified IG issues on a case study research approach. The most important drawback relating to this approach is the limitation of generalizability of findings from a case study research. This limitation is addressed by using an analytical generalization approach using logic models.

6.2.1 Case study design

The case in this research is a dynamic business network that includes several parties collaborating together through dynamic networked business processes. The unit of analysis within this case is a networked business process. Based on the specified research question, a proper case study design to evaluate the practical significance of the identified IG issues should enable evidence to be collated which sufficiently support the internal validity of the findings. The case study design should also enable the triangulation of empirical evidence to ensure the construct validity as well as the internal validity of findings from the case study (Flyvbjerg, 2006). Based on these criteria, among possible case study designs (see (Yin, 2013)), we conduct the intended case study within an embedded single case study i.e. a single case with multiple units of analysis. This means that we select a SBN and focus on multiple networked business processes within the selected SBN.

To do this, we select a BN that is formed in the financial industry in the Netherlands (see Case C that is described in Chapter 3). This BN is orchestrated by a car leasing organization. Other parties are car dealers, maintainers, and insurance organizations. This BN is in a transition towards the provision of integrated mobility solutions for customers. To do this, new parties are added to this BN, such as car rental companies, other transportation service providers, and fuel service providers. The mass customization of the integrated mobility solution by this BN requires dynamic interactions between parties through the formation and execution of dynamic networked business processes.

Based on the described case study design, within this mobility BN we select two networked business processes (i.e. units), including a customer invoicing process and a mobility solution offering process. These two networked business processes sufficiently cover relevant empirical evidence to ensure the internal validity of findings in the case study.

In this SBN, a customer can receive services from different providers within the mobility value network during a contract, but pays once for all of the services. The customer invoicing networked business process that is choreographed by the car leasing organization, is composed of all related processes for customer invoicing within the parties. When a request is received to invoice a customer for mobility solutions within a specified time interval, the car leasing organization identifies all parties that have provided products or services to the customer within the specified time interval. Then the customer invoicing networked business process is formed and executed to issue the requested invoice.

Due to the mass-customization of mobility solutions, the car leasing organization within the BN is responsible for offering mobility solutions that match customer expectations. The car leasing organization as the orchestrator of the business network gathers information about customers' experiences that are distributed among all parties within the mobility value network. An integrated package of mobility products and services is then offered which best fits with the expected customer experience.

In order to do this, the car leasing organization forms and executes the mobility solution offering process. This networked business process choreographs customer processes that are defined by parties to interact with customers and to offer new products and services.
In the described case study design, construct, internal, and external validity of findings need to be ensured (Yin, 2013). These aspects of validity of findings in the designed case study are described further.

Construct validity of findings in the designed case study

Construct validity refers to using appropriate concepts and terms during data gathering (Flyvbjerg, 2006). To achieve construct validity there must be consistency within data gathering and analysis in a case study. Within this research we need to use a varied set of concepts from different related contexts such as IG, business process management, and BNs. Therefore we need to ensure that all concepts are used and interpreted consistently in all steps. To do this, based on (Yin, 2013) we use four main tactics within data gathering and analysis. As described in Section 6.4, we use in-depth interviews supported by semi-structured questionnaires for gathering data. To ensure construct validity within these in-depth interviews we apply these tactics:

- When preparing for the case study we ensure that all interviewers have a thorough understanding and interpretation of all key concepts.
- During in-depth interviews, the definitions of key concepts are presented to interviewees.

To ensure construct validity when analyzing gathered data we use the following tactics:

- The found evidence is triangulated between different sources.
- The analyzed results are presented to interviewees again to ensure all findings have been interpreted correctly.

Internal validity of findings in the designed case study

Internal validity of the findings from a case study implies reliability of causal relationships between found evidence (Cook et al., 1979). In the context of this case study, the internal validity of findings depends on the empirically proved relationship between the observed IG issues and the dynamism of inquired networked business processes. To ensure the internal validity of findings in this case study, we use logic models that link the dynamism of networked business processes to the identified IG issues. These logic models (see Section 6.3), provide a well-established basis for gathering and analyzing empirical evidence to show how dynamism of networked business processes in SBNs can result in the IG issues. Meanwhile, these logic models strongly counter the biased evidence issued within the conducted empirical research.

We require sufficient empirical data to be gathered in order to use the logic models as a basis for linking dynamism of the investigated networked business processes to the identified IG issues. The numbers of selected networked business processes (i.e. units in the multi-unit single case study design) is determined based on the adequacy of empirical evidence to cover all logic models. In this case study sufficient evidence from the two selected networked business processes.

Meanwhile, the internal validity of findings from the case study requires an explanation of why/how a mapped empirical evidence results in other mapped empirical evidence within a logic model. To do so, we highlight transitions between mapped empirical evidences (see the description in Section 6.5).

External validity of findings in the designed case study

External validity is the extent to which findings from a case study can be generalized. Generalization of findings in empirical studies can be done through analytical generalization and statistical generalization (Yin, 2013). In statistical generalization, an inference is made on the basis of empirical data collected from a representative sample within a context. Alternatively, analytical generalization uses relevant theories to generalize findings from a case study (Darke et al., 1998; Yin, 2013). In this research we use an analytical generalization approach. In this way, we rely on theories, which are used within the logical reasoning for the development of the logic models in Section 6.3, to generalize empirical findings from the case study.

Regarding the described tactics to support the validity of the designed empirical research, logic models have a core role in supporting the internal and external validity of the findings from the designed case study. Regarding this critical role of the logic models within the conducted empirical research, the development of these logic models on the base of the relevant theories is described in the next section.

6.3 Logic models to describe the link between dynamism of networked business processes and the IG issues

Logic models are used as analytical tools in different contexts such as health care programs, organizational change theories, and national policy making (Funnell and Rogers, 2011). Regarding characteristics of each of these contexts, different approaches are used to design a logic model.

The context of this research, i.e. service-oriented business networking is a highly complex area. This complexity results from dynamic interactions among autonomous parties to provide an integrated solution for customers. To address this complexity, in line with Chapter 2, we use a system design approach which has been recognized as a suitable approach to deal with complexity (Boulding, 1956).

In the context of system theory, different methods have been developed to support structured design and representation of a system. These include the viable system method (Gummesson et al., 2012a), viewpoint based system design methods (Espejo et al., 1996; Kotonya and Sommerville, 1996), and object-oriented design methods (Booch, 2006). In this chapter, since we concentrate on IG issues, we use the object-oriented design method as starting point. This is because it provides many structured analytical tools and representation notations.

The object-oriented design method addresses two views for development of logic models. These are the static view and the dynamic view. The static view represents the static relationship between objects of a system within a system structure. The dynamic view addresses interactions between objects and represents the impact of change in one object on other objects.

Regarding the static and dynamic views within the object-oriented design method, we conduct two main steps to develop logic models that enable us to link dynamisms of networked business processes to the identified IG issues. The first step concentrates on the characterization of static relationship between dynamic networked business processes and IG domains. This characterization is established upon a theoretical description of networked business process and IG, as described in Chapter 5. It also describes the information exchange between parties within managing networked business processes. Outputs of this step are structures of relationships between related concepts as represented by class diagrams. The structured characterization of the relationship between networked business processes and IG domains provide a well-established basis for the second step.

In the second step, we investigate how dynamism of networked business processes can influence IG domains. The investigation is based on logical reasoning supported by relevant theories from the literature. In doing so, we analyze how each aspect of the dynamism in networked business processes, as described in Chapter 5 (i.e. dynamic partnering, dynamic external processes, and dynamic internal processes), influences IG domains. Logic models representing lines of reasoning, link aspects of dynamism in networked business processes to concrete IG issues that are expected by related theories from the literature. To facilitate the use of related theory for deductive reasoning, we use intermediate outcomes (Wholey, 1979) to link between DNBPs and IG issues.

Intermediate outcomes are sources of issues that threaten high quality and secure information exchange. Since there is a wide range of literature on the sources of IQ and information security issues, using the intermediate outcomes enables us to base our logical reasoning on relevant theories. To simplify the representation, we show logic models pertaining to each IG domain separately. This means a separate logic model is presented for information product quality issues, information service quality issues, security issues, and metadata issues. The outputs of this step are concrete IG issues in DNBPs that are deduced from logical reasoning.

The described two steps for the development of the logic models that link the dynamism of networked business processes to the identified IG issues are elaborated in the following of this section.

6.3.1 Characterizing IG within managing networked business processes

We rely on related theories on IG in the context of business networks for the logical representation of relationship between IG and networked business processes. In this context, IG is seen as a part of network governance (Kravets and Zimmermann, 2012; Lajara and Maçada, 2013; Trang et al., 2013). Network governance, as a dynamic capability, aims to align resources within a network that are provided by parties to achieve expected joint outcomes (Sambamurthy et al., 2003; Mithas et al., 2011). In this way, IG in the context of BNs, concentrates on the alignment of information resources provided by different parties to support expected outcomes (Tallon et al., 2013).

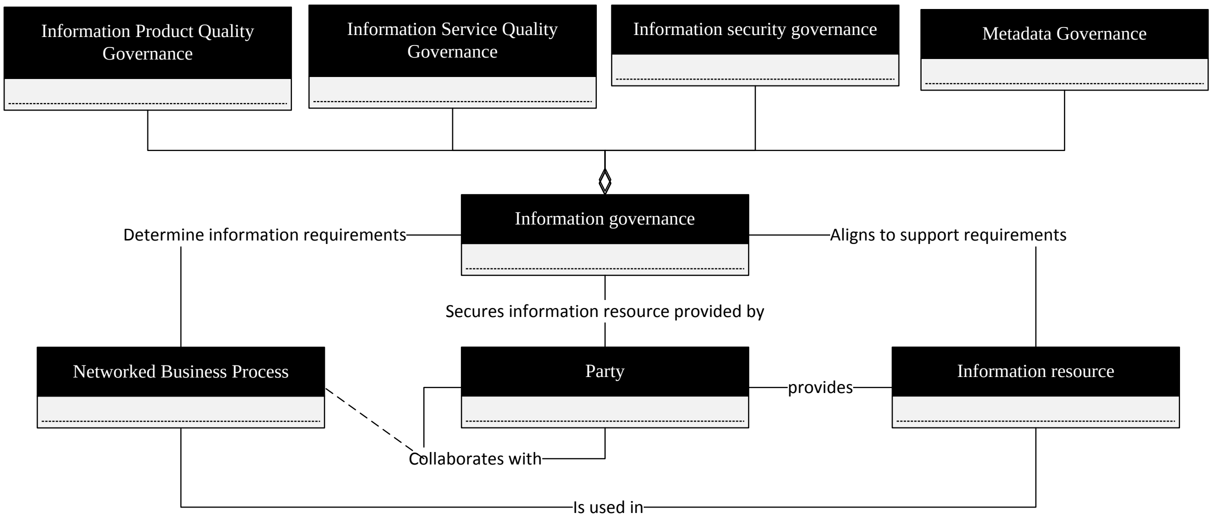

Figure 6.1- IG in the context of business networks

Expected outcomes in the context of BNs can be achieved by composing and enacting networked business processes (Mehandjiev and Grefen, 2010). In this way, in the context of this research, IG is seen as mechanisms that align information provided by parties to be used effectively in composing and enacting networked business processes (see Figure 6.1).

Regarding the IQ definition, that is fitness of information for use (Wang, 1998), the alignment addresses the provision of information that conforms to the expected requirements of networked business processes management . The alignment is supported by information product quality governance, information service quality governance, and metadata governance. Information product quality governance aligns information production processes that are distributed among different parties with the information requirements for composing and enacting networked business processes. Information service quality governance aligns the conversion of information products to information services in a way that can be used within composing and enacting networked business processes. This may be realized by information query schemes or syntactic adaptions. Metadata governance enhances semantic exchange of information within networked business processes. Meanwhile, IG should safeguard information assets that are shared by a party through security governance mechanisms.

Figure 6.1 clearly addresses IG as a dynamic capability supporting high-quality and secure information exchange. However, to be able to investigate IG issues resulting from dynamic networked business processes, the logic of information exchange within networked business processes needs to be elaborated further. To do so, we refine information exchange logic within networked business processes (see Figure 6.2).

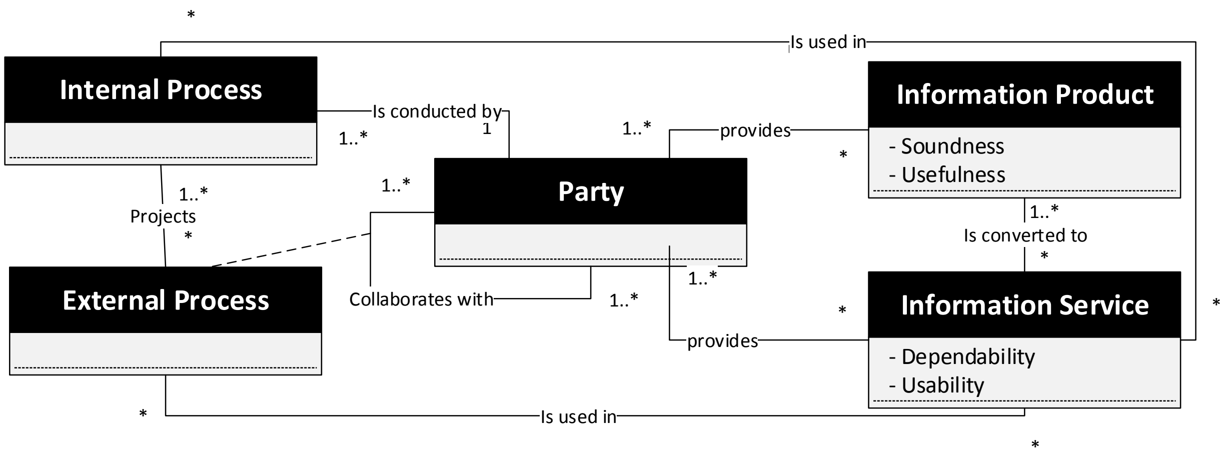

Figure 6.2- Information exchange within networked business processes (a structure view)

According to Chapter 5, we decompose networked business processes into external and internal processes. Information resources also are decomposed into information products and information services. Information products are converted to information services to be used within internal and external business processes (see Figure 6.2). The conversion can be realized by an automatic application, an information query, or by a manual procedure. The conversion can also highlight syntactic and semantic representations of an information product. The conversion can be realized by a party that provides information or a party that uses it (see (Seguel et al., 2014) that describes protocol adaption within supply chains and demand chains). This conversion should be in line with quality, security, and metadata requirements determined by IG.

6.3.2 Linking dynamism of networked business processes to the IG issues

In this step we intend to link dynamisms of networked business processes to the identified IG issues. We investigate how dynamisms of networked business processes can lead to the identified IG issues. Regarding the object-oriented design method, this step addresses a dynamic view on relationships between concepts that are characterized in Section 6.3.1. To do so, we rely on logical reasoning based on related theories from the literature. To enhance the reliability of the logical reasoning, it is based on four facets (Petticrew and Roberts, 2008); see Figure 6.3.

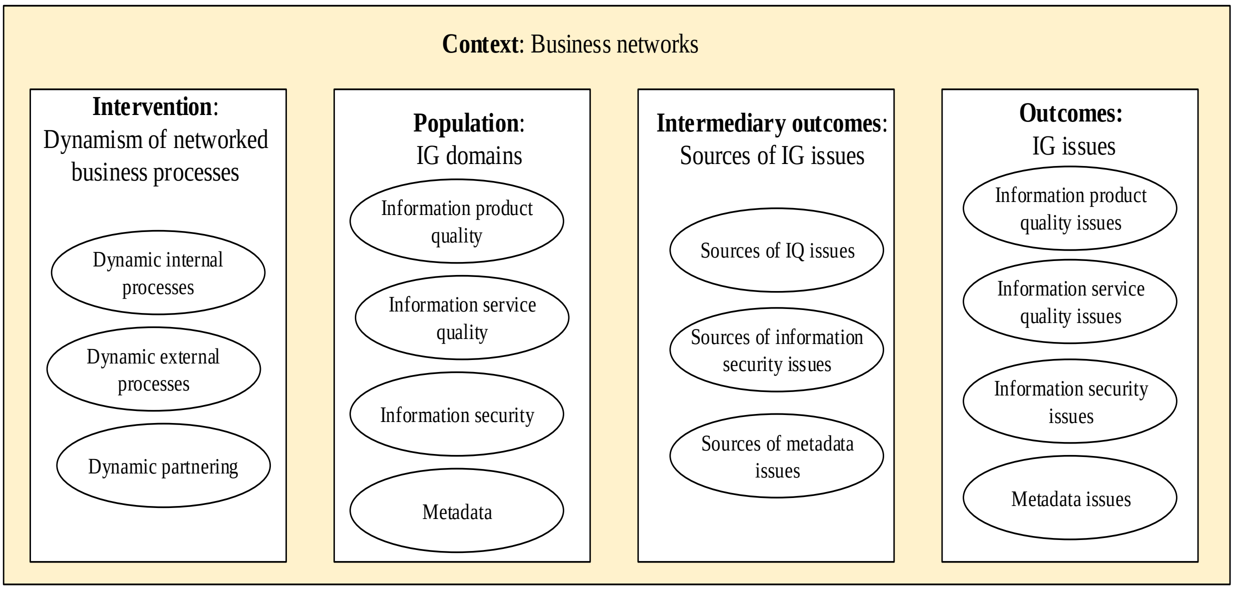

Figure 6.3- The logical reasoning schema

The logical reasoning explains how dynamism of networked business processes (as the intervention facet) affects different IG domains (as the population facet) with emerging issues (as the outcome facet). To support our line of reasoning using related theories we also use the intermediary outcomes facet. The intermediary outcomes are sources of IG issues that have been addressed in previous related studies. Based on this structured logical reasoning we intend to show how dynamism of networked business processes triggers the sources of IG issues.

To simplify the representation, we describe logical reasoning pertaining to each of the IG domains (i.e. the population facet) separately. Within each IG domain, we firstly address sources of issues based on relevant theories. Then we deduce how dynamism of networked business processes triggers these sources of issues.

Information product quality issues

Sources of information product quality can be characterized within mapping-related issues and changes to underlying objects (Wand & Wang, 1996; Stvilia et al., 2007). Mapping-related issues arise when there are incomplete, ambiguous, inaccurate, inconsistent, or redundant information products in databases (Wand and Wang, 1996; Lee et al., 2002; Price and Shanks, 2005). Mapping-related issues address intrinsic aspect of information product quality (Xu et al., 2002). Changes to underlying objects, on the other hand, address issues resulting from changes to a real-world object that is represented by an information product. Figure 6.4 shows how the dynamism of networked business processes can trigger these two sources of information product quality issues. It also shows resulting concrete information product issues. We describe Figure 6.4 in the next paragraphs.

Information is produced by parties in BNs (see Figure 6.2). The production of information can be seen as mapping real-world objects by information products. Due to the autonomy of parties in SBNs, each party can use different mapping schema for the production and storage of information in databases. In stable BNs, this diversity can be handled by a global mapping schema. However dynamic partnering in SBNs challenges the possibility of using a global schema. In this way, dynamic partnering can trigger mapping-related issues. Mapping-related issues can lead to syntactic inconsistency, semantic inconsistency, incompleteness, repetition, and garbling of information products (Wand & Wang, 1996; Lee et al., 2002; Price & Shanks, 2005).

On the other hand, information is used for composing and enacting internal and external business processes (See Figure 6.2). This means that information production should produce information on objects that are related to managing internal and external business processes. The dynamism of internal and external business processes can result in relevance of emerging objects and outdating of current objects. Since the change of the information production process is time-consuming, the dynamism of internal and external business processes can result in late delivery of information products, incomplete information products in support of emerging requirements and also information products with no added value.

Information service quality issues

Information services are provided by parties within a BN and are used within networked business processes (see Figure 6.2). In this way, where information product quality addresses intrinsic aspect of IQ, information service quality refers to relational and reputational aspects of IQ (Wang and Strong, 1996; Strong et al., 1997; Stvilia et al., 2007). The relational aspect of information service quality implies the usability of an information service by a consumer. In this way, the relational aspect of information service quality concentrates on representational dimensions of IQ such as understandability and interpretability. The reputational aspect of information service quality in the context of BNs

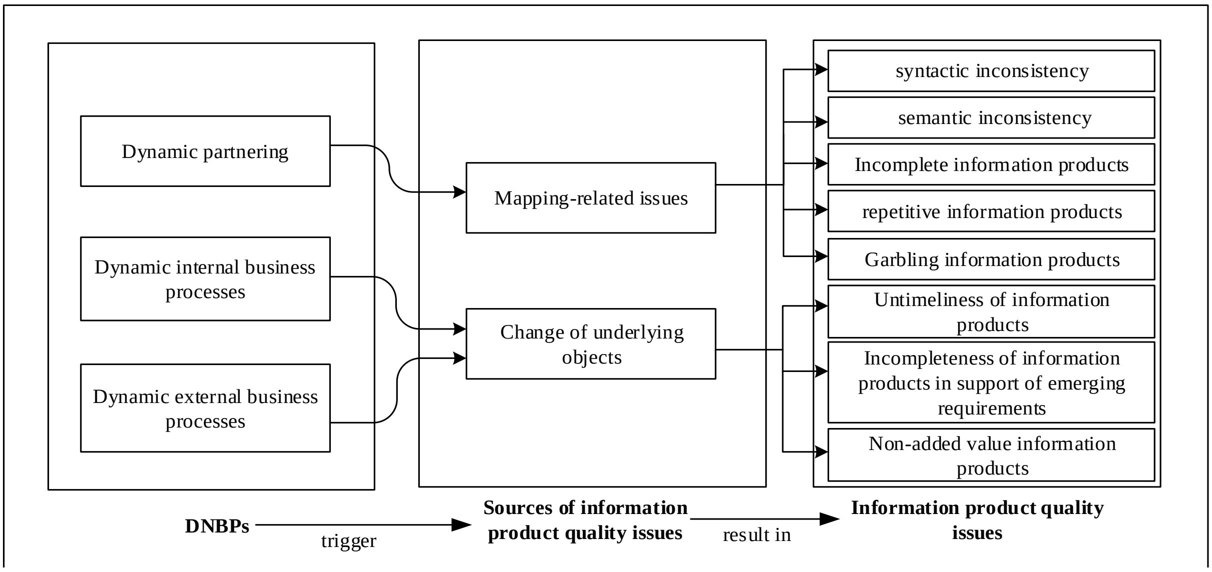

Figure 6.4- Information product quality issues in DNBPs

can be described as the concept of trust. In this way, the reputational aspect addresses reliability and acceptability of an information service provided by parties.

Relational aspect of information service quality can be threatened by context change (Strong et al., 1997; Kahn et al., 2002; Stvilia et al., 2007). Context itself consists of two main components. These include context language, which is also addressed by context ontology, culture, or norms, and context interaction standard including interaction protocols. Dynamic partnering in SBNs leads to collaborations among parties from different contexts with different languages. The variety of languages originating from different contextual cultures may cause improper interpretation of information services by information consumers (Nakatani et al., 2006; Hüner et al., 2011b) (see Figure 6.5). On the other hand, dynamism of external business processes leads to the need for change of interaction protocols in a way that is aligned with interaction requirements that are specified by external business processes.

Dynamic partnering also intensifies the need for change of interaction protocols to support interaction requirements of a specific party. Change of interaction protocols that is triggered by dynamic partnering and dynamic external business processes can easily result in non-understandability of information services by (some) parties (Falge et al., 2012a; Felici et al., 2013) (see Figure 6.5).

The reputational aspect of information service quality is strongly tied with the provenance of an information service. Information services are provided by parties within a BN (see Figure 6.2). Dynamic partnering in SBNs leads to change of information services provenance. This change can result in non-reputed, quality-unaware, and unreliable information services (see

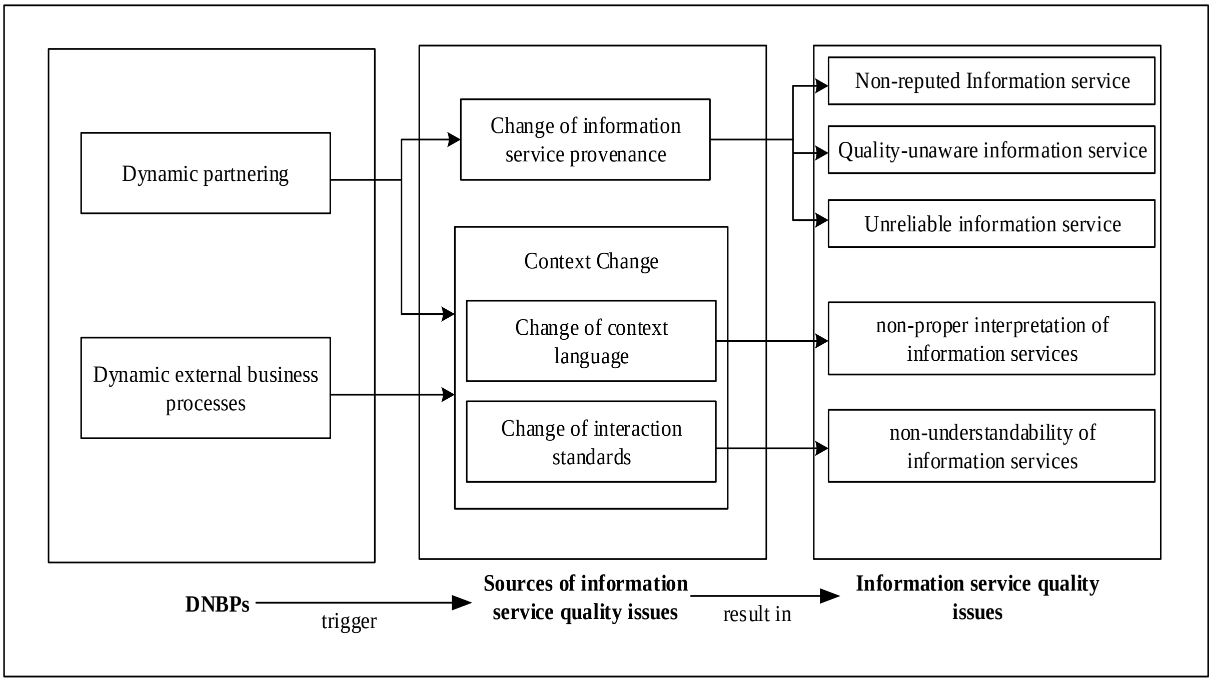

Figure 6.5- Information service quality issues in DNBPs

Figure 6.5). Non-reputed information services arise because reputation can be achieved through long-term interactions (Kelton et al., 2008). A change in the source of information can also lead to quality-unaware information services because the assessment of information service quality is usually based on the certification of its provenance (Haug and Stentoft Arlbjørn, 2011). Reliability of information service is basically depends on trustworthiness of its provenance. Consequently, change of information service provenance threatens trustworthy and reliability of information services.

Information security issues

For the characterization of sources of information security issues we rely on related works that have investigated information security issues in relevant contexts, particularly in the context of cloud computing (e.g. see (Subashini and Kavitha, 2011; SO, 2011; Chen and Zhao, 2012)). Cloud computing is a relevant basis, because Figure 6.2 indeed characterizes an information as a service scenario (Maximilien et al., 2008). Figure 6.2 declares that information that is produced and stored in a party's database is converted into an information service to be used by another party. In this way, the information production and storage (and possibly conversion), are outsourced by the information consumer to the information provider.

On this basis, regarding related literature (see (Subashini and Kavitha, 2011; SO, 2011; Chen and Zhao, 2012)) we characterize four main sources of information security issues that can be triggered due to the dynamism of networked business processes. These are change of security policies, change of information provenance, change of information locality, and change of information segregation (see Figure 6.6).

In the context of BNs, security policies need to be developed on two levels: a party level and

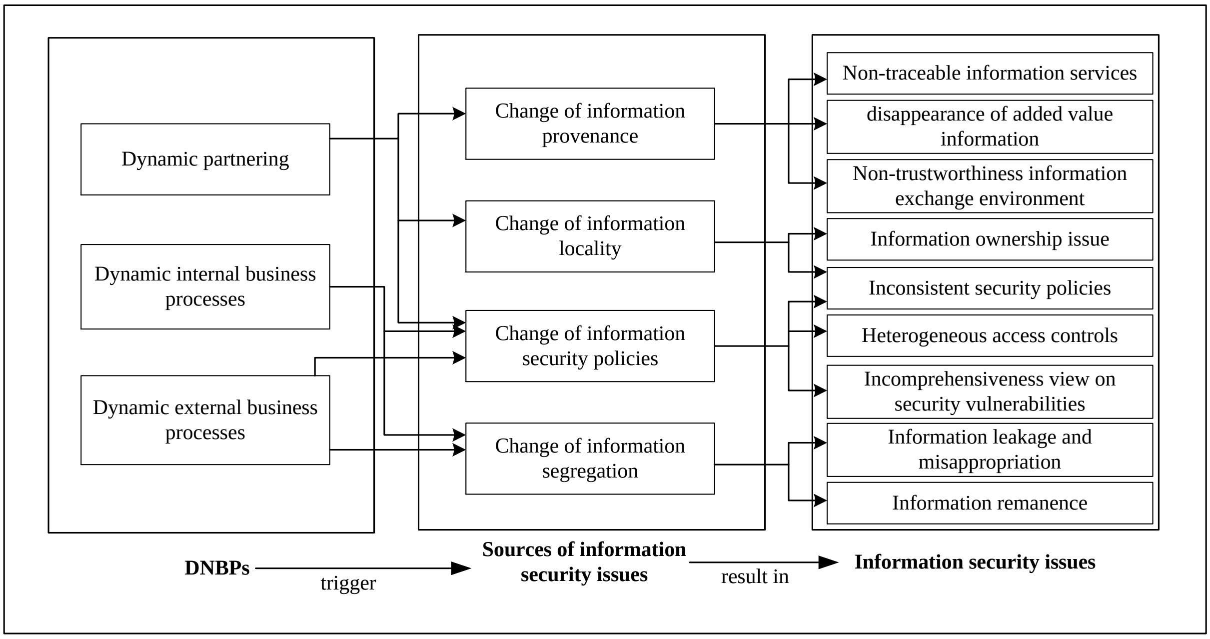

Figure 6.6- Information security issues in DNBPs

a network level. A party level security policy supports confidentiality, availability, and integrity of information assets within the boundaries of a party. However, network level security policy relates to information that is exchanged between parties within composing and enacting networked business processes. The network level security policy should be aligned with parties' local security policies. However, it also needs to be aligned with required information accesses by a networked business process.

Dynamic partnering threatens consistency of network level security policy with new added parties' security policies. On the other hand, the dynamism of networked business processes necessitates the occasional change of market level security policies that likely results in inconsistency of security policies between different networked business processes. The inconsistency of network level security policies causes the issues of heterogeneous access controls as well as an incomprehensive view on security vulnerabilities.

The issues caused by change of information provenance in the information service quality domain, which addresses issues that an information service consumer deals with, are described information service quality issues. Change of information provenance also causes issues within the security domain that need to be addressed by an information security governor (von Solms, 2005). The information security governor should provide a trustworthy environment that supports reliability and reputation of information services to be used within networked business processes. The change of data provenance that is triggered by dynamic partnering hampers traceability of information services (Handel and Wang, 2011). In addition, change of information provenance can easily result in disappearance of added value information services (Roy et al., 2013; Lu and Xu, 2014). On the other hand, a lack of clarity regarding information provenance, due to lack of information service traceability, can threaten trustworthiness of information exchange environment. This in turn can cause reluctance among information service providers to share their information assets (Yang, 2012; Lotz et al., 2012).

Information is stored in databases that are distributed among different parties within a SBN (See Figure 6.2). Due to the difference of compliance and information security policies in different organizations, the locality of information is important. Dynamic partnering causes a change of information providers within networked business processes. In this way, dynamic partnering triggers change of locality of information sources that are used. The change of locality results in the need for handling diversified and inconsistent security policies. On the other hand, information created through the execution of a networked business process (e.g. data logs, or customer experience resulted from a networked business process) also needs to be stored in distributed databases located within different parties. The change of locality that is triggered by dynamic partnering leads to issues of ownership of information which is created collaboratively (Miseldine et al., 2008; Haug and Stentoft Arlbjørn, 2011).

In order to ensure confidentiality of information, information that is used within a networked business needs to be segregating from information that is used by other networked business processes. This segregation is necessary to manage access for information within different networked business processes (Brodkin, 2008; Chen and Zhao, 2012). Dynamism of internal and external business processes causes changes to information segregation. These changes are needed to be able to manage confidentiality within different networked business processes. However, this change of information segregation can result in information leakage and misappropriation (Sathyanarayana and Sheela, 2013; Roy et al., 2013) as well as information remanence issues (Sathyanarayana and Sheela, 2013).

Metadata issues

Metadata is information about information that enhances the understandability of an information service by a consumer (Khatri and Brown, 2010). Metadata governance supports semantic interoperability of information services provided by parties within a BN through the formation of a shared ontology about related concepts (Uschold and Gruninger, 2004). Therefore, sources of issues that threaten understandability and interpretability of information services are also regarded as the sources of metadata issues. In this way, according to Figure 6.5, the sources of metadata issues in the context of SBNs are changes to information provenance and context changes (see Figure 6.7).

Metadata governance involves forming a collaborative repository of metadata used by different parties in order to facilitate understandability of information services by different parties (Schemm and Legner, 2008a; Hüner et al., 2011a). An information service that is provided by a party to be used within a networked business process by another party should be referred to its related metadata in a collaborative metadata repository (see Figure 6.2). Change of information service provenance that is triggered by dynamic partnering troubles the availability of a relevant metadata in a formed collaborative metadata repository (Hüner et al., 2011a). It also affects the traceability of metadata related to a provided information service (Myrseth et al., 2011). A metadata governor, who is responsible for aligning

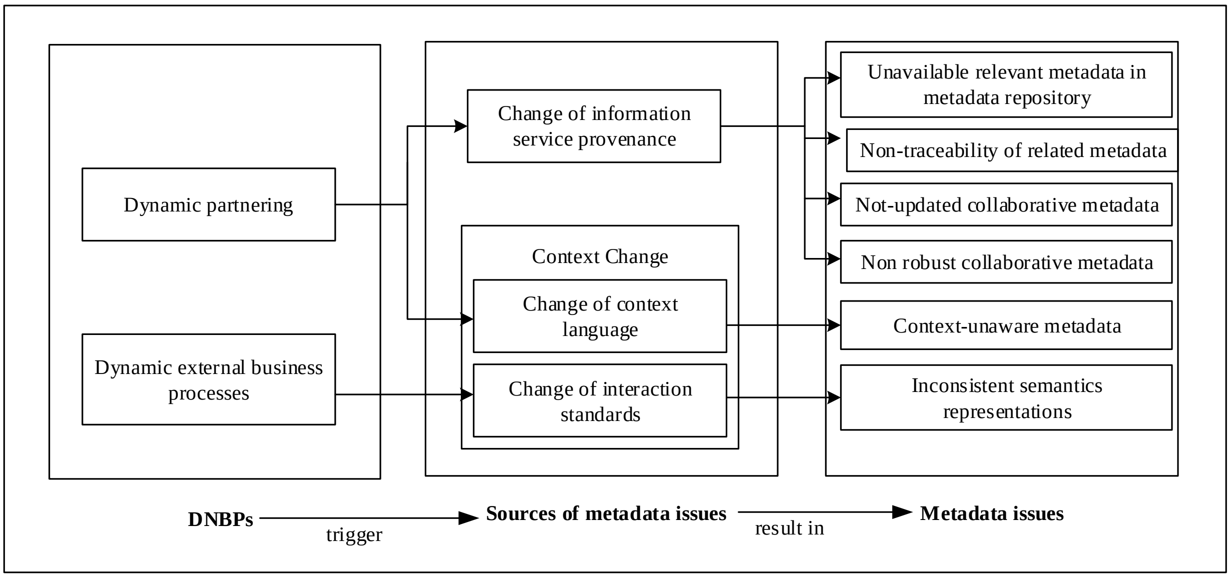

Figure 6.7- Metadata issues in DNBPs

semantics used in different information services by different parties, also needs to evolve collaborative metadata to keep it aligned with the semantics of new information services (see Figure 6.1). On the other hand, evolution of metadata necessitates changing semantic adaptors that are used by information service providers (Kalfoglou and Schorlemmer, 2003). Since a reliable change of semantic adaptors needs considerable attention, the collaborative metadata used needs to be as robust as possible (Batini, 2004). In this way, metadata governance requires balancing between update and robust characteristics of a collaborative metadata.

Context changes in SBNs are triggered by dynamic partnering and dynamic external business processes. Collaborative metadata that is used to support semantic interactions among parties are usually context specific such as ebXML in the context of conventional supply chains (Bechini et al., 2008). Change of context language, resulting from adding new parties from new contexts, threatens context-awareness (specific meaning of an information service in its related context) of information services that are exchanged within networked business processes (Schemm and Legner, 2008b; Falge et al., 2012a). On the other hand, semantic representation of information services should be aligned with network interaction standards (e.g. an OWL based semantics representation). Dynamic external business processes, which address change of network-level standards, trigger change of pre-determined semantic interaction standards. This leads to inconsistent semantic representations within dynamic networked business processes (Becker et al., 2008; Barnickel et al., 2010).

The developed logic models, which are based on related literature, link the dynamism of networked business processes in the context of SBNs to the identified IG issues. These logic models provide a well-established basis for gathering and analyzing empirical evidence to investigate the practical relevance of the identified IG issues. Gathering and analyzing empirical evidence, which are based on the developed logic models, are described in the following sections.

6.4 Gathering empirical evidence

As described in Section 6.2, for gathering relevant evidence we concentrate on two networked business processes, namely customer invoicing and mobility solution offering processes. These processes are examined within the SBN that is formed by a car leasing organization. Data gathering is handled within three steps, according to the three facets of our logic models (see Fig. 6.3). In the first step we gather data about the mobility business network. In the second step, we gather data for the characterization of the two selected networked business processes. Finally, in the third step, we collect relevant data on arisen IG issues resulting from the dynamism of two characterized networked business processes. These three steps are described further.

In the first step we concentrate on gathering data for the characterization of the mobility BN as the context of this empirical research. This characterization is required because the dynamism of networked business processes originates from the characteristics of the mobility BN. In this part we refine the dynamic interactions among collaborating parties within this SBN in more detail. To do this, we use in-depth interviews as well as related archival records. The in-depth interviews are supported by a semi-structured questionnaire.
In the second step we concentrate on collecting data for the characterization of the two selected networked business processes. The process for customer invoicing is modelled in collaboration with a key employee from the financing department of the car leasing organization. The networked business process, which offers mobility solution for a customer, is modelled in collaboration with a key employee from the marketing department. The developed models are documented within choreography and orchestration diagrams (see Appendix F). To test the correctness of the documented models, they are presented in a workshop for experts from the enterprise architecture, finance, marketing, IT, and procurement departments of the car leasing company.

The third step concentrates on collecting data on IG issues resulting from the dynamism in the two selected networked business processes. The data collection in this step is also based on in-depth interviews that are supported by a semi-structured questionnaire. The semi-structured questionnaire is developed based on the identified IG issues (see Appendix G). Indeed, items of the semi-structured questionnaire explores if the theoretically predicted IG issue is observed in the selected networked business processes and if so, how the dynamism of the networked business processes result in the IG issue that has arisen.

In order to gather relevant data, we organize the in-depth interviews in two rounds. In the first round, five in-depth interviews are conducted with key employees from the enterprise architecture, finance, marketing, procurement, and IT departments of the car leasing organization. The interview with the employee from the finance department focused on the information product and information service quality issues within the customer invoice networked business process. The interviews with the employees from the marketing and procurement departments concentrated on the information product and information service quality issues within the mobility solution offering networked business process. Interviews with employees from the enterprise architecture and IT departments focused on information security and metadata issues within both of the networked business processes.

We conduct a preliminary analysis on the conducted interviews in order to investigate if the gathered data cover all of the identified IG issues (see the results of this preliminary analysis of gathered data in (van Beek, 2015)). The second round in-depth interviews are conducted for two reasons. The first reason is to investigate the construct validity of the gathered data in the in-depth interviews. To do this, the results of preliminary analysis of gathered data are presented within a two-hour workshop to the all interviewees. Based on feedback from the interviewees, inconsistent interpretations of the gathered data are recognized and improved. The second reason is to gather complementary data on the IG issues that have not been covered within the first round. To do this, we conducted three in-depth complementary interviews with the employees from the enterprise architecture and IT departments.

6.5 Analyzing the gathered evidence

Analysis of the evidence is based on our theoretically-supported logic models (see Section 6.3). Indeed, for analyzing findings from the case study we rely on theoretical propositions (Yin, 2013) that are stated within the developed logic models. In other words, it can be said that we match empirical evidence to theoretically predicted events, which is considered to be the use of logic model as an analytical technique (Mulroy and Lauber, 2004; Funnell and Rogers, 2011). In doing so, we investigate how evidence on the IG issues are linked to the dynamism of the networked business processes.

Using logic models to analyze case study evidence requires considering two critical principles, highlighting transitions as well as attending to contextual conditions (Yin, 2013).The highlighting transitions principle in the developed logic models is considered by the trigger and the result relations between the facets of the logic models (see Figure 6.4, 6.5, 6.6 and 6.7). This principle addresses the need for an explanation of why/how a piece of mapped empirical evidence results in other mapped empirical evidence within a logic model. In order to address this principle we explain how the dynamism of the selected networked business processes triggers the sources of IG issues and how the IG issues sources lead to the observed IG issues. Although this explanation enhances the internal validity of the logic model based analysis of the found evidences, it also needs to be constructively validated. To ensure the construct validity of the explanations, we present the derived explanations for domain experts (see Section 6.4). We also rely on the triangulation of the findings from different sources (i.e. different interviewees).

Considering the contextual conditions principle refers to investigating rival explanations of the found evidences. In the context of this research two types of rival explanations can be considered as below:

- Explanation of empirical findings in a way that denies the relationship between the observed IG issues and the dynamism of the networked business processes.
- Explanation of other lines of reasoning (i.e. in parallel with the stated lines of reasoning) to link the dynamism of networked business processes to the IG issues.

The explanation of empirical findings by logic models should be in line with theoretical foundations in the context (Yin, 2013). However, the former type of rival explanations is opposed to theories that support the relationship between the dynamism of networked business process and the emergence of the empirically observed IG issues. Therefore, this type of rival explanations is rejected due to its incompatibility with the theoretical foundation of the research context.

The second type of rival explanations addresses exploration of other (new) sources of IG issues through findings from the case study. In this research we do not concentrate on exploring the sources of IG issues and the existing theories on the sources of IG issues sufficiently support the used lines of reasoning, we do not consider these rival explanations here, though they may be applicable. However, the findings from the conducted case study can be used in future research to explore new sources of IG issues.

6.6 Findings

The results of the conducted case study are reported in Table 6.1. As described in the design of the case study and the used analytical technique, the found evidence is reported in order to explain how the dynamism of the networked business processes result in the IG issues. In order to highlight transitions between the found evidence we explain empirical finding relating to each of the IG issues separately. IG issues that are triggered by the identical aspect of the networked business process dynamism and originated from the same source of IG issues are represented in same rows in Table 6.1.

Table 6.1- Findings from case study research in a business network that provides integrated mobility solutions

The identified IG issues		Explanation of the empirical findings that represents the practical relevance of the identified IG issue
Information product quality issues	Syntactic inconsistency	Due to the variety of invoice formats that are used by different parties, some personnel in the accounting department are employed to re-enter financial information that are received from other parties. The car leasing organization cannot standardize invoicing formats within all parties because parties in the business network change repeatedly.

	Semantic inconsistency/ Garbling information products/ non-proper interpretation of information services	Different maintainers, which are dynamically selected by customers, use different terms which cause misinterpretation of received information. Although there is a clear definition about different maintenance services in the car leasing organization (as an ontology), this ontology is not consistently used among all related parties that dynamically interact within the mobility business network. It is also difficult to generalize the definitions of the services consistently since maintainers are selected by customers dynamically.
	Repetitive information products	Due to the autonomous nature of parties, the same financial information that is stored by the car leasing organization is also kept by car rental companies.
	Incomplete information products / Incompleteness of information products in support of emerging requirements	Customers' experience information is distributed among all parties. The marketing department of the car leasing organization needs to integrate this distributed information within an integration schema. The integration schema includes different information objects that are necessary for a decision support system to offer a mobility solution. However, relevant parties do not produce the required information objects. Due to the dynamism of parties, the car leasing organization cannot easily distribute information production responsibilities to ensure the production of the required information.
	Untimeliness of information products	In many cases services that have been provided are not stated on an invoice because the information has not been updated by parties. This is because parties collaborating within a networked business process for the provision of a mobility solution are dynamic. Therefore the car leasing organization cannot apply a predefined standardized procedure to ensure that information is received on time from all parties.

	Non-added value information products	There is a large amount of information relating to car deficiencies stored by car leasing organization. In the new business model developed, monitoring assets (i.e. cars) is undertaken by car rental companies. Therefore, information about car deficiencies would be useless for the car leasing organization. However, since car rental companies are dynamically selected within the formed networked business processes, the car leasing organization prefers to keep information on car deficiencies to ensure its availability.
Information service quality issues	Non-reputed Information service	The car leasing organization occasionally receives insubstantial financial information, especially by maintainers. However, the dynamic partnering, resulting from adding new parties to the mobility business network, makes it difficult to conduct auditing activities to certify the quality of the financial information by all parties.
	Quality-unaware information service	Within the mobility solution offering networked business process, the car leasing organization proposes mobility solution with its pertaining cost for a customer. The proposition of the cost for the proposed solution is based on a customer's behavior that has been recorded by all parties within previous interactions. However, dynamic partnering makes it difficult to guarantee the expected quality of information that is provided by parties.
	Unreliable information service	Issuing an invoice embracing all history of services provided to a customer may not be possible because of the absence of information by some parties that already have left the business network.

	Non-understandability of information services	The car leasing organization is set up to be able to handle predefined interaction standards with key parties like car rentals (like predefined XML formats that are shared among all parties). The predefined information services format needs to also be aligned with interaction standards that are regarded by external business processes. The dynamism of the external business processes (like the change of a software service that is provided by a car rental) can cause to the non-understandability of exchanged information services.
Information security issues	Non-traceable information services	Handling customers' complaints about issued invoices necessitates the traceability of related information provenance. However, due dynamic partnering in the business network, often the provenance of the related information cannot be recognized easily.
	Disappearance of added value information	If parties who own critical information (e.g. car rental companies) leave the business network this can interrupt the provision of mass customized solutions.
	Non-trustworthiness information exchange environment	Many of the parties who collaborate in the business network are competitors such as car rental companies or car dealers. If competing parties are in doubt about the misuse of their information asset by their competitors, the business network would be disrupted. However, the change of information services provenance makes it difficult to set well-established procedures to ensure proper use of information assets by all parties.

	Information ownership issue/ Information leakage and misappropriation/ Information remanence/	Understanding a customer's experience about a provided integrated mobility solution involves sharing and collaboratively using information stored in distributed CRM systems. The car leasing organization aims to form a central data warehouse to use decision support systems to offer a mobility solution for a customer. However, storing information services provided by other parties who are dynamically changing, in the centralized data warehouse is challenging. On the other hand, since decision support systems can also be used by other parties (like car rentals to offer a competitive price), it is likely that competitors' information may be misappropriated. The car leasing organization intends to segregate information provided by each party within the central data warehouse. However, the dynamism of networked business processes to provide a mobility solution may result in the remanence of information.
	Inconsistent security policies/ Heterogeneous access controls/ Incomprehensiveness view on security vulnerabilities	The parties within the mobility business network apply different and inconsistent authorization and authentication polices to access information related to customers' experience that are stored in distributed databases. The alignment of these inconsistent security policies is difficult to be governed by the car leasing organization. This is due to the dynamism of parties that collaborate and also the change of information services that are required to offer a mass-customized mobility solution. On the other hand, although the car leasing organization is responsible for the security of information that is gathered in the central data warehouse, the change of external business process makes it difficult to ensure the effectiveness of the applied security procedures. These external processes may include application services that are used by car rentals to provide customer related information.

Metadata issues	Unavailable relevant metadata in metadata repository	The car leasing organization uses a predefined definition of the services that are reported in customer invoices. However information sent by other parties (particularly car maintainers) is often not matched with any predefined definition. The standardization of the terms in all parties within the business network is difficult because of the dynamic partnering.
	Non-traceability of related metadata	To respond customer complaints, information in an invoice needs to be re-interpreted by using original information. This re-interpretation requires traceability of metadata. However, because of the lack of a joint standardized ontology among all parties and the dynamism of parties, it is possible that the financial information may be interpreted in an inconsistent way than originally intended.
	Not updating collaborative metadata	Emerging services provided by new parties (e.g. different navigation and intelligent traffic management services) that aim to collaborate within the mobility business network necessitates updating the ontology that is used by the car leasing organization.
	Non robust collaborative metadata	The mass-customization of mobility solutions through the mobility solution offering process needs collaboration among parties with other markets. For instance, the car leasing organization can be asked to handle hotel booking for some customers. This causes the need for using multiple market-specific interaction standards (i.e. dynamic external business processes). On the other hand, updating the collaborative ontology that is used by the car leasing organization in order to be aligned with emerging market-specific terms requires changing external business processes within other collaborating parties.

	Context-unaware metadata	The deficiencies terms used by car rental organizations are not the same deficiencies terms used by maintainers due to the context difference. The standardization of these terms within all related parties is difficult for the car leasing organization due to the addition of new parties, particularly new maintainers, dynamically.
	Inconsistent semantics representations	In order to align inconsistent metadata used by different parties within the mobility business network, the car leasing organization can use ontology matching tools. These tools enhance dynamic evolution of relevant collaborative metadata. However, aligning inconsistent metadata using conventional ontology matching tools cannot be realized as different parties use different ontology representation standards (e.g. OWL, WSMO, and METERO-S),

The findings from the case study, as reported in Table 6.1, show the practical relevance of the theoretically identified IG issues within composing and enacting dynamic networked business processes in SBNs. Based on the represented explanations, all of the 28 identified IG issues are practically relevant. However, regarding the scientific rigorousness levels of an evidence (see (Keele, 2007)), the findings relating to different IG issues are not at the same level of the confidence. Although the majority of the findings are based on evidence that has been experienced in the case study, some others have not been observed due to limitations in the case study. An important limitation in this case study is that although the mobility BN is in transition from a stable supply chain towards a dynamic BN, it currently does not meet all the characteristics of a highly dynamic BN. This limitation is difficult to resolve because highly dynamic BNs that provide a complete package of integrated solutions for customers are currently quite rare. To counter this limitation in the conducted case study, about the IG issue that have not been experienced yet because of the explained limitation, we rely on strong expectations of employees who are involved in the investigated networked business processes. Repeated and similar expectations by different key employees regarding an event, provides sufficient confidence about IG issues which have not yet been experienced in this case. Based on the described confidence levels in the conducted case study, 21 of the IG issues have been experienced within the investigated networked business processes. The other 7 remaining IG issues are strongly expected by employees involved within the networked business processes. More detail on the confidence level of the IG issues is represented in Appendix H.

6.7 Discussion

In this chapter the practical relevance of the theoretically explored IG issues is investigated. The investigation, which was conducted through a directed empirical exploration on the IG issues within networked business processes in a real-life SBN, shows that the all identified IG issues are recognizable in practice. The findings, which are based on the analysis of empirical evidence by logic models, illustrate how the dynamism of networked business processes can result in the identified IG issues. The findings clearly show that BNs need to tackle emerging IG issues, particularly if they aim to co-create integrated solutions for customers through composing and enacting dynamic networked business processes. Investigating the sources of emerging IG issues, as described within the developed logic models in this chapter, can facilitate developing relevant solutions that enable BNs to deal with these issues.

The main limitation of this investigation is the difficulty in directly observing some highly expected IG issues. Because the BN investigated here is not yet extremely dynamic, some of the expected IG issues in highly dynamic networked business processes have not been clearly experienced in this BN yet. Although this BN is in a transition from a stable supply chain towards a dynamic BN, it has not yet reached the level of an extremely agile and dynamic BN to provide mass-customized integrated mobility solutions (see Chapter 3). Due to this limitation, more empirical studies in other dynamic business networks are needed to enhance the confidence of the empirical findings within the conducted case study research. Further empirical research in other SBNs would enhance the confidence of the findings on the practical relevance of the identified IG issues.

Part 3

An Architectural Solution for Information Governance in Service-Oriented Business Networking

In this part we develop a solution to counter the identified IG issues in the previous part of the thesis. For this purpose, we synthesize a solution that supports the provision of high quality information within composing and enacting dynamic networked business processes in SBNs. The main research question that is addressed here is:

RQ3- How can information be governed through an architectural solution to ensure high quality information exchanges among collaborating parties within dynamic networked business processes in SBNs?

In order to answer this research question, a reference architecture is developed that supports governing information assets in SBNs. The development of the desired reference architecture is conducted within the architectural analysis and the architectural synthesis steps. The quality of the developed reference architecture is discussed based on its completeness, conceptual integrity, buildability, and applicability. The knowledge presented in the developed reference architecture eases designing domain-specific architectures to enhance managing dynamic inter-operations in SBNs.

7

A Reference Architecture to Support Information Governance in Service-Oriented Business Networking

Chapter 7

A Reference Architecture to Support Information Governance in Service-Oriented Business Networking

This chapter describes the design of a reference architecture that integrates relevant knowledge on governing information in the context of SBNs. This reference architecture highlights the classes of the information system components and their interactions in order to support the provision of high quality information, which is used within managing dynamic networked business processes in SBNs. The relevance of designing this reference architecture is discussed in Section 7.1. While the approach used to design the reference architecture is described in Section 7.2. The results of the architectural analysis based on the described approach, which incorporates the functional and non-functional system requirements, are reported in Section 7.3. The designed reference architecture, resulting from the architectural synthesis phase, is represented in Section 7.4. The evaluation of the synthesized reference architecture is then presented in Section 7.5. This chapter concludes with a discussion about the developed reference architecture in Section 7.6.

7.1 Introduction

Different types of solutions can be used to govern information assets (Tallon et al., 2013). In this section we firstly position the desired solution, which is an architectural design, within a broad landscape of IG solutions. Then, the desired architectural solution is characterized.

7.1.1 Positioning the desired IG solution within a broad landscape of IG solutions

Service orientation in BNs is a necessity in current globalized and customer-centered business environments (as described in Part One). Service orientation requires handling dynamic interactions among collaborating parties through managing dynamic networked business processes. Managing these processes requires supporting high quality information exchanges (Otto et al., 2011). Information assets within SBNs must be constantly adapted to keep aligned with the changes of networked business processes. As information is having an increasing role in directing business decisions (Chen et al., 2012), IG can enhance networked business processes management by providing high quality information. This role of information as a business enabler is highlighted in SBNs that need to sense and respond quickly to environmental opportunities (see Chapter 4).

The core research question that is addressed in this part is “How information can be governed in order to ensure high quality information exchanges among collaborating parties within composing and enacting dynamic networked business processes in SBNs?” To answer this question, in this chapter we design a reference architecture that supports dealing with the IG issues resulting from the dynamism of networked business processes in SBNs. Importantly, the architecture also ensures high quality information is provided for decision making, in order to improve management of networked business processes.

In designing this architecture, this chapter concentrates on IQ and metadata domains. Indeed, as described in Chapter 5, the two objectives of IG are to ensure high quality information exchanges and to safeguard information assets (Tallon et al., 2013). In this chapter the objective of ensuring high quality will be addressed. In this way, we do not address the information security domain for governing information in SBNs directly in this chapter. Narrowing the scope of the research in the solution domain is primarily due to complexities in dealing with the IG issues in the context of SBNs. Due to the nature of information security solutions, a composite view is required that embraces different business-related, organization-related, system-related, and technology-related concerns (e.g. see the Open Group Architecture Framework TOGAF (Open Group, 2009) that addresses all of the described views for architecting information security). This issue of composite view on information security significantly increases the complexity of an IG solution.

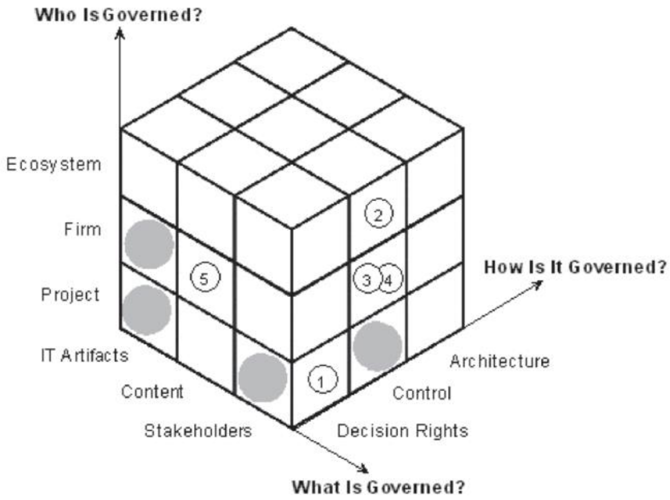

Figure 7.1- The IT governance cube based on (Tiwana et al., 2013)

In this way, regarding the aforementioned research question we narrow the scope to the IQ and metadata domains that are related to the described first objective of IG, which is to ensure high quality information exchanges. These two domains are considered together, as governing IQ is strongly interrelated with governing metadata in the context of SBNs. Indeed, based on the description of the IG domains in Chapter 5, the understandability of information services depends on quality of collaborative metadata that is evolved in order to support semantic interactions among parties.

The mechanism that can be used to govern information can be classified within structural, procedural, and relational mechanisms (Tallon et al., 2013). Structural mechanisms address practices for assigning responsibilities for supervising, directing, and planning IG. Procedural mechanisms imply processes and routines that can be applied for monitoring, decision-making, and intervening in order to govern information. Relational mechanisms highlight the active participation of, and collaborative relationship among, different related stakeholders of information assets.

Another classification of IG solutions (Tiwana et al., 2013) proposes a cube for the characterization of governance concepts in the context of IT. The cube, as shown in Figure 7.1, embraces three dimensions, respectively; who is governed, what is governed, and how it is governed. The first dimension, i.e. who is governed, addresses the scope of the governance that in (Tiwana et al., 2013) has been classified within a project, a firm, or ecosystem. The second dimension, i.e. what is governed, pertains to IT artefacts such as hardware and software, the content of those artefacts (e.g. information), or the stakeholders involved in producing and consuming them. The third dimension, i.e. how is it governed, represents the mechanisms used to govern. This cube characterizes governance mechanisms within the allocation of decision rights, formal and informal control mechanisms, or the use of architecture itself as a mechanism for governance.

The third classification of related solutions in this context addresses different levels of the realization of IG solutions (see (Sadiq, 2013)). Different solutions for managing IQ are characterized within organizational, architectural, and computational solutions. Organizational solutions refer to the development of IQ objectives, as well as the development of strategies to establish roles, policies and standards. Architectural solutions point out the technology landscape required to deploy developed IQ management processes and policies. Computational solutions pertain to IT tools and computational techniques such as record linkage, lineage and provenance, and semantic alignment.

Regarding the research question that is going to be addressed in this chapter, the context of the desired solution is a BN. Indeed, according to the 'who is governed' dimension in Figure 7.1, we address a situation in which business partners, who are highly autonomous, globally distributed, and heterogeneous in terms of their operating environment, collaborate within a service ecosystem. More precisely, we intend to concentrate on specific types of BNs that are addressed by SBNs in this research (see the characteristics in Chapter 2). In this context, collaborating parties share their assets such as IT assets (e.g. computational assets in the form of software as services) and information assets. According to the research question in this chapter, among different assets that are shared among collaborating parties (i.e. "what is governed" dimension in Figure 7.1), we concentrate on information assets. Sharing and exchanging information assets can be handled through global data warehouses that are formed to support collaborative decisions, federated databases that integrate distributed data sources within collaborating parties, or information exchanges (e.g. in the form of messages) among collaborating software services. Among the different governance mechanisms that can be used to govern information assets (i.e. "how is it governed" dimension in Figure 7.1), in this research we concentrate on formal control mechanisms.

Regarding different mechanisms that can be used for governance, we focus on the procedural mechanism based on (Tallon et al., 2013). The reasons for this focus are:

- The procedural mechanism can be applied in different structures (i.e. centralized, decentralized, or hybrid structures). Based on our implications from service orientation in real-life BNs (as reported in Chapter 3), BNs may use different governance structures during their service orientation transitions. In this way, procedural mechanisms can provide a well-established basis that ensures IQ in different stages of service orientation within a variety of governance structures. In order to develop an IG solution based on the procedural mechanism that is usable by different SBNs within different stages of service orientation transitions, we consider a completely decentralized governance structure. Other possible governance structures to apply the developed procedural mechanism can be derived by centralizing some decision rights and routines, which are considered completely distributed in the developed solution. Indeed, the completely decentralized structure that is considered in this chapter to realize the developed procedural IG mechanisms can be a well-established basis for designing IG mechanisms in centralized or hybrid structures.

- The realization of relational mechanisms, such as trust among collaborating parties, may require more long-term interactions among parties. For example, difficulties in developing informal trust-based governance mechanisms in dynamic situations where the behavior of collaborating parties are not predictable have been reported (De Man and Roijakkers, 2009). However, some argue that different governance mechanism are complementary (Peterson, 2004). In this way, the procedural mechanism developed in this chapter can be enhanced by relational mechanisms such as dynamic trust management approaches. In this research, based on the separation of concerns principle, we concentrate on procedural mechanisms. Enhancing the proposed procedural mechanism using relational governance mechanisms may be an important focus of future research.

According to the classification of the IG solutions by (Sadiq, 2013), as described above, a procedural mechanism can be realized within an organizational solution (i.e. a clearly defined process to ensure quality of information). Meanwhile, procedural mechanisms in the context of SBNs need to be applied within an architectural solution due to the distribution of responsibilities relating IG procedures among all collaborating parties and the frequency of information-intensive interactions in SBNs (as described in Part One). An architectural solution exploits IT to support a systematic realization of IG procedures in the context of SBNs. This chapter will describe this architectural solution that supports the realization of a procedural mechanism for governing information assets in SBNs. This architectural solution is characterized further in Section 7.1.2.

7.1.2 Characterizing the desired architectural solution

In the previous sub-section, the architectural solution is positioned within a broad landscape of possible solutions for governing information. In this sub-section we characterize the addressed architectural solution in more detail. In order to describe it in a structured way, we use the dimensions that are used in the context of architectural developments (Grefen, 2015a). These dimensions are:

The aspect dimension describes a number of aspects from which we can view an architecture. An aspect defines which characteristics are included in an architecture and which are left out. Frameworks that describe different concrete aspects include the Truijens 5 aspects framework (Truijens, 1990), and the Kruchten 4+1 aspect framework (Kruchten, 1995).

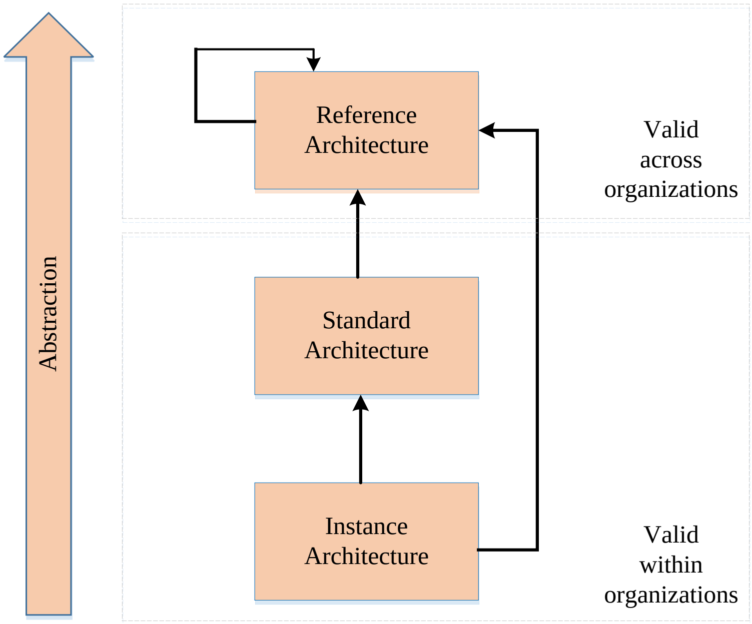

Figure 7.2- Reference, standard and instance architectures

The aggregation dimension describes the levels of aggregation, which determine the level of detail of an architecture description. In the context of this research three main aggregation levels can be considered for architectures descriptions (Grefen, 2015a). These include the market-level, the party-level, and the system-level. Market-level architectures refer to the structure of business networking systems at the level where multiple parties interact within a BN. Party-level architectures describe an architecture at the level of individual organizations (i.e. collaborating parties within a BN). System-level architectures describe architectures of an individual system of an individual collaborating party.

The abstraction dimension addresses the abstraction levels at which an architecture is described. Within this dimensions, the three main types of architecture descriptions can be considered, respectively, reference architectures, standard architectures, and instance (or concrete) architectures (see Figure 7.2) (Grefen, 2015a). A reference architecture can be defined as a standard for a class of systems across organizations (or BNs); that is, without having an organizational context. A reference architecture describes a system within a conceptual level, therefore it is context-abstracted. A standard architecture refers to the refinement of a reference architecture within an organizational (or a BN) context. In this way, a standard architecture can be defined as a class of systems within a specific organization context. An instance architecture is the architecture of one specific system in one specific context.

The realization dimension describes a number of levels ranging from information system goals (i.e., what we want to accomplish with the system described by an architecture) to means (i.e., how we want to accomplish things with an architecture). According to the BOAT framework (Grefen, 2010) which characterizes different levels of the realization of e-business scenarios, we characterize realization within the business level, the architecture level, and the technology level. This means that we address the BOAT business and organization levels within our business-level. The business level describes the business objectives of an information system. The architecture level refers to the conceptual software structure (software architecture) required to support and enable the business objectives. The technology level describes the technological realization of the systems which are specified within the software architecture. This level covers the concrete ingredients from information and communication technology, possibly including hardware, software, languages and protocols.

Based on the described four dimensions, the architectural solution developed in this chapter is characterized in the following of this section.

Characterizing the desired architectural solution within the aspect dimension

Regarding the third research question, the desired architectural solution intends to support governing information within networked business processes. More precisely, the desired architectural solution intends to support high quality information exchange to compose and enact dynamic networked business process. In this way, the desired architectural solution should consider information and process aspects as relevant views. To do so, the identification of the requirements that need to be addressed by the desired architecture should consider information and process aspects. In other words, with respect to the integrated architectural framework (Maes et al., 2000), the desired architectural solution indicates the requirements relating to the interactions between business process and information aspects. Thus, information and process aspects can assist in identifying the requirements that need to be fulfilled by the desired architectural solution (described further in Section 7.3).

The desired architectural solution is described within the system aspect in order to address the identified requirements. This is based on the 5 aspects framework (Truijens, 1990). This aspect also specifies the structure of the software modules that fulfil expected requirements.

Characterizing the desired architectural solution within the aggregation dimension

According to the three aggregation levels, the desired architectural solution is described within the three aggregation levels. This means that we start with a highly aggregated description of the architectural solution (i.e. in the market-level) and decompose it to obtain the party-level, and the system-level architectures.

Characterizing the desired architectural solution within the abstraction dimension

Regarding the three levels of the abstraction, we describe the architectural solution within the reference architecture abstraction level (i.e. the highest abstraction level). This level of the abstraction is suitable in our research due to these reasons:

- In SBNs parties collaborate from diverse contexts in order to co-create integrated solutions (see Chapter 2). The description of the architectural solution within a reference architecture, which is abstracted from any specific context, enables information governors in SBNs to use the developed solutions as a governing tool that can be applied for parties collaborating from different contexts.

- Regarding the difference between management and governance activities, as described in (Dallas and Bell, 2004), a reference architecture is more suitable to be used as a governance tool. While, standard and concrete architectures can be used to establish information management activities. More precisely, the difference between management and governance can be described as the difference between resource-based view and dynamic capabilities perspective in the context of strategic management (Teece et al., 1997). Management addresses activities that enable an organization to use its resources (i.e. resource-based view), whereas governance deals with guiding and directing those activities in order to keep them aligned with environmental changes (i.e. dynamic capability). In this way, governance (as a dynamic capability) addresses higher order capabilities when compared to management. The development of an architectural solution for IG within the reference architecture abstraction level is more fitting to the nature of governance. As (van Grembergen, 2007) states, architectural solutions within the standard and instance abstraction levels can be used by information (and IT) managers in order to manage delivery (and consumption) of high quality information effectively, whereas reference architectures are used by information governors to guide and direct information management.
- An abstract description of the architecture facilitates knowledge sharing about the required procedures in a structured way. This is particularly relevant as the IG procedures that are addressed by the architectural solution need to be considered by all collaborating parties. Meanwhile, the description of the architectural solution within the conceptual level addresses the classes of required software components without addressing any concrete technology related specifications. This facilitates communication with experts from business and IT domains within collaborating parties.
- Regarding autonomy of collaborating parties in SBNs (see Chapter 2), the reference architecture, as a conceptual foundation, facilitates and directs the development of high-quality context-specific architectures by collaborating parties.

Characterizing the desired architectural solution within the realization dimension

In the realization dimension, we position the desired architectural solution within the architecture level. This means we describe the structure of the software components and their interactions in order to support the required routines for governing information. This level of the realization is determined because implementing IG mechanisms in SBNs requires them to be supported by automated/semi-automated software components. The automation/semi-automation of the IG routines is necessary in the context of SBNs in order to react to the changes rapidly (as described in Chapter 4). Within the realization dimension,

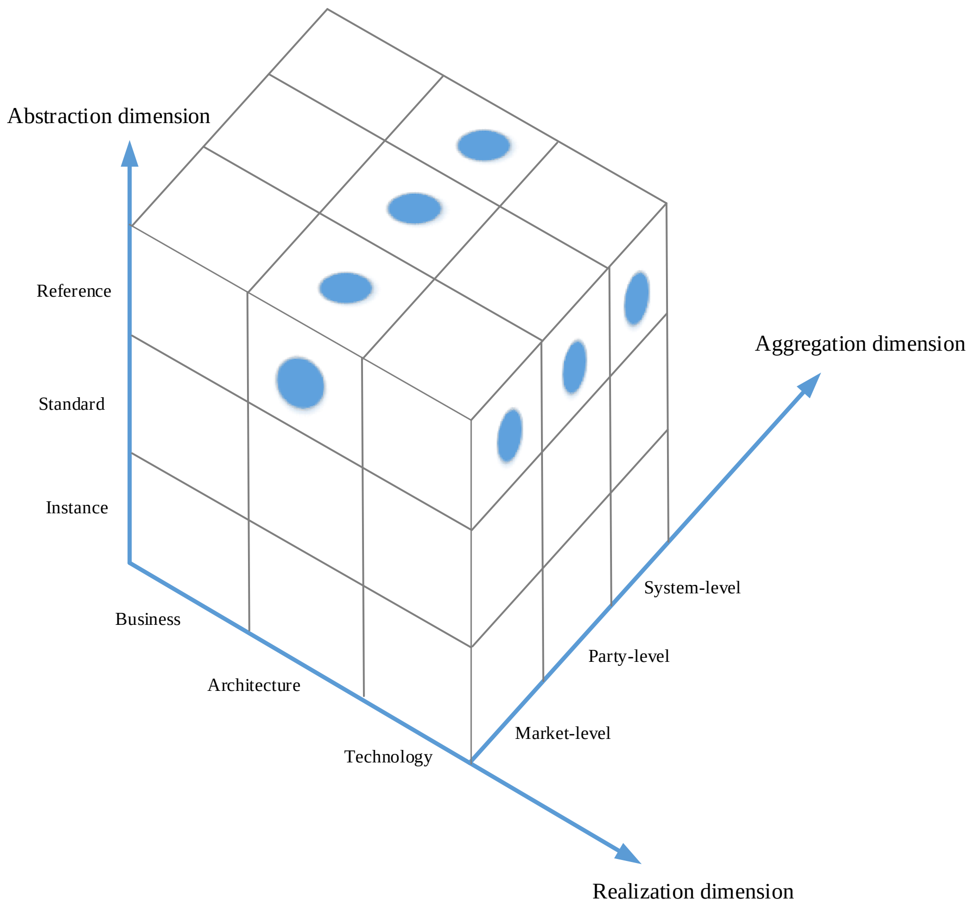

Figure 7.3- The characterization of the desired architectural solution

we do not address the technology level because autonomous collaborating parties can use different technological infrastructures. The buildability of the developed reference architecture using relevant technologies is investigated in Section 7.5.

The desired architectural solution is positioned within the architecture cube, see Figure 7.3. The desired architectural solution for governing information, described above and shown in Figure 7.3, can be characterized as the reference information system architecture that supports governing information exchanged within networked business processes. The approach used to develop the characterized architectural solution is described in the next section.

7.2 The approach used to develop the characterized architectural solution

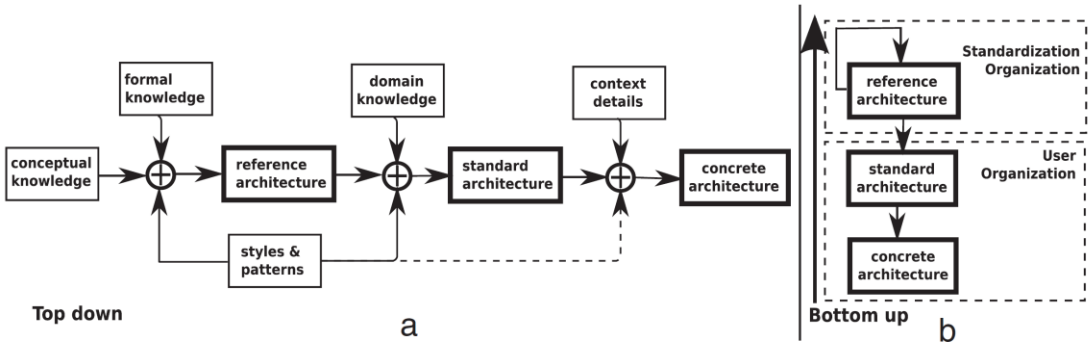

Figure 7.4- Top down and bottom-up directions for developing reference architectures

The development of reference architectures can be directed following a top-down or a bottom-up direction (Angelov et al., 2012), see Figure 7.4. Selecting a top-down or bottom-up approach to develop a reference architecture depends on the "novelty" of the desired reference architectures as well as the "goal" of its development (Angelov et al., 2009). The novelty of reference architectures refers to the existing experience in the domain at the time of the definition of the reference architecture. From the novelty point of view, reference architectures can be classified within "Futuristic Reference Architectures" (FRAs) and "Practice Reference Architectures" (PRAs). FRAs are developed before the existence of significant practical experience with the design of concrete related architectures. In this way, the goal of FRAs is to make an attempt to "look into the future" and to foresee the major design principles that will be of importance in the design of concrete architectures for a specific domain. Examples of FRAs are represented in (Grefen et al., 2009a; Norta et al., 2014).

On the other hand, PRAs are developed based on accumulated practical experience in domains. Indeed, the development of PRAs is based on aggregation of different concrete relevant architectures that are used in practice. PRAs are usually developed for standardization and also knowledge transformation purposes. Examples of PRAs are described in (Scheer and Nüttgens, 2000; Weske, 2012), which have been developed to represent accumulated knowledge about systems that support business process management.

The reference architecture that is developed in this chapter can be considered an FRA. Indeed, the desired reference architecture pertains to emerging IG issues in a novel business situation that is addressed by SBNs. In this way, the top-down direction is fitting for the development of the desired reference architecture.

As shown in Figure 7.4, the development of reference architectures in a top-down direction is primarily based on using knowledge of the domain for which it is developed, preferably using a widely accepted reference model for that domain. Also, the development of reference architectures is based on using one or more architecture styles and a number of architectural patterns. Architectural styles show the general structure of system components, such as a layered or a component based style. Architectural patterns are generally recognized recurring (sub)structures that are used to describe part of the overall structure of an architecture (e.g. architectural patterns introduced in (Bass, 2007)).

In order to conduct the top-down direction for the development of the desired reference architecture, we conduct two steps, the architectural analysis and the architectural synthesis. Based on (Hofmeister et al., 2007), the architectural analysis step specifies architecturally significant requirements that should be considered. The architectural synthesis step proposes the architectural solution that addresses the specified requirements.

The architectural analysis step specifies the functional and non-functional requirements that need to be considered when developing the reference architecture. The specified requirements determine the required features of the desired reference architecture in order to govern information within dynamic networked business processes in SBNs. Regarding the described top-down direction, the architectural analysis step should be based on relevant knowledge. To do this analysis, we use relevant knowledge within reference models for dynamic business networking (e.g. (Camarinha-Matos et al., 2005; Camarinha-Matos and Afsarmanesh, 2007; Camarinha-Matos and Afsarmanesh, 2008)) and dynamic networked business process management (e.g. (Angelov and Grefen, 2008; Grefen et al., 2009a; Mehandjiev and Grefen, 2010; Norta et al., 2014). We also rely on a dynamic capability based view (Teece et al., 1997; Teece, 2007) on the mechanisms that can be used for information governance (is described further). The architectural analysis step is described in Section 7.3.

The second step, architectural synthesis, is the core element in the development of the desired reference architecture. This step addresses the move from the problem domain to the solution domain. Within the architectural synthesis step, the information system components and their interactions when supporting IG within networked business processes are described. The described components of reference architectures are abstract classes of required software components. Based on the characterization of the desired reference architecture in the previous section, the architectural synthesis is represented within the three aggregation levels. This means that, firstly the highly aggregated reference architecture is represented within the market-level aggregation. Then it is decomposed within the party-level and the system-level reference architectures. The description of the architectural synthesis and its elaboration within the three aggregation levels, together with the used architectural styles and patterns, are described in Section 7.4.

7.3 Architectural analysis

In line with the majority of architectural design methods (see (Hofmeister et al., 2007)) the development of the architectural solution is initiated by the architectural analysis step. As described, the architectural analysis step addresses the specification of the functional and the non-functional requirements that need to be covered by the developed architecture. The architectural analysis step embraces the problem statement and the specification of the requirements that are represented by use case models (Kruchten, 2004). The issues that need to be addressed by the desired reference architecture are described in Part Two of the dissertation. In this section we concentrate on the specification of the functional and non-functional requirements based on the identified IG issues. As described in Section 7.1, we address the IQ and metadata issues in SBNs within the architectural analysis step.

To do this, we first describe a viewpoint based approach to identify the functional requirements (see the sub-section 7.3.1). The identified functional requirements are elaborated in the sub-section 7.3.2. The non-functional requirements are described in the sub-section 7.3.3. The identified functional and non-functional requirements are used further for the architectural synthesis and the architectural evaluation.

7.3.1 A view point based approach for the identification of the functional requirements

We use a viewpoint based approach to identify the functional requirements that need to be covered by the desired reference architecture (see (Kotonya and Sommerville, 1996)). In the context of requirement engineering (e.g. see (Hull et al., 2010)), a view-point based approach implies that requirements should be considered from different relevant perspectives. In order to identify the relevant perspectives, we rely on the specification of the related research question which states "*how can information be governed within dynamic networked business processes in SBNs?"*

Based on this research question, we identify two types of viewpoints, relating to *what* needs to be governed, and secondly, *how* it can be governed.

From the first point of view (i.e. *what* needs to be governed), we focus on governing information artefacts exchanged within inter-organizational interactions among collaborating parties in SBNs. As described in Chapter 5, in this research we consider that inter-organizational interactions are handled via managing networked business processes. In this way, from this point of view, we consider *governing information artefacts that are exchanged within networked business processes*. For more clarification of the related views from this viewpoint, we rely on the framework for information management that is developed by (Maes, 1999). This framework provides a relevant basis because it clearly describes the relationship between information artefacts and business processes. This framework highlights that business processes are supported and enabled by information that is provided by an information provision system. Based on this framework, the business process aspect and the information aspect are considered as relevant views within the "what needs to be governed" viewpoint.

To identify the relevant viewpoints on *how* information can be governed, we concentrate on the viewpoints related to the procedural mechanisms for IG. As described previously, the procedural mechanisms refer to the routines (or activities) that can be applied to direct information assets that are exchanged within networked business processes. Based on this description of the procedural mechanisms for IG, we point out the two relevant views, namely the governance routines and the governance directions. The governance routines, as the core of procedural mechanisms, refer to the activities that need to be conducted. The governance direction, in line with the relevant theories in the context of enterprise governance (e.g. see (Lankhorst et al., 2009; Hoogervorst, 2009)) and IT governance (e.g. (Henderson and Venkatraman, 1993; Van Grembergen and De Haes, 2009)) addresses the top-down and bottom-up directions for governance. The establishment of the governance routines differs in top-down and bottom-up directions. Thus the governance direction is considered as the relevant view to identify the functional requirements.

Therefore, four relevant views are considered for the identification of the IG functionalities in the context of SBNs. These four views are illustrated in the below.

Information aspect

This aspect, as the core relevant view regarding the research question, indicates information assets that are produced, stored and provided by collaborating parties in SBNs. The relevant domains that are considered within this aspect in the development of the desired reference architecture are information product quality, information service quality, and metadata. These three domains are described in Chapter 5. To identify the functional requirements, we use this aspect to represent information product quality, information service quality, and metadata issues that are identified in Chapter 5.

Business process aspect

The business process aspect highlights networked business processes in SBNs. Information services that are provided by collaborating parties are exchanged within networked business processes, as described in Figure 6.1. Networked business processes in the context of SBNs are managed in order to handle inter-organizational interactions to provide mass-customized integrated solutions. In order to support the required characteristics of SBNs networked business processes need to be dynamic in this context. As previously described, the dynamism of networked business processes in SBNs is due to the need for the adaption based on changes of expected customers' experience and also changes of collaborating parties and their provided products and services. The IG issues resulting from the dynamism of networked business processes are identified in Chapter 5 and Chapter 6.

Based on the described business process centered view on managing inter-organizational interactions in SBNs, information can be exchanged for different purposes within networked business process management stages. The refinement of information exchanges within networked business processes requires consideration of different stages of networked business process management to identify functional requirements for governing information. In other words, governing information can imply different requirements within different stages of networked business process management.

We consider the two main phases for the management of networked business processes, in line with previous research (Camarinha-Matos et al., 2005; Grefen et al., 2009a; Norta et al., 2014; Fdhila et al., 2015). These two phases are the formation and the enactment of networked business processes. The formation phase reflects design-time decisions in order to set a shared objective, that is, an expected integrated solution by a customer in SBNs. It also includes selecting parties that can collaborate to achieve the targeted objective as well as composing networked business processes that should be executed. These decisions are supported by knowledge systems that enable each party to share and use accumulated knowledge and expertise within BNs (see e.g. the design-time architecture in (Grefen et al., 2009a) or the framework for shared service composition (Afsarmanesh et al., 2015)). The enactment phase addresses run-time executions of networked business processes that have been composed. The enactment is supported by process systems that enable execution of intra and inter-organizational business processes (see e.g. the run-time architecture in (Grefen et al., 2009a)).

The consideration of the design-time and the run-time phases within the process aspect is relevant for the identification of the functional requirements that need to be covered for governing information in SBNs. More precisely, the distinction between design-time and run time phases within this aspect is relevant for the following reasons:

- Firstly, this distinction enables us to distinguish between information within knowledge and process systems. The difference between these two systems has been described previously (Alavi and Leidner, 2001)) and has been regarded in relevant architectures (e.g. see (Grefen et al., 2009a)). Information in knowledge systems is shared, integrated and analyzed (e.g. within data warehouse systems) to support decision-making. However, in process systems information is exchanged in order to fulfil a work process such as supply chain processes. According to the CrossWork architecture (see (Grefen et al., 2009a)), in design-time phases knowledge systems are used to make decisions to compose networked business processes (e.g. by using agent-based technologies). Within the run-time phase, process-oriented systems are applied in order to enact composed networked business processes (e.g. by using service-oriented computing technologies).
- Secondly, the distinction between design-time and run-time phases within the business process aspect enables network orchestrators to distinguish between design-time and run-time fitness between parties and also their assets (particularly information assets). Fitness of information assets within design-time and run-time phases can have different requirements. Design-time fitness of information assets refers to coordination within a value network for the production and supply of required information for collaborative decision making. Since in SBNs, producing

information for decision making is distributed among all parties (e.g. information on customers' experience is produced by parties collaborating in value network), design-time fitness ensures that required information for making well-established collaborative decisions to develop networked business processes are produced and supplied by all parties. The design-time fitness of information assets, to identify environmental opportunities and compose relevant networked business processes can be handled within virtual enterprise breeding environments (Camarinha-Matos & Afsarmanesh, 2007; Camarinha-Matos et al., 2011). On the other hand, run-time fitness of information assets addresses syntactic and semantic interoperability of information objects that are exchanged among parties. Run-time fitness of information can be handled by protocol adaptors (e.g. see (Seguel et al., 2014)) to ensure exchanged information among parties within enacted networked business processes is used appropriately.

Governance routines view

Within procedural mechanisms, routines indicate activities that need to be conducted to govern information. To identify the routines for governing information in the context of SBNs, we rely on a dynamic capabilities perspective on IG. Dynamic capabilities, as described in Chapter 4, aim to align a system with respect to changes in an environment. Dynamic capabilities are defined as 'the ability to integrate, build, and reconfigure internal and external competences to address rapidly-changing environments' (Teece et al., 1997). Dynamic capabilities govern the rate of change of operational capabilities to be aligned with the environmental changes (Collis, 1994). The difference between dynamic capabilities and operational capabilities is described in more detail in Chapter 4.

Dynamic capabilities perspective is a relevant basis for the identification of IG routines in the context of SBNs for the following reasons:

- Firstly, in the related theory, IG is characterized as dynamic capability; e.g. see (Sambamurthy and Zmud, 1999; Kooper et al., 2011; Otto, 2013).
- Secondly, regarding the difference between management and governance (Dallas and Bell, 2004), characterizing the IG routines from a dynamic capabilities point-of-view enables us to clearly distinguish between IG activities and information management activities such as information exchange management and information integration activities. In this way, information management activities are directed by IG routines to keep aligned with changes in environment.
- Thirdly, as dynamic capabilities are more relevant in dynamic business situations (Teece, 2007; Lichtenthaler, 2009), the characterization of the IG routines based on the dynamic capabilities perspective enables us to deal with issues and exploit opportunities resulting from the dynamism in SBNs.

A dynamic capability perspective points out abilities in systems to govern internal resources in accordance with environmental changes (Winter, 2003). It addresses the three main

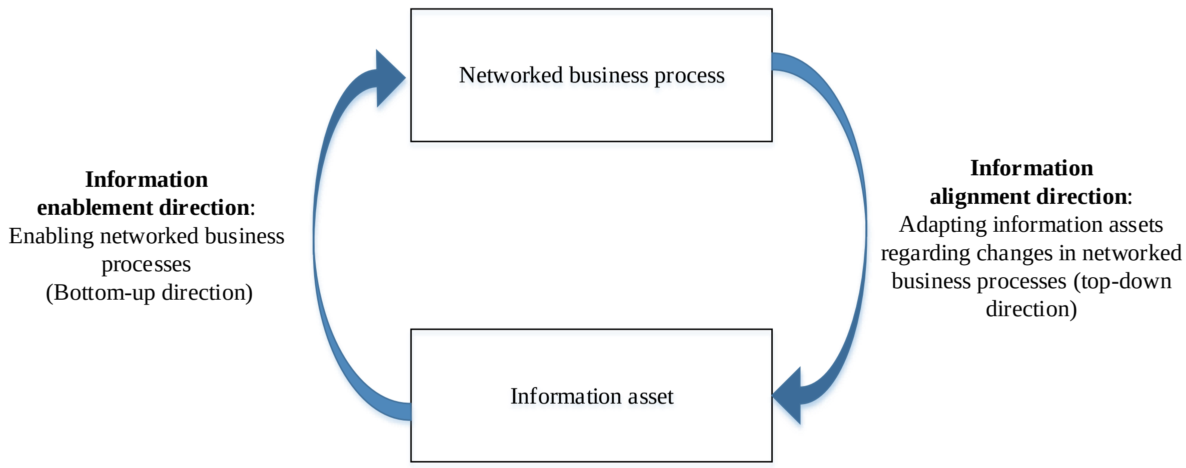

Figure 7.5- The information alignment and enablement direction for IG

abilities: sensing, responding, and improving (or reconfiguring) (Teece, 2007). Sensing refers to the ability to recognize opportunities and issues resulting from changes. Responding is the ability to react quickly in order to exploit sensed opportunities or deal with the recognized forthcoming issues. Improving refers to the ability for continuous learning in order to reconfigure resources to be aligned with the sensed and responded changes.

In this way, IG routines can be characterized as the ability to sense information quality and metadata related issues and opportunities resulting from changes in SBNs. It is also characterized by the ability to respond to changes by exploiting the opportunities for enhancing IQ and metadata or by dealing with emerging IQ and metadata issues. Finally it also includes improving information management activities in order to keep them aligned with changes in environment.

Governance directions view

Enterprise and IT governance theories (Henderson and Venkatraman, 1993; Maes et al., 2000; Hoogervorst, 2009; Van Grembergen and De Haes, 2009) address two main directions for governance. Firstly, an alignment direction which implies the adaptation of information assets to support networked business processes that are formed based on changes (i.e. top-down direction). Secondly, an enablement direction which enhances networked business processes in relation to possibilities that are recognized within information assets (i.e. bottom-up direction); see Figure 7.5.

In the context of this research, the alignment direction can be considered as a process-driven direction to govern information assets. On the other hand, the enablement direction highlights a data-driven direction for governing information assets. A data-driven direction for governing information assets addresses the enhancement of networked business processes by using data analytics. In the context of dynamic interactions within service-oriented BNs, both of the mentioned directions need to be considered for governing information assets. The alignment direction is necessary to adapt information production processes, information integration schemas, and information exchange protocols regarding emerging expectations in service-oriented BNs. The enablement direction also needs to be considered, due to the increasing role of information as the driver of networked business processes in dynamic business situations (Van Der Aalst, 2011).

Bottom-up and top-down directions for governing information can be seen as consistent with data-driven and process-driven strategies in the context of IQ management (Batini et al., 2009). However, much of the research on applying these strategies has focused on managing IQ and not its governance. For instance, data driven methods for IQ management, such as probabilistic methods, empirical techniques, and knowledge based techniques, have focused in the most part on record linkage, data integration, and schema integration (e.g. see (Lenzerini, 2002; Shvaiko and Euzenat, 2005; Özsu and Valduriez, 2011)).

Based on the viewpoint based approach for the architectural analysis, the relevant views are summarized in Table 7.1. Based on the determined relevant views, the information and process aspects are integrated. This is done in order to identify IG functional requirements that address governing information assets that are exchanged within networked business processes. In addition, governing information in different phases of the networked business process management requires different functionalities. The integration of these two aspects results in six (i.e. 3*2) sub-aspects that need to be considered for the identification of the IG functionalities.

The governance direction and governance mechanisms views are also inter-related. This means that the governance routines, which are determined based on a dynamic capability

Table 7.1- The views for the identification of the functional requirements to support governing information within networked business processes

<table>
<tr><td colspan="5" rowspan="3"></td><td colspan="5"><u>How</u> it can be governed</td></tr>
<tr><td rowspan="4">Governance directions</td><td rowspan="2"></td><td colspan="3">Governance mechanisms</td></tr>
<tr><td>Sensing</td><td>Responding</td><td>Improving</td></tr>
<tr><td rowspan="5"><u>What</u> needs to be governed</td><td></td><td colspan="3">Process Aspect</td><td>Alignment</td><td colspan="3" rowspan="2">3*2=6 views</td></tr>
<tr><td></td><td></td><td>Design-time</td><td>Run-time</td><td>Enablement</td></tr>
<tr><td rowspan="3">Information aspect</td><td>Information product quality</td><td colspan="2" rowspan="3">3*2=6 views</td><td colspan="5" rowspan="3">6 *6 = 36 IG functionalities</td></tr>
<tr><td>Information service quality</td></tr>
<tr><td>metadata</td></tr>
</table>

perspective, can support both of the alignment and the enablement directions. In the alignment, that is, top-down direction, the IG is triggered by a sensed IG issue that results from changes to networked business process. In the enablement, that is, bottom-up direction, the IG is triggered by a sensed possibility in information assets to enhance networked business processes.

In this way, we need to consider the six (i.e. 2*3) routines for governing information assets within networked business processes. The combination of the “what” and the “how” related views points out thirty six (i.e. 6*6) functional requirements that should be addressed in order to support governing information in SBNs. Although these identified IG functionalities would be meaningful in stable BNs such as conventional supply chains, they are a necessity in SBNs in order to manage dynamic interactions among parties. The identified functional requirements based on the described views are elaborated in the following sub-section.

7.3.2 The identified functional requirements

Regarding the viewpoint based approach the identified functional requirements for governing information within dynamic networked business processes in SBNs are reported in Table 7.2.

Table 7.2- The identified functional requirements

Governance routines	Information aspect domains	Governance directions	Process view phases	Description of the identified functional requirement	
Sensing	Information product quality	A	D-T	FR1	sensing information product quality issues resulting from dynamic networked business process composition
			R-T	FR2	sensing information product quality issues resulting from dynamic networked business process enactment
		E	D-T	FR3	sensing information product quality related possibilities to enhance networked business process composition
			R-T	FR4	sensing information product quality related possibilities to enhance networked business process enactment
	Information service quality	A	D-T	FR5	sensing information service quality issues resulting from dynamic networked business process composition
			R-T	FR6	sensing information product quality issues resulting from dynamic networked business process enactment
		E	D-T	FR7	sensing information service quality related possibilities to enhance networked business process composition
			R-T	FR8	sensing information product quality related possibilities to enhance networked business process enactment
	metadata	A	D-T	FR9	sensing metadata issues resulting from dynamic networked business process composition
			R-T	FR10	Sensing metadata issues resulting from dynamic networked business

					process enactment
		E	D-T	FR11	sensing metadata related possibilities to enhance networked business process composition
			R-T	FR12	sensing metadata related possibilities to enhance networked business process enactment
Responding	Information product quality	A	D-T	FR13	responding to information product quality issues resulting from dynamic networked business process composition
			R-T	FR14	responding to information product quality issues resulting from dynamic networked business process enactment
		E	D-T	FR15	responding to information product quality related possibilities to enhance networked business process composition
			R-T	FR16	responding to information product quality related possibilities to enhance networked business process enactment
	Information service quality	A	D-T	FR17	responding to information service quality issues resulting from dynamic networked business process composition
			R-T	FR18	responding to information product quality issues resulting from dynamic networked business process enactment
		E	D-T	FR19	responding to information service quality related possibilities to enhance networked business process composition
			R-T	FR20	responding to information product quality related possibilities to enhance networked business process enactment
	metadata	A	D-T	FR21	responding to metadata issues resulting from dynamic networked business process composition
			R-T	FR22	responding metadata issues resulting from dynamic networked business process enactment
		E	D-T	FR23	responding to metadata related possibilities to enhance networked business process composition
			R-T	FR24	responding to metadata related possibilities to enhance networked business process enactment
Improving	Information product quality	A	D-T	FR25	improving information production systems based on issues resulting from dynamic networked business process composition
			R-T	FR26	improving information production systems based on issues resulting from dynamic networked business process enactment
		E	D-T	FR27	improving information production systems based on possibilities resulting from dynamic networked business process composition
			R-T	FR28	improving information production systems based on possibilities resulting from dynamic networked business process enactment
	Information service quality	A	D-T	FR29	improving information servicing systems based on issues resulting from dynamic networked business process composition
			R-T	FR30	improving information servicing systems based on issues resulting from dynamic networked business process enactment
		E	D-T	FR31	improving information servicing systems based on possibilities resulting from dynamic networked business process composition
			R-T	FR32	improving information servicing systems based on possibilities resulting from dynamic networked business process enactment
	metadata	A	D-T	FR33	improving collaborative metadata management based on issues resulting from dynamic networked business process composition
			R-T	FR34	improving collaborative metadata management based on issues resulting from dynamic networked business process enactment
		E	D-T	FR35	improving collaborative metadata management based on possibilities resulting from dynamic networked business process composition
			R-T	FR36	improving collaborative metadata management based on possibilities resulting from dynamic networked business process enactment

7.3.3 Non-functional requirements

Non-functional requirements for developing architectures refer to quality attributes that need to be considered during developing architectures (Bass, 2007). In this research we use the identified non-functional requirements to evaluate the quality of the synthesized reference architecture.

Different quality attributes have been proposed to develop and evaluate architectures (e.g. see (Kazman et al., 1996; Clements et al., 2003)). To identify the most important and relevant attributes, we rely on the characterization of the desired reference architecture (see Section 7.1). In this way, we concentrate on quality attributes, as non-functional requirements, which are more important and critical for reference architectures. To do so, based on the previous works (see (Angelov et al., 2012; Angelov et al., 2014) that have modified general quality attributes for reference architectures, we concentrate on the four main quality attributes that need to be considered for reference architecture. These quality attributes, as the non-functional requirements for developing the desired reference architecture, are describes in the following section.

Completeness

Reference architectures need to be complete in their scope as they aim to bring together relevant domain knowledge in a structured way. Therefore, reference architectures should cover all relevant issues within the desired scope. In this thesis, (as described in Section 7.1) the desired scope of the reference architecture is governing information assets within dynamic networked business processes in SBNs. In this way, the developed reference architecture should address all information quality and metadata issues resulting from the dynamism of networked business processes in SBNs.

Conceptual integrity

Conceptual integrity addresses the underlying principles and patterns that unify the design of reference architectures at all levels. Reference architectures are conceptual models that need to be used consistently and smoothly within concrete scenarios. Therefore they should follow clear and well-defined principles and patterns (Proper and Greefhorst, 2010; Greefhorst and Proper, 2011, Proper and Greefhorst, 2011).

Buildability

Because reference architectures are developed to be used in different contexts, they need to be buildable in different contexts with various technologies and legacy systems. This means that although a reference architecture needs to be abstract from any specific technology, it should be buildable by different technologies. PRA should be buildable by conventional in-hand technologies. Buildability of FRA can be supported by the state-of-the art technologies or even by developing technologies.

Applicability

Reference architectures are developed in order to be applied within concrete architectures in different contexts. In this way, applicability of reference architecture addresses the extent to which a reference architecture can be applied within concrete architectures. More specifically, applicability of a reference architecture can be described as the level of overlap between the elements of a reference architecture and the elements of the related concrete architectures.

In addition to the above non-functional requirements, reference architectures also need to be acceptable. The acceptability quality refers to the level of acceptance of a reference architecture within its related community. Preferably, the acceptance of reference architectures needs to be assured by a certification holder institute. However, the acceptability is more critical for PRAs than for FRAs. This is due to the fact that relating communities have not yet formed formally within FRAs and shared understanding on relevant concepts has not been achieved to date. Therefore, acceptability cannot be considered as a critical requirement for FRAs.

7.4 Architectural synthesis

In this section the architectural synthesis, as the second step for the development of the desired reference architecture is represented. The architectural synthesis step moves from the problem domain (as addressed in Section 7.3) to the solution domain. More precisely, this step describes how the identified requirements for governing information within dynamic networked business processes in SBNs can be fulfilled.

Designing reference architectures should be based on well-defined architectural principles (Proper and Greefhorst, 2010; Greefhorst and Proper, 2011; Proper and Greefhorst, 2011). Architectural principles as general guidelines direct architectural decisions that are made within architectural synthesis. In order to support conceptual integrity within architectural synthesis, we firstly state the architectural principles that are considered. As Greefhorst & Proper (2011) argue, the derivation of relevant architectural principles depends on the identification of pertinent underlying drivers that motivate them.

In this research, to identify the relevant underlying drivers, we rely on the characteristics of the context of the desired reference architecture (i.e. the characteristics of SBNs as described in Chapter 2), the characteristics of the desired reference architecture (as described in Section 7.1) and the key implications that are considered within the architectural analysis step (as described in Section 7.3). The drivers that are considered in order to identify the relevant architectural principles are described in Table 7.3. The derived architectural principles are described further in the following of this section.

Principle 1- IG responsibilities are distributed among all collaborating parties (business related)

This principle originates from the characterization of SBNs (see Chapter 2) which indicates that the coordination of interactions among collaborating parties is governed through distributed structures in SBNs. In SBNs the coordination role can differ regarding the characteristics of desired integrated solutions that are going to be co-created with customers. This implies that different collaborating parties in a value network that offer a service-oriented value, need to be able to coordinate all other parties in order to provide a complete product service packages for customers. This distributed structure for network coordination indicates that different collaborating parties should be able to govern information that is used within networked interactions.

Principle 2- Collaborating business parties autonomously self-govern information artefacts that they use within composing and enacting networked business processes (business related).

Autonomy of collaborating parties results from actor-to-actor relationships among them in SBNs. Actor-to actor relationships in SBNs implies that each collaborating party (including customers that create value) intends to optimize its experience within the collaborative value

Table 7.3- The derivation of the architectural principles from the relevant underlying drivers

Underlying driver that motivates architectural principle	**Architectural principle**
Service orientation in BNs stresses dynamic inter-organizational interactions among collaborating parties that are coordinated in decentralized structures to provide mass-customized solutions for customers	Principle 1- IG responsibilities are distributed among all collaborating parties (business related)
Service orientation in BNs leads to actor-to-actor relationships among collaborating parties in a value network that are adapted independently based on customer experiences	Principle 2- Collaborating business parties autonomously self-govern information artefacts that are used within composing and enacting networked business processes by them
Governing decisional information exchanges to compose dynamic networked business processes addresses different functional requirements than governing operational information exchanges within enacting dynamic networked business processes	Principle 3- Decision-oriented and work process-oriented interactions among collaborating parties are separated (Business information system, and process aspect related)
IG as a dynamic capability points out higher order abilities that directs information management abilities which support integration and inter-operability of exchanged information assets	Principle 4- Activities relating to executing and governing interactions are separated
Governing information requires the exchange of information with its related quality and metadata	Principle 5- Information is exchanged together with its quality and related metadata

network by orchestrating resources provided by all other collaborating parties. Thus, collaborating parties independently make decision and autonomously govern information assets that are used to adapt their actor-to-actor interactions.

Principle 3- Decision-oriented and work process-oriented interactions among collaborating parties are separated. (Business information system and process aspect related).

This principle refers to the different nature of interactions in design-time and run-time interactions among collaborating parties. This separation, which is in line with related architectural solutions for dynamic business networking (e.g. (Grefen et al., 2009a; Mehandjiev and Grefen, 2010)) enables us to consider the difference between knowledge and process systems within the developed reference architecture.

Principle 4- Activities relating to executing and governing interactions are separated. (Business and information system related).

Based on the difference among executive and governance activities, the desired reference architecture should concentrate on directing information management activities in order to align these activities with changes in the context of SBNs. Indeed, based on the characterization of the desired reference architecture, it only addresses governance activities. In this way, modules relating to executive interactions among collaborating parties (e.g. modules supporting information exchanges and integration for decision making) are not considered in the developed reference architecture. The modules within the desired reference architecture address governing executive modules to ensure high quality information is exchanged within networked business processes in SBNs.

Principle 5- Information is exchanged together with its quality and related metadata. (Information aspect)

Quality-aware information exchange is considered the basis for managing and governing IQ (e.g. see (Marchetti et al., 2003; Scannapieco et al., 2004)). Exchanging information, together with its related metadata, also forms the basis of the developing ontology mapping based semantic integration (e.g. see (Noy, 2004; Patil et al., 2005)). In this way, within the developed reference architecture, collaborating parties share their decisional and operational information together with its related quality and metadata (e.g. by using IQ factory service that is developed in (Scannapieco et al., 2004)).

The above architectural principles are considered to be the basis for making architectural decisions within developing the reference architecture. The consistency of the architectural decisions with these principles is discussed in Section 7.5 in order to represent the conceptual integrity of the developed architecture.

In addition to the architectural principles, developing reference architectures should be based on relevant reference models or more abstract reference architectures; see Figure 7.4. Developing a reference architecture involves applying relevant accumulated domain knowledge within reference architectures.

To build the desired reference architecture we rely on the three types of related reference models. These include, firstly a reference model on structures supporting dynamic business networking as the general context of the desired reference architecture. Secondly, a reference model to support dynamic networked business processes within BNs. Thirdly, we include the reference model for information quality management in cooperative information systems. The reference model for dynamic business networking enables us to use relevant accumulated knowledge on this context to describe structures and interactions within SBNs. The reference architecture for managing dynamic networked business processes provides a well-established basis to describe managing networked interactions within structures supporting SBNs. The third reference architecture proposes abstract and general services that are used for IQ management in the desired context. We elaborate these three reference models in the following sub-sections.

Reference model on inter-organizational collaborations structures

As the basis for domain knowledge on dynamic business networking we rely on the reference model that characterizes inter-organizational collaboration structures (Camarinha-Matos et al., 2005; Camarinha-Matos and Afsarmanesh, 2007; Camarinha-Matos and Afsarmanesh, 2008); see Figure 7.6. We describe a SBN as a dynamic virtual organization that is formed within a value network based on the classification of different inter-organizational collaborations within this reference model. Parties in a SBN have a long-term and strategic collaboration for co-creating customer-centric values for customers. Service-oriented value networks embrace all parties that can provide core or enriching products and services that enhances customers' experience (e.g. see the formation of service-oriented BNs based on service-oriented strategy in (Grefen, 2015b)). Dynamic virtual organizations (as grasping market opportunity centric collaboration structures) are formed within service-oriented value networks to provide an integrated solution for a customer (or a group of customers that expect a similar experience). Parties within dynamic virtual organizations in the context of SBNs collaborate within a whole lifecycle relating to an integrated solution to produce and co-create an expected value-in-use with customers. Designing dynamic virtual organizations to provide integrated solutions for customers can be facilitated by service-oriented business model design tools, as developed by (Grefen, 2015b).

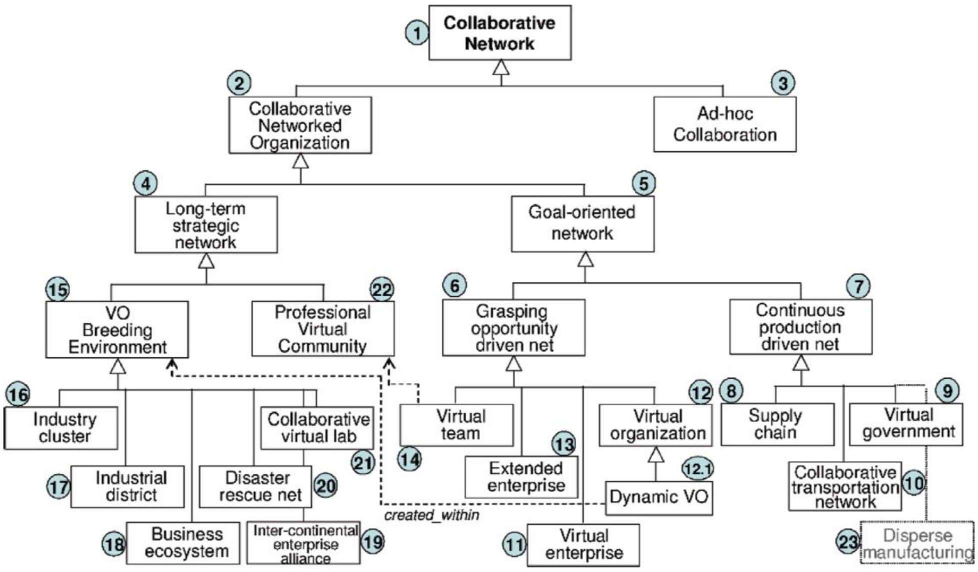

Figure 7.6 - Characterizing inter-organizational collaborations structures based on the reference model in (Camarinha-Matos et al., 2005, Camarinha-Matos and Afsarmanesh, 2007, Camarinha-Matos and Afsarmanesh, 2008)

Describing SBNs using the reference model represented in Figure 7.6, also enables us to elaborate design-time and run-time interactions among collaborating parties more clearly. In this way, we describe inter-organizational interactions in design-time as long-term strategic interactions within service-oriented value networks. These strategic interactions among collaborating parties enable them to share their knowledge to better understand expected experiences of potential customers and design networked business processes that support proposing integrated solutions for customers. Indeed, SBNs need to form long-term collaborations within value networks in order to be able to sense customer experiences regarding integrated solutions. It also allows SNBs to collaboratively innovate and produce new products and services. Run-time interactions refer to interactions among collaborating parties within a dynamic virtual organization to provide and co-create a proposed integrated solution. In this way, a grasping opportunity in the context of SBNs can be seen as an opportunity for co-creating integrated solution for a customer.

Reference model to manage dynamic networked business processes

As the context of the desired reference architecture, in this research we concentrate on interactions among parties that are handled within networked business processes. Regarding the characterization of SBNs structures, managing networked business processes in design-time is handled within value networks. Indeed, design-time networked business processes within a value network support proposing integrated solutions to customers. When a proposed solution is agreed by a customer, co-creating a composed integrated solution with a customer is initiated. A designed networked business process is enacted when co-creating value with customers starts. The enactment of a composed networked business process may proceed in a few moments, for example in the case that proposed integrated solution is composed e-services. Alternatively it may take some years in the case that a product needs to be supported by all relating after-sale services during its usage by a customer. Enacted networked business processes are conducted within dynamic virtual organizations according to the described structure for run-time interactions (see Figure 7.6).

As a basis for domain knowledge on design-time and run-time interactions among collaborating parties, we rely on the architecture to manage dynamic networked business processes. This architecture is developed in the CrossWork project (Grefen et al., 2009a; Mehandjiev and Grefen, 2010; Norta et al., 2014)). The architecture in CrosWork describes how networked business processes are composed (i.e. design-time) and enacted (i.e. run-time) within dynamic virtual organizations (see Figure 7.7). In the context of SBNs, we can say that a goal that needs to be fulfilled by a networked business process is co-creating an integrated solution for a customer. In this way, CrossWork reference architecture describes how networked business processes are dynamically composed (within value networks) and enacted within a virtual organization in order to co-create integrated solutions.

Regarding Principle 3, which states decision-oriented and work process-oriented interactions among collaborating parties are separated, it can be said that all parties within a service-oriented value network collaborate (through exchanging relevant decisional information) to compose networked business processes that support proposed integrated solutions for customers. Within the run-time phase, parties around a composed networked business process collaborate within a dynamic virtual organization in order to enact the composed networked business process to co-create the proposed integrated solution.

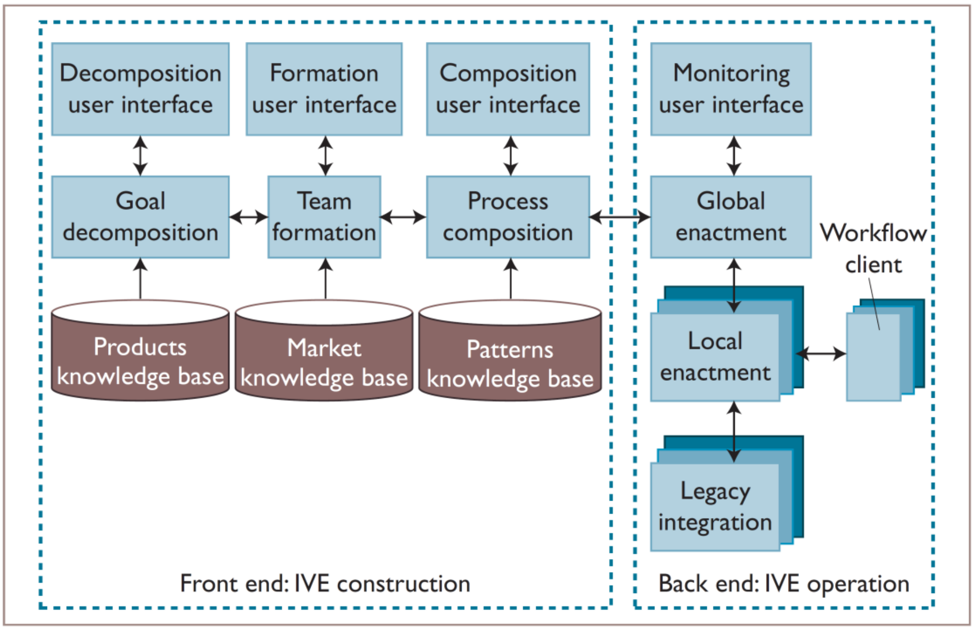

Figure 7.7- Cross-work architecture for managing dynamic networked business processes in virtual organizations (Mehandjiev and Grefen, 2010, Wang, 1998)

Reference model for managing IQ in inter-organizational interactions

The third reference model that is used to synthesize the desired reference architecture, addresses the management of quality of information that is exchanged within cooperative information systems. For this purpose, we refer to the DaQuinCIS architecture (Scannapieco et al., 2004). This reference architecture on the basis of the TDQM-CIS framework (Wang, 1998; Bertolazzi and Scannapieco, 2001) specifies three services to manage IQ within its life-cycle in cooperative information systems. These services include the quality notification service, the data quality broker, and the data quality factory. These services handle quality-aware information exchange, integration, and improvement among collaborating parties in a BN (see Figure 7.8). Regarding the described difference among management and governance, this architecture addresses activities related to managing quality-aware information exchanges.

According to the characteristics of the desired reference architecture, in this research we address governance of information exchange and the direction of the IQ management activities based on the three main mechanisms which are introduced in Section 7.3.; i.e. sensing, responding, and improving. We describe a reference architecture that directs the services proposed in DaQuinCIS architecture to keep them aligned with changes in dynamic interactions within SBNs.

Architectural style to synthesize the desired reference architecture

Developing reference architectures also should be based on well-defined architectural styles. Architectural styles are generally recognized structures that describe overall structure of architectures. Given the dominance of service-oriented architecture (SOA) style in the

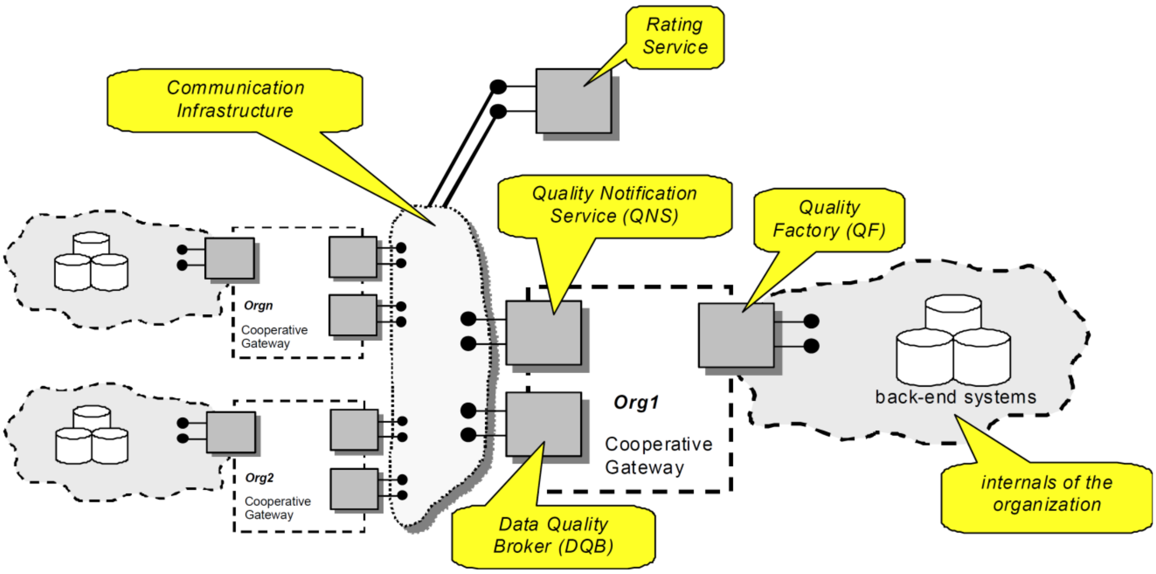

Figure 7.8- DaQuinCIS reference architecture (Scannapieco et al., 2004)

context of dynamic business networking (Papazoglou et al., 2007; Papazoglou et al., 2008)), the architectural style used should be aligned with SOA. However, the reference architecture needs to be technology independent to support the realization of concrete systems in different contexts with various technological infrastructures. In this way, we use the component-oriented style to design the reference architecture, which is aligned with the SOA, but is a technology and platform-independent style.

The component-oriented style defines structures by grouping coherent system functionalities into components and encapsulating this functionality from its environment through the definition of explicit interfaces of the components. We use the component-oriented UML diagrams (Booch, 2005) for the representation of the designed reference architecture. Based on that, we describe the high-level derived system components and their interdependencies within the component structure model.

On the basis of the described architectural principles, the related reference models and the used architectural style, the synthesis of the desired reference architecture is represented in the next section. In line with the three aggregation levels that are addressed in Section 7.1, i.e. market-level, party-level, and system-level, we describe the developed reference architecture in the three aggregation levels.

7.4.1 Synthesizing the reference architecture in a market-level aggregation

Reference architectures in a market-level aggregation describe how the main systems belonging to the collaborating parties interact in BNs. In this way, within this aggregation level, we describe system components in a high aggregation level that collaborate together to support governing information. Information is exchanged among collaborating parties within value networks that strategically collaborate to provide a better experience for potential customers. Information is also exchanged among parties collaborating in a dynamic virtual organization that intends to co-create integrated solutions with customers.

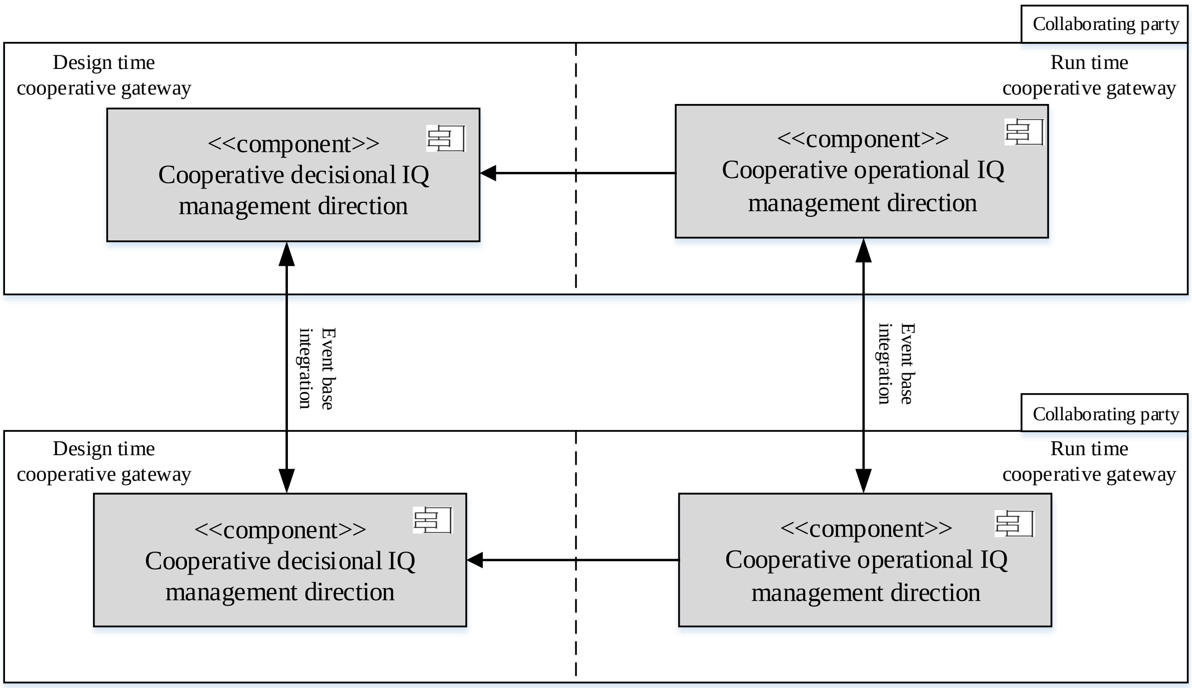

Figure 7.9- The reference architecture for supporting IG in SBN in a market-level aggregation-level

Based on the CrossWork architecture, from a networked business process management point of view, information exchange among parties collaborating in a value network (i.e. design-time) can be considered as decisional information sharing to compose customer experience centric networked business processes. Information exchange among parties within a dynamic virtual organization highlights operational business objects, for example, business documents or messages that are exchanged in order to enact a composed networked business process. Quality of information exchanges, within design-time and run-time interactions need to be managed by the service proposed by the DaQuinCIS architecture. In DaQuinCIS architecture, cooperative gateways within each collaborating parties interface both internally and externally through IQ management services. In accordance to this reference model, the market-level interactions for directing quality-aware information exchanges are also represented within interactions among cooperative gateways. The services for directing IQ management within the cooperative gateways are represented at a high aggregation level (see Figure 7.9). This figure as a market-level architecture describes the inter-organizational interactions to support high quality information exchanges. Since composing and enacting networked business processes are handled internally by each of the collaborating parties (Architectural Principle 2), the related modules proposed in the CrossWork architecture are not represented in this aggregation level.

Among the three main activities for governing information (i.e. sensing, responding, and improving), sensing needs to be conducted interactively. The reason for this is that changes within SBNs are recognized by different parties. For instance, during the co-creation of an integrated solution, different parties can collaborate within different steps of a product service system lifecycle (see Chapter 2). Change of customer requirements during the usage of a product service system can be recognized by a party that collaborates within a related usage step. These distributively recognized changes can result in IQ issues for a party that sensed the change, but also can result in IQ issues for other collaborating parties within a SBN.

Governing information in a BN requires announcing recognized changes, which can result in IQ issues for different collaborating parties, among whole parties in a BN. According to DaQinCIS architecture, this announcement is fulfilled by interactions among the notification services. A collaborating party that senses a change resulting IQ issue, announces all other collaborating parties in a BN.

In addition, the announcement can differ depending on the nature of the sensed change (Principle 3). A change in design-time (e.g. change on the specification of a product or service within a value network) must be announced for all collaborating parties within the relating value network. A change in run-time (e.g. a new customer requirement on a provided solution) needs to be announced for collaborating parties that interact within the relating virtual organization. The requirement to announce design-time changes is due to the commitment of parties to support the strategic success of a value network. Announcements relating to run-time are required due to the commitment of collaborating parties within a dynamic virtual organization for co-creating value-in-use in SBNs.

The interactions between cooperative IQ management direction services among collaborating parties is based on the event-based integration pattern (see (Shaw and Garlan, 1996; Fielding, 2000; Bass, 2007)). This pattern enables related parties to easily share changes on IQ and metadata, both in design-time collaborations (i.e. within value network) and run-time collaborations (i.e. within dynamic virtual organization that enacts a networked business process). This pattern supports the dynamic nature of SBNs through the ease of adding new components (e.g. new parties within value network) that listen for events. In addition, this interaction pattern is in line with the principle of autonomy of collaborating parties in SBNs, because collaborating parties can register interest in the type of announcements that are most relevant to their business.

7.4.2 Synthesizing the reference architecture in a party-level aggregation

The reference architecture in a party-level aggregation describes the structure of the system in support of IG at the intra-organizational level. At this aggregation level we describe how each collaborating party directs IQ management within composing (i.e. design-time) and enacting (i.e. run-time) dynamic networked business process. Regarding the reference model for the characterization of the inter-organizational interactions (Figure 7.6), the synthesized architecture in this aggregation level describes the systems that need to be used by parties collaborating in value networks in order to propose integrated solutions with customers. In this way, based on the services proposed in DaQuinCis architecture we decompose the

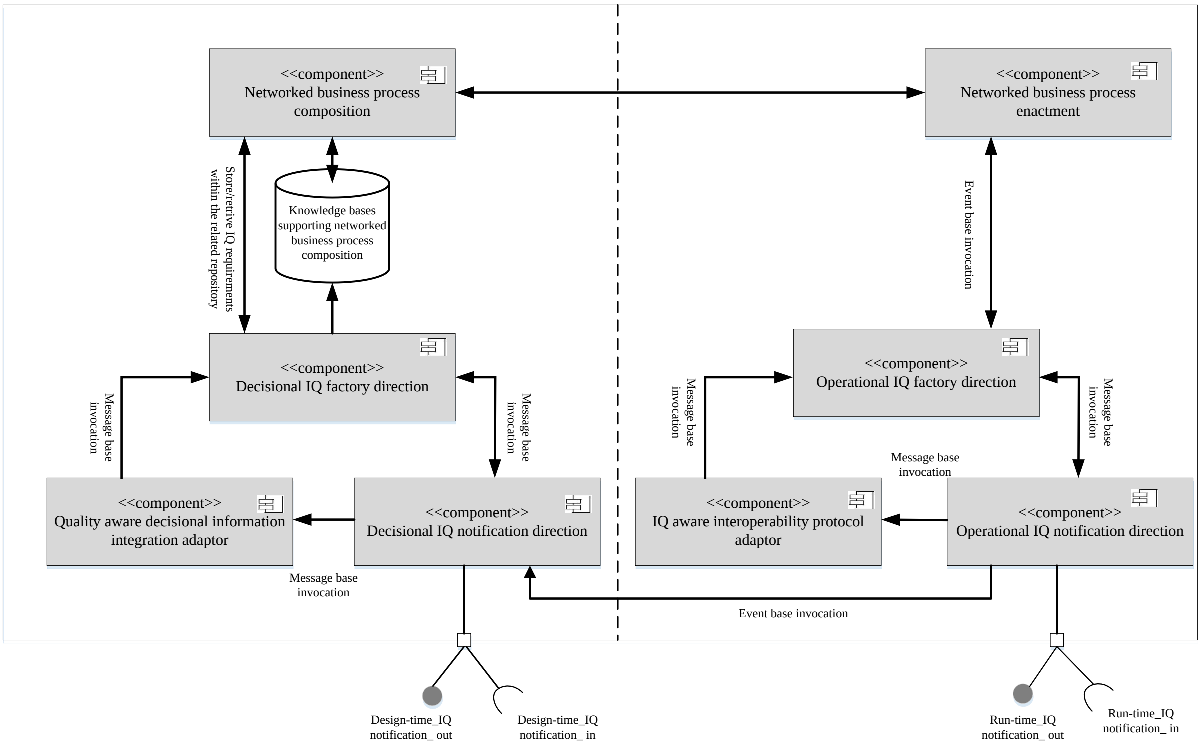

Figure 7.10- The reference architecture for supporting IG in SBNs in a party-level aggregation

cooperative decisional and operational IQ management services into the factory, integration, and notification services; as shown in Figure 7.10.

These services are responsible for ensuring high quality information exchange within inter-organizational interactions. The interactions of these services with the modules for composing and enacting networked business processes are described in Figure 7.10. On the basis of Principle 1 and Principle 2, we consider that all collaborating parties conduct the functionalities for governing information independently. This means that each collaborating party makes decisions to propose more customer-centric values via knowledge that is captured within a value network. Each party then uses all relating resources distributed among collaborating parties to co-create proposed solutions. In this way, according to the CrossWork architecture, each collaborating party intends to ensure quality of decisional information that is stored in related knowledge bases (as described within Figure 7.7).

Since the focus of this research is on networked business processes, among the knowledge bases that are introduced in the CrossWork we concentrate on a knowledge base that supports composing networked business process. Also, among the design-time modules within the CrossWork architecture, we highlight the process composition component. Regarding the CrossWork architecture, we intend to describe how quality of information stored in the knowledge base supporting the composition of networked business processes, can be ensured by a party collaborating in a value network.

Meanwhile, since each collaborating party can enact composed networked business processes, we describe how quality of information exchanged within enacted networked business processes can be supported. To do this, in line with Principle 3, we decompose the design-time and run-time components within each collaborating party (see Figure 7.10) Regarding the principle of the separation of IQ management and governance activities (Principle 4) we concentrate on governing information assets and not the management of information exchanges. For the synthesis of the desired reference architecture, we address the services that direct quality-aware information exchanges. According to Principle 5), we synthesize the architecture based on this foundation that all parties collaborating in a SBN exchange information together with its quality and related metadata.

The three main services for governing information are identified based on the DaQuinCIS architecture. We describe how these three services interact within collaborating parties to support IG within dynamic networked business processes in SBNs. According to Principle 3 and on the basis of CrossWork architecture, networked business processes are composed in design time. According to the reference model for inter-organizational interactions, composing networked business processes are conducted within value networks that are formed to propose integrated solutions.

Within the synthesized party-level architecture we represent all related activities for composing a networked business process including goal decomposition, team formation, and process composition, by the single aggregated service; i.e. the networked business process composition service. Composed networked business processes support proposed integrated solutions via collaborating parties. Composing networked business processes is supported by knowledge bases that store information on market, products and services, collaborating parties, and process patterns. Base on the reference model represented in Figure 7.6 the co-creation of a proposed integrated solution for a customer is handled by a dynamic virtual organization. Parties within a formed virtual integration collaborate to co-create a proposed solution with customers. This co-creation of the proposed integrated solution is handled by enacting composed networked business processes. According to the CrossWork architecture, co-creating proposed integrated solutions is conducted by the global enactment service. In the following of this section we describe how the IG services interact with these the services for composing and enacting dynamic networked business processes.

Within the represented party-level reference architecture, the IQ factory direction service is responsible for directing an IQ factory service. The IQ factory service has been specified in previous research (see (Cappiello et al., 2003; Scannapieco et al., 2004; Li and Osei-Bryson, 2010)). The IQ factory service is based on measuring the IQ of the information source (e.g. through methods proposed in (Cappiello et al., 2003; Heinrich et al., 2007; Heinrich and Klier, 2011) and intervening in order to fulfil required quality (e.g. by triggering synchronization tasks). The IQ factory direction service ensures that measuring quality of information and exchanging quality information with other collaborating parties is aligned regarding changes in the collaboration environment. In this way, the IQ factory service direction service within the developed reference architecture ensures that measurements and executions for improving IQ are aligned with changes.

The adaption direction service governs integration executions in design-time and run-time. Quality-aware information integration in design-time is supported by quality-aware integration schemas (see (Lenzerini, 2002; Shvaiko and Euzenat, 2005)). In run-time, quality aware information exchange within enacted networked business processes can be supported by different interoperability protocol adaptors (e.g. see (Motahari Nezhad et al., 2010; Pastrana et al., 2011; Seguel et al., 2014)). The adaption service directs the quality aware integration and interoperability solutions to keep aligned with the realized changes.
According to the alignment (top-down) and the enablement directions for governing information, the IG services can be triggered by changes in networked business processes (i.e. top-down) and also changes in IQ that are sensed by the notification service (i.e. bottom-up). These changes can be in design-time and run-time. In this way, the four main scenarios that are represented within Figure 7.10 are described in the following paragraphs.
The top-down IG scenario in design-time is triggered by changes in a composed networked business process. This may include, for example changes in integrated solutions that are planned to be proposed. These changes can result in IQ issues (see Chapter 5 and Chapter 6). The changes on IQ requirements of a networked business processes are stored in the IQ repository (as described further in Section 7.4.3). The low quality information is identified by the IQ factory service that measures the quality of information. An identified IQ issue resulting from changes in composed networked business processes may include not producing (or updating) information on an entity that is not relevant for the changed composed networked business within a BN. If this occurs, collaborating parties are notified via the notification service. It is likely that some other collaborating parties may need to reconfigure their composed networked business process in order to deal with the announced IQ issue. The notified IQ issue also can invoke the adaption service to modify integration schemas and their related metadata to keep aligned with the recognized changes in the composed networked business processes.

The bottom-up IG scenario in design-time is initiated by the IQ issue (or opportunity) that is notified by another collaborating party within a value network through an IQ related event. The IQ factory direction service can be invoked in order to align IQ factory service with emerging IQ issues and possibilities that are announced. It also can require adapting used integration schemas and metadata in order to keep aligned with other collaborating parties within a value network. The adaptation of integration schema or the used metadata can also result in invoking of the IQ factory service. This reconfigures information stored in related knowledge bases on the basis of the adapted schema and metadata.

The top-down IG scenario in run-time is launched when a change in an enacted networked business process is realized. This change can be due to the change in customer expectations during the usage of a product or service. This change needs to be handled by a party that manages customer’s experience. These changes that are reflected by IQ related events, invoke the operational IQ factory direction service. Changes on an enacted networked business process can result in IQ issues. These may include untimely information services regarding new quality requirements or incomplete underlying information services regarding the emerging information service requirements (see Chapter 5). New IQ requirements need to be considered within enacting the networked business process. The operational IQ factory direction service ensures that emerging IQ requirements in run-time are considered within enacting networked business process (as described further, through directing IQ related rules). The recognized IQ issues are also sent to the operational IQ notification direction service who announces the issues to other parties collaborating within the enacted networked business process. This notification direction service ensures that announcements are aligned with the dynamic nature of operating parties so that they can then adapt their information products, services and related metadata in response to the changed enacted networked business process. The notification service can also invoke the adaption service, which directs adaption of interoperability protocols regarding the changes.

The bottom-up IG scenario in run-time is initiated when a collaborating party is announced by another party about an identified IQ issue. Based on the analysis of received announcements, the operational IQ notification direction service invokes the operational IQ factory direction service in order to improve relevant information products and services. It also can invoke the quality-aware interoperability protocol adaptor service which directs adaption of interaction protocols supporting inter-operability among collaborating parties. The adaption of the interoperability protocols can require reconfiguring information products and services, which is directed by the operational IQ factory direction service. Since the IQ notification within run-time can also be used to enhance composing IQ aware networked business processes in design-time, announced IQ notifications in run-time are also sent to the decisional IQ notification direction service.

7.4.3 Synthesizing the reference architecture in a system-level aggregation

The reference architecture in a system-level aggregation is the structure of one specific information system component of one specific party. In Section 7.4.2 we specified six information system components at party-level aggregation (see Figure 7.10). In this section we decompose each of these six information system components supporting IG within dynamic networked business processes in SBNs.

Decisional IQ factory direction service

This service is responsible for direct executions which support quality of information that is stored and used for decision making in knowledge systems within collaborating parties in SBNs. This component is decomposed to the two main services. These services are directing IQ measures to keep them aligned with IQ requirements and directing IQ improvement executions within knowledge systems to fulfil the expected IQ requirements (see Figure 7.11).

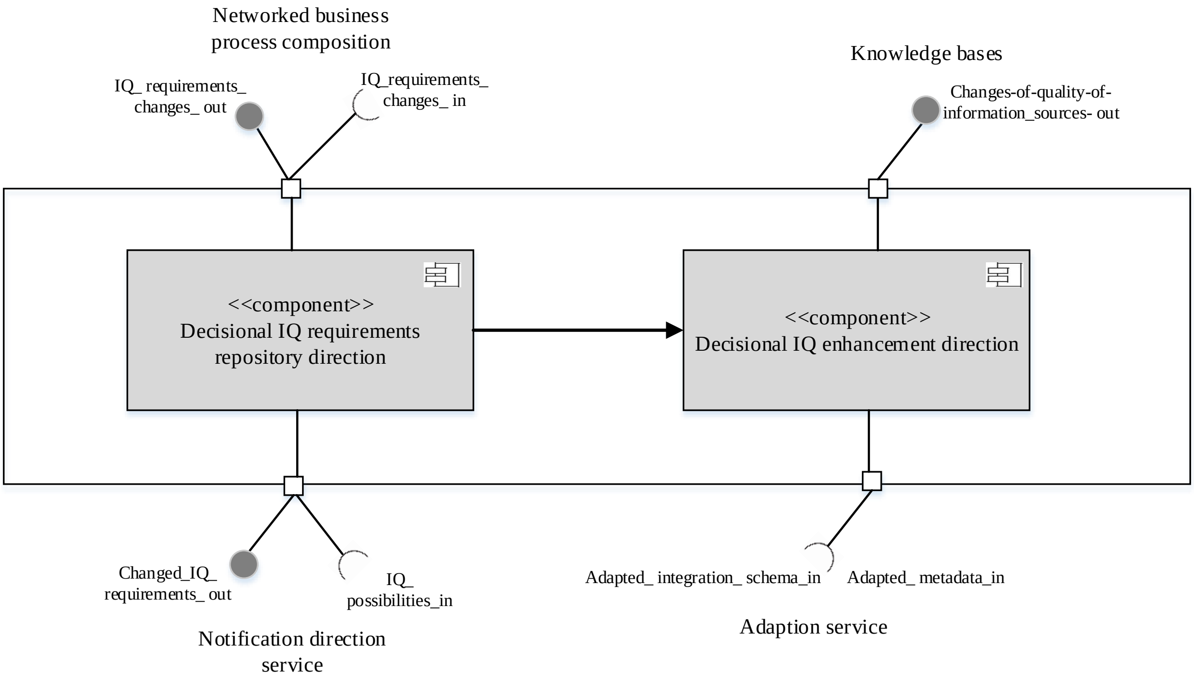

Figure 7.11- Decisional IQ factory direction service

The identification of IQ issues is conducted via measurements that are applied to assess quality of information within knowledge systems. The quality requirements of information products and services are stated within related measures. For example, information on customer experience on a product needs to be updated within two weeks. An IQ issue occurs when an expected IQ measure is not satisfied. Since information is used within networked business processes, quality requirements of information in different composed networked business processes can be different. Therefore changes in composed networked business processes can result in the need to update IQ requirements. In this way, in order to sense emerging IQ issues, IQ requirements need to be kept aligned with changes in composed networked business processes.

IQ requirements can be managed through an IQ requirements repository (e.g. see (Jarke et al., 1999; Jarke et al., 2013)). When a change is recognized in a composed networked business process, this service is responsible for executing IQ requirements updating tasks. In other words, this service ensures that IQ requirements are aligned with dynamically composed networked business processes (top-down direction). In addition, when a change is notified (through the notification service), this service updates the related measures within the IQ requirements repository. This updating may trigger the composing networked business process module (bottom-up direction) to reconfigure a composition regarding IQ issues.

The decisional IQ enhancement direction service within this module ensures that the updated IQ requirements are fulfilled, by executing relevant IQ factory tasks. This can be conducted via the executive IQ factory services that have been described in previous research (see (Scannapieco et al., 2004; Milano et al., 2007)). This service directs executive IQ factory services to ensure composed networked business processes are based on high quality information that are stored within related knowledge bases. In addition, when an adaption is recognized by the quality adaption service (e.g. metadata adaption or syntactic interaction protocol adaption), this service ensures that used information products and services are in line with the realized adaption.

Quality-aware decisional information integration adaptor

This service is responsible for keeping quality-aware integration tasks in line with recognized IQ issues and possibilities. Different quality-aware information integration solutions have been developed in the context of cooperative information systems (see e.g. (Lenzerini, 2002; Dustdar et al., 2012)). The adaptor service in the developed reference architecture intends to govern the quality aware integration solutions in order to keep them aligned with changes. To do this, in line with related literature in the context of model-driven information integration (e.g. see (Doerr et al., 2006; Berger et al., 2010)) we distinguish among an integration schema that supports the business logic for integrating information from different sources, and metadata that represents domain language for ontological matching of information sources. The adaptor service needs to govern both of these two aspects of integration (see Figure 7.12).
The quality-aware information integration schema adaptor governs the change of used schemas by collaborating parties to integrate information. From a top-down perspective, a

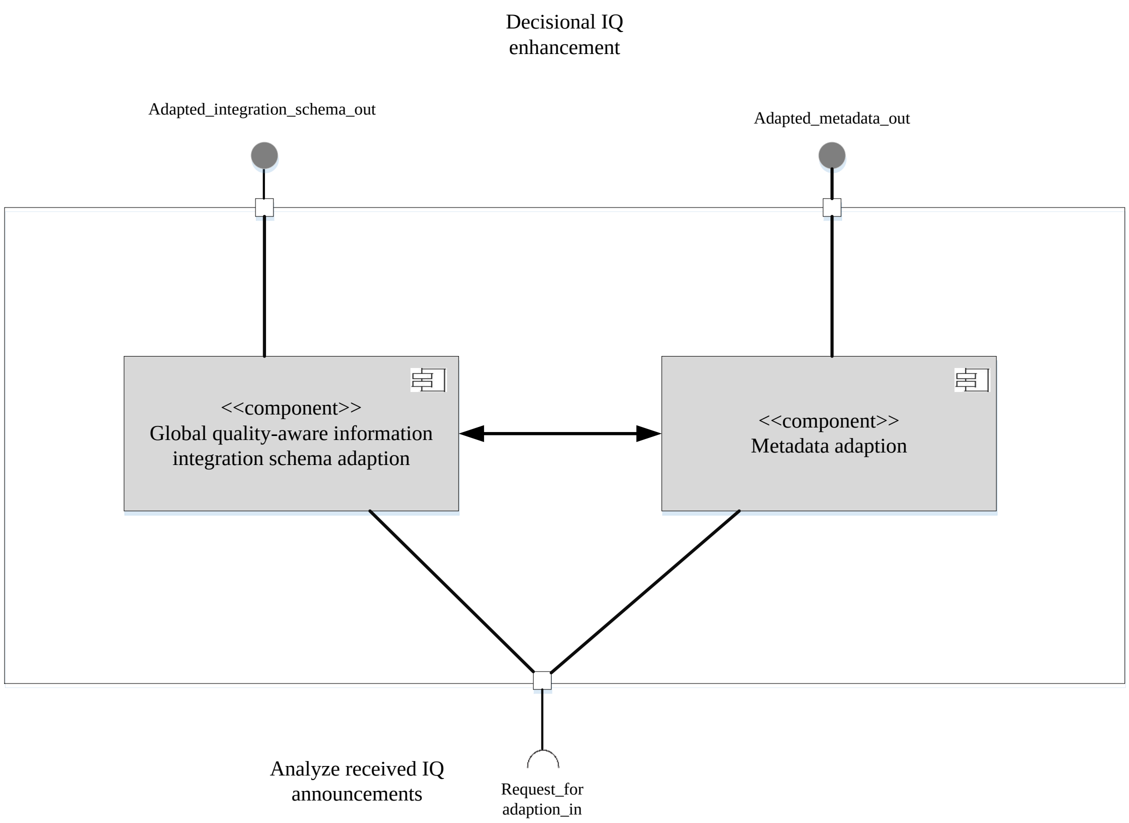

Figure 7.12- Quality-aware decisional information integration adaptor

quality-aware information integration schema needs to be adapted regarding the emerging IQ requirements to support collaborative decision making to compose networked business processes. On the other hand, from a bottom-up perspective, an integration schema needs to be adapted to respond to dynamism of information sources that are provided by collaborating parties within a SBN. This service ensures that the used quality-aware information integration schema supports the decision-making requirements, which are stored in the IQ requirements repository. It also exploits high quality information sources within a SBN.

The metadata adaptor governs a collaborative metadata that is used for ontological matching of different information sources that are provided by collaborating parties. Regarding the dynamic nature of SBNs, the used metadata needs to be evolved to be in line with the requirements of knowledge systems. It must also be able to support ontological matching of new information sources provided by new parties due to the dynamic nature of SBNs.

Decisional IQ notification direction service

The responsibility of this service is to govern the announcement of IQ issues that have arisen due to the dynamism of composed networked business processes. According to the DaQuinCIs architecture, IQ announcements are exchanged among collaborating parties within a SBN. The direction service in the developed reference architecture ensures that a recognized IQ by a party is announced to all other related parties. This service also analyzes received announcements on IQ from other collaborating parties. The modules representing these two functionalities are shown in Figure 7.13.

The IQ requirements repository is directed by the IQ requirements repository service. If there are changes within IQ requirements repository resulting in IQ issues, the IQ announcement direction service is responsible for announcing the recognized IQ issues for collaborating parties. The announcement can be made by the IQ notification service (e.g. see (Marchetti et al., 2003; Caro et al., 2005)). However, due to the dynamic nature of collaborating parties, the IQ notification needs to be governed to ensure announcements are made to parties who are currently collaborating within a value network. The content of the announcement can be an emerging IQ requirement that need to be fulfilled by collaborating parties within a composed networked business process. It also can be the change of quality of information sources that are provided by an announcing party. In addition, this service uses run-time IQ announcements. Run-time IQ announcements that can be used in design-time can be real-life IQ requirements that are recognized during enacting a composed networked business processes. For example consider a situation that it has been predicted that a vehicle’s location information needs to be updated within every 10 minutes. However, the experience in executed instances shows that updating this information every 8 minutes can enhance run-time routing decisions. This run-time IQ notification, which can be recognized by the run-time IQ factory direction service (as described further within Figure 7.14), enables the design-time IQ factory direction service to update the IQ requirements repository to enhance run-time decisions.

A collaborating party can receive IQ notifications from different parties. In order to direct responding to these notifications, they need to be analyzed. This analysis determines if a collaborating party needs to respond to an IQ notification or not. Based on this analysis the decisional IQ requirements repository can be updated. For example, a new networked business process composed by a collaborating party may require other parties to increase the quality of specific information sources. Also, the analysis can trigger the adaption service in order to align the integration schema and related collaborative metadata regarding the quality issues and possibilities of information sources within a SBN.

Operational IQ factory direction service

Enacting composed networked business processes to co-create integrated solutions can deal with different changes. These changes primarily originate from changes in customer expectations during the usage of products or services. The operational IQ factory direction service ensures that information objects that are used within enacting networked business processes fulfil the required quality attributes that are expected. The required quality attributes are mainly determined in design-time but can be changed during the enactment phase. To direct these required changes, this service handles the two main functionalities (see Figure 7.14). Firstly it ensures that IQ requirements are aligned with changes in networked business processes (i.e. top-down direction). In addition, it supports enhancing enacted networked business process in relation to IQ issues and possibilities that are detected (i.e. bottom-up direction).

IQ requirements of an enacted networked business process can be seen as business rules that need to be considered. This may be via a business rules engine (Norta et al., 2014). These IQ requirements as rules are set out within composing networked business process. However, changes in run-time can cause changes in IQ requirements. The operational IQ related rule direction ensures that considered IQ related business rules are changed (and aligned) regarding the run-time changes of enacted networked business processes. This service

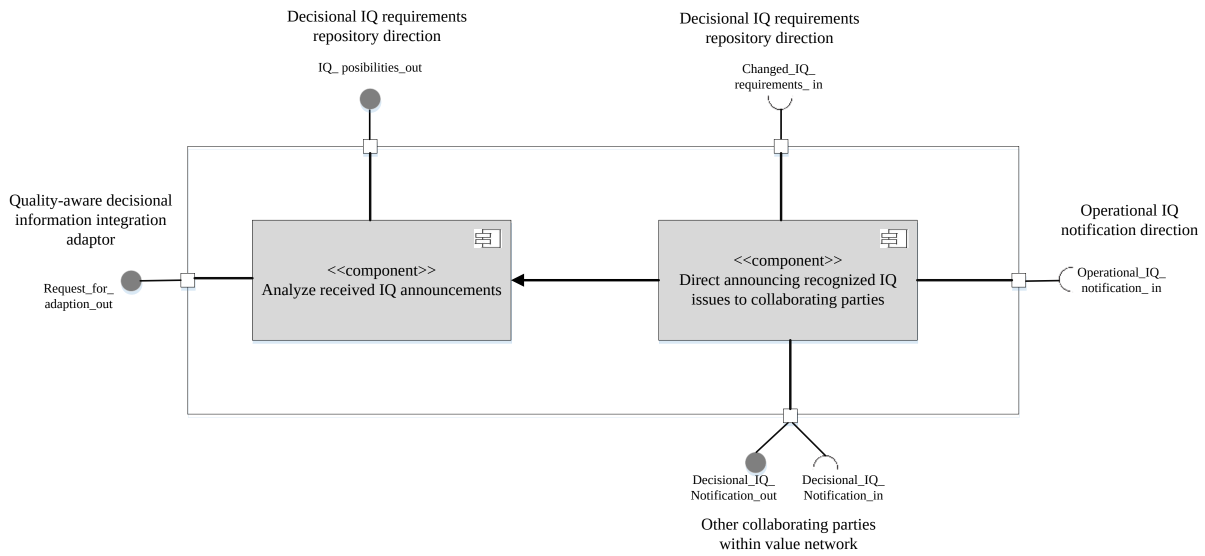

Figure 7.13- Decisional IQ notification direction

updates IQ related business rules within networked business process enactment. If there are changes in IQ related business rules collaborating parties need to be notified within an enacted networked business process. This enables them to adjust the information sources that are provided by them to fulfil related IQ requirements. This service need to be linked to the IQ driven networked business process enhancement service since changes in IQ related rules can result in switching information resource providers.

On the other hand, as the enabling role of the IG, the IQ driven global workflow direction enhances the enacting networked business process regarding IQ possibilities or detecting possible IQ issues. Solutions supporting IQ-aware adaption of enacted networked business processes have been increasingly considered in recent research, see e.g. (Metzger et al., 2012; Baumgrass et al., 2014). The IQ driven global workflow direction service offers a solution which enhances enacted networked business processes on the basis of data quality possibilities. The enhancement of enacted networked business processes is usually supported by event-driven control solutions that predictively generate IQ related events to adapt control flow regarding pre-detected IQ issues. In addition, quality aware business process mining approaches (e.g. (Perez-Castillo et al., 2011; Van Der Aalst, 2011)) can be used to direct enacted networked business processes regarding IQ possibilities. The IQ driven enhancement of enacted networked business processes also can be achieved by improving IQ related business rules.

Quality-aware interoperability protocol adaptor

When an information source needs to be changed, the quality-aware interoperability service ensures that interoperability protocols are adapted to support syntactic and semantic

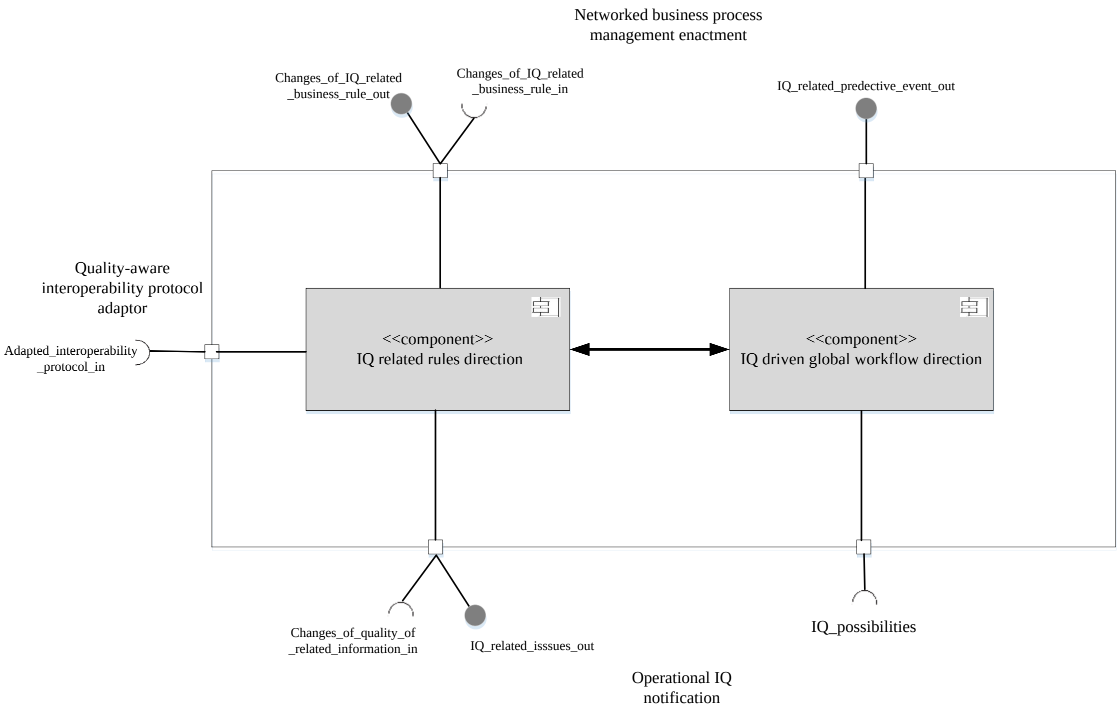

Figure 7.14- Operation IQ factory direction

consistency of information sources exchanged. Different syntactic and semantic interoperability protocols can be used within inter-organizational interactions. These interoperability protocols can be based on different interoperability techniques that have been developed. These include standardization based approaches such as XML, ebXML or RosettaNet approaches. Alternatively syntactic and sematic middlewares such as CORBA and data orientated middlewares (e.g. see (Sheth and Larson, 1990)). Dynamic interoperation among collaborating parties requires adapting the used interoperability protocols (e.g. see (Seguel et al., 2014). The quality-aware interoperability protocol adaptor directs adapting the used protocols (see Figure 7.15) on the basis of changes of information sources that are used within enacted networked business process.

Operational IQ notification direction

The operational IQ notification direction service, governs announcing IQ changes to all collaborating parties within a virtual organization that is formed to enact a networked business process; see the component for directing announcing recognized IQ issues and possibilities in Figure 7.16. This component addresses the functionality for governing IQ related announcements that are sent to collaborating parties. It also directs the reflection on the IQ related announcements that are published by the other collaborating parties within an enacted business network. This governance is required, due to changes resulting from dynamic partnering in run-time. This means that this component determines which collaborating parties should be announced about the recognized IQ related issues. This component also ensures that all IQ related announcements that are published by other

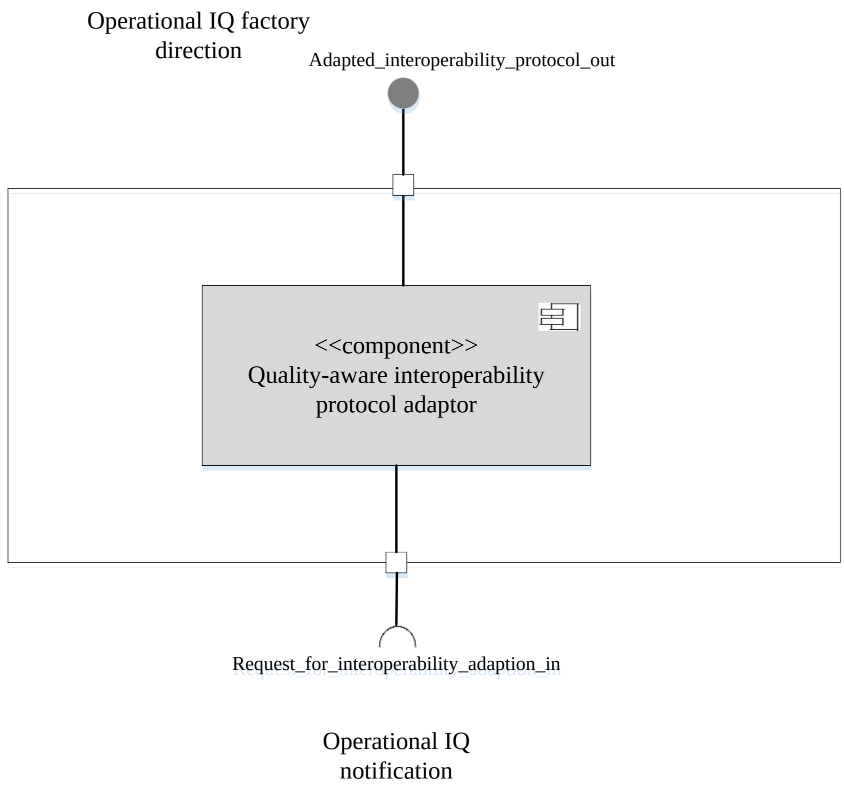

Figure 7.15- Quality-aware interoperability protocol adaptor

relevant collaborating parties are received. Governing the notification is necessary in SBNs due to the changing nature of collaborating parties within networked business process enactment.

The operational IQ notification direction service also directs analyzing received IQ related announcements. In the case that received announcements require a response, this service triggers the quality aware interoperability protocol adaptor service and also the operational IQ factory direction service. The interoperability protocol adaptor service is triggered when received announcements necessitates the change of an information source that is used. Changing information source, which is possibly provided by a switched party, can require the adaption of interoperability protocol to ensure syntactic and semantic consistency of used information sources. The IQ factory direction service may also be triggered, because the analyzed IQ announcements can result in the need for a change to IQ related rules or IQ related process events.

In addition, the operational IQ notification direction service can also send announcements relating to the decisional IQ notification direction service. These announcements can enrich knowledge bases particularly those related to collaborating parties and their resources. This enhances decision-making on composing networked business processes. This is IQ related feedback on composed networked business processes.

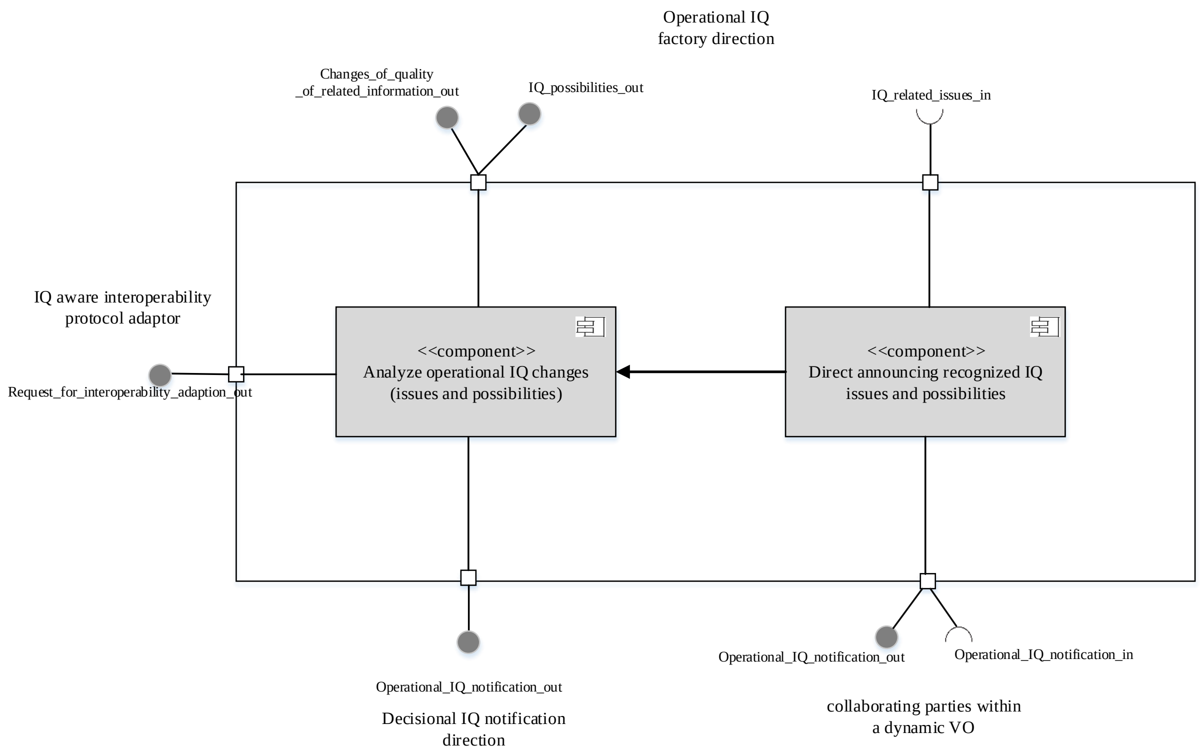

Figure 7.16- Operational IQ notification direction

7.4.4 Traceability of the synthesized components

The synthesized reference architecture, which is described within three aggregation level, should counter the IG issues in dynamic networked business process as identified in Part 2. This can be investigated through the traceability of the synthesized components, which addresses how the designed modules counter the IG issues in SBNs.

In order to represent the traceability of the designed components, we firstly map the IG issues on the functional requirements that have been identified. We then map the designed components on the functional requirements. In this way, we link the designed architectural solution with the problem domain. The representation of the traceability of the designed components helps to identify the class of the proposed solution (in the form of the synthesized component) relating to the IG issues. The representation of the traceability of the designed components helps to derive concrete solutions from the synthesized reference architecture.

Two steps are addressed within the development of the reference architecture. These are the architectural analysis and the architectural synthesis. We represent the traceability of the designed components within the two steps. In doing so, we firstly represent how the IG issues in SBNs (as identified in Chapter 5) are addressed by the considered functional requirements. Then we represent how the synthesized components within the developed reference architecture fulfil the identified functional requirements. These two stages link the proposed solution (i.e. the synthesized components) to the problems that should be countered.

As a first step, we map the identified functional requirements on the explored IG issues. In doing so, we need to consider the three points:

- The identified IG issues in Chapter 5 only address the alignment direction within the architectural analysis step. This means that we have concentrated on the exploration of the IG issues that have emerged due to the dynamism of networked business process (i.e. top-down direction). However, in this chapter the enablement direction also is considered within the identification of the functional requirements (see Section 7.3).
- An IG issue needs to be addressed with three functional requirements which represent whole lifecycle. This includes sensing, responding, and improving in order to deal with the related issue.
- Regarding the approach for the identification of the functional requirements, those are more aggregated than the identified IG issues. So, it is possible that some IG issues are addressed by the same functional requirements.

These IG issues are mapped to the identified functional requirements (see Table 7.4). Since in this chapter we narrow the scope of the research within IQ and metadata domain, as

Table 7.4- Mapping the comprehensively explored IG issues on the identified functional requirements for governing information assets within SBNs

	Information product quality issues							Information service quality issues					Metadata issues					
	Modification of information product syntactic inconsistency	Modification of information product semantic inconsistency	Aligning information production processes	Linkage of relevant information products	Dismission of not-added value information products	Information product synchronization	Evolution of pooled master information products	Clarifying garbling information services	Information service quality certification	Quality aware information service brokery	Handling information networkability	Continuity of information service	Metadata collaborative repository	Metadata traceability	Modification of collaborative metadata inconsistency	Metadata evolution	Collaborative metadata robustness	Metadata context awareness
FR1	■	■	■	■	■	■	■											
FR2	■	■			■	■												
FR5								■		■	■							
FR6								■		■	■							
FR9													■	■	■	■		■
FR10													■	■	■	■		■
FR13	■	■	■	■	■	■	■											
FR14	■	■			■	■												
FR17								■		■	■							
FR18								■		■	■							
FR21													■		■	■		■
FR22													■		■	■		■
FR25	■	■	■	■	■	■	■											
FR26	■	■			■	■												
FR29								■		■	■							
FR30								■		■	■							
FE33													■		■	■		■
FR34													■		■	■		■

described in Section 7.1, in Table 7.4 we address IG issues relating to these domains.

As shown in Table 7.4, many of the explored IG issues resulting from the dynamism of networked business processes are addressed by the identified functional requirements. However, the identified functional requirements can address each of the IG issues in more detail. Three of the IG issues are not covered by the identified functional requirements. These IG issues can be conceived as potential risks. This means that they are issues that have not been addressed within the developed reference architecture through well-established decisions.

The first issue that has not been addressed in detail is information quality certification. This has not been considered directly within the identified functional requirements due to Principle 1, which states that all collaborating parties are independently governing information assets that are used. Certification is usually conducted by an external party which has legitimation to certify quality of information provided by different collaborating parties. Fulfilling this issue can require centralization of some IG duties. This conflicts with the wide distribution of IG responsibilities among autonomous collaborating parties. In this way, this issue can be considered as a trade-off point within the development of concrete architectures to counter context-specific IG issues. In concrete architectures a trade-off must be handled in order to decide about the importance of the (complete) distribution of all IG responsibilities among independent collaborating parties. A decision must also be made to decide if the IQ certification needs to be completed by an external party. This decision strongly depends on the governance concerns and structures within BNs.

The second IG issue that is not addressed directly by the identified functional requirements is continuity of information services. Within the developed reference architecture this continuity depends on the commitment of collaborating parties within service-oriented value networks (strategic long-term commitment) and formed virtual organizations (operational short-term commitment). However, again based on Principle 1, no specific functionality has been considered to ensure this commitment. This issue also can be considered as a trade-off point between the need for autonomy among collaborating parties and the need to ensure the long-term and short-term commitment of collaborating parties within SBNs.

The third unaddressed issue is collaborative metadata robustness which can result in a clutter risk for knowledge and process systems. This means that based on the developed reference architecture, collaborating parties need to respond to all changes within a value network. Although reactions to received announcements are triggered by an analysis component, the developed architecture does not clearly address robustness as a criterion within analyses.

As the second step to represent the traceability of the developed reference architecture, we map the identified functional requirements on the synthesized system components (see Table 7.5.) To do this, we rely on the synthesized components within the third-aggregation level (i.e. system-level aggregation level). All of the identified requirements are addressed logically by the synthesized components (see Table 7.5). However, these required functionalities have been fulfilled by abstract components due to the abstract nature of the developed reference architecture. Linking the synthesized components to the IG issues in the context of SBNs, helps to design concrete architectures to counter context specific concrete IG issues in real-life SBNs (see Table 7.4 and Table 7.5), This provides a useful basis to address the classes of relevant solutions to counter IG issues. However, the development of concrete solutions to counter IG issues requires refinement of the proposed classes of solutions by considering context specific factors.

Table 7.5- Mapping the synthesized components on the identified functional requirements

	Design-time components						Run-time components				
	Decisional IQ requirements repository direction	Decisional IQ enhancement direction	Global quality-aware integration schema adaption	Metadata adaption	Analyze received IQ notifications	Direct announcing IQ issues to collaborating parties	IQ related rules direction	IQ driven global workflow direction	Quality aware interoperability protocol adaptor	Analyze operational IQ changes	Direct announcing operational IQ issues and possibilities
FR1					■	■					
FR2										■	■
FR3					■	■					
FR4										■	■
FR5					■	■					
FR6										■	■
FR7					■	■					
FR8										■	■
FR9					■	■					
FR10										■	■
FR11					■	■					
FR12										■	■
FR13			■								
FR14									■		
FR15			■								
FR16									■		
FR 17			■								
FR18									■		
FR19			■								
FR20									■		
FR21				■							
FR22									■		
FR23				■							
FR24									■		
FR25	■	■									
FR26							■	■			
FR27	■	■									
FR28							■	■			
FR29	■	■									
FR30							■	■			
FR31	■	■									
FR32							■	■			
FR33				■							
FR34									■		
FR35				■							
FR36									■		

7.5 Evaluation of the synthesized reference architecture

Architectures are evaluated to investigate their suitability (Clements et al., 2003). An architecture is a suitable design if the system that results from it will meet its quality goals (Clements et al., 2003). In this way, evaluation of architectures is a more efficient way of avoiding disasters that may arise as a result of improper architectural decisions. The quality of reference architectures directly influences the quality of the resulting concrete architectures. Reference architectures are used as a basis for developing concrete architectures. Therefore, reference architectures need to be evaluated to ensure they direct developing high quality concrete architectures.

A variety of methods have been developed for evaluating architectures. These include the Scenario-Based Architecture Analysis Method (SAAM) (Kazman et al., 1996) and the

Architecture Trade-off Analysis Method (ATAM) (Kazman et al., 1998). Although there are differences among architecture evaluation methods in relation to their various angles and perspectives, they follow a similar objective and use similar consonant evaluation logic (Dobrica and Niemelä, 2002).

Architecture evaluation methods, which have been mainly developed to evaluate concrete architectures, deals with difficulties in the evaluation of reference architectures (Angelov et al., 2008). These difficulties arise due to differences between concrete and reference architectures. These differences may include the generic nature of reference architectures compared concrete architectures, the absence of a clear group of stakeholders for reference architectures, and highly abstraction of reference architectures. The difficulties resulting from these differences between concrete and reference architectures have been clearly described in (Angelov et al., 2008; Angelov et al., 2014). In order to deal with these difficulties, architectural evaluation methods have been adapted for use when evaluating reference architectures. For example, ATAM has been extended in (Angelov et al., 2008; Angelov et al., 2014) by introducing ATAM/R (ATAM for Reference architectures).

According to four non-functional requirements that are identified in Section 7.3, the developed reference architecture needs to be evaluated in relation to its completeness, conceptual integrity, buildability, and applicability. In this thesis, due to the limitations on time, we conduct a preliminary evaluation. The evaluation of the developed reference architecture needs to be addressed in future work more precisely.

Completeness of the developed reference architecture

Completeness of architectures points out that all functional requirements that need to be fulfilled within the desired scope are addressed. The scope and requirements of concrete architectures are determined by related stakeholders. However, due to the absence of concrete stakeholders for reference architectures, the evaluation of the completeness of reference architectures needs to be conducted on the basis of classes of stakeholders (as described in ATAM/R). In this way, the investigation of the completeness of the developed reference architecture requires the recognition of functional requirements of stakeholders in real-life SBNs. This is then compared with the considered functional requirements. Meanwhile, to investigate the completeness of the developed reference architecture we need to compare the functionalities of its components with the functionality of concrete solutions that are used by different stakeholders in real-life SBNs.

However, in this research the described approach cannot be applied. This is due to the limitations resulting from the futuristic nature of the developed reference architecture and the scarcity of established IG solutions in real-life SBNs. As a preliminary evaluation of the completeness of the developed reference architecture we refer to the traceability of the synthesized components. Indeed, since in Chapter 5 we have explored a comprehensive list of IG issues in the context of SBNs, and Table 7.4 and Table 7.5 indicates that almost all of the IG issues have been addressed by the synthesized reference architecture. It also indicates that the developed reference architecture is complete in its scope. However, this logical argumentation requires an empirical investigation using real-life SBNs.

Conceptual integrity of the developed reference architecture

Conceptual integrity of architectures is determined by the derivation and usage of relevant architectural principles within developing architectures (see the role of architectural principles described in (Greefhorst and Proper, 2011)). Architectural principles direct architectural decisions when designing architectures. This direction aims to unify all architectural decisions in response to the required contextual characteristics and goals. The role of architectural principles in conducting architectural decisions is further highlighted within the development of reference architectures (Greefhorst and Proper, 2011).

To evaluate the conceptual integrity of the developed reference architecture, we concentrate on the investigation of the relevance of derived architectural principles. This is due to the critical role of architectural principles in directing architectural decisions when designing reference architectures. We then probe the usage of the derived architectural principles in a proper way to make architectural decisions within the architectural synthesis step.

Investigating the relevance of architectural principles requires relevant stakeholder involvement. This involvement should be from different real-life SBNs from a variety of contexts. Evaluating the architectural decisions in accordance with the architectural principles also requires holding different workshops with scholars and practitioners from different contexts (as proposed in ATAM/R).

In this research we conduct a preliminary informal evaluation of the conceptual integrity of the developed reference architecture. To do this, we organized a workshop within a business process management cluster meeting at IS group of IE&IS department at TU/e. In the first part of the workshop we presented the characteristics of SBNs and an overview of IG issues in this context. We then presented information on the architectural principles (see Section 7.4) for the development of the reference architecture. We then led an open discussion based on the semi-structured questions relating to the evaluation outputs. These included risks, non-risks, sensitivity points, and trade-offs. The aim of this discussion was to obtain relevant thoughts of the participating members.

The second part of the workshop focused on the presentation of the developed reference architecture and the architectural decisions that were made. Again, based on the semi-structured questions, an open-discussion was conducted to investigate the consistency of the architectural decisions with the considered architectural principles. Following the investigation of the architectural principles, we evaluated the consistency of the made architectural decisions and architectural principles. In order to do this evaluation, we determined the most ten important architectural decisions that have been made during the synthesis of the developed reference architecture. During the workshop, the relevant experts reflected their thoughts on non-risks, risks, sensitivity points, and trade-offs regarding the architectural decisions made in accordance with architectural principles. The findings from the conducted workshop are described in Appendix I.

Buildability of the developed reference architecture

The buildability of architectures can be investigated by addressing technologies that support their realization. Regarding the high abstraction of components within reference architectures, their buildability can be investigated by highlighting classes of technologies that can support realization of related concrete context-specific architectures. Practice reference architectures, which aim to unify existing concrete architectures, need to be buildable through on-the shelf technologies that are easily accessible. However, the buildability of futuristic reference architectures can be based on classes of developing or emerging technologies, which are not yet widely used. In this way, regarding the futuristic nature of the developed reference architecture, we do not need to limit supporting technologies to those that are widely used in BNs.

We refer to the CrossWork architecture to support composing and enacting dynamic networked business process (see section 7.4). In this way, according to the Internet-based support of CrossWork architecture (see (Grefen et al., 2009a)) we use a multi-agent system (MAS) platform as the basis for design-time components. We also use service-oriented computing (SOC) technology as the basis for run-time components (Grefen et al., 2009a). Composing and enacting dynamic networked business processes have been sufficiently described in previous work by using respectively a MAS platform and a SOC platform that employs technologies from the Web service stack (Grefen et al., 2009a; Mehandjiev and Grefen, 2010; Seguel et al., 2014; Norta et al., 2014).

We first describe classes of algorithms and techniques that can be used within a MAS platform to govern the quality of decisional information. We then address classes of techniques and technologies that can be used within a SOC platform to govern quality of exchanged messages among services.

The adaption of integration schemas and collaborative metadata within the quality aware decisional information integration adaptor component can be supported by ontology matching algorithms (Shvaiko and Euzenat, 2005; Euzenat and Shvaiko, 2007). These algorithms can be implemented as intelligent agents within the MAS platform in design-time. These intelligent agents are able to select the most appropriate matching algorithm in order to respond to an adaption request and apply the selected ontology matching algorithm (e.g. see (Acampora et al., 2012)).

The decisional IQ factory component is a control component that adapts the IQ factory service. The realization of the IQ factory service has been addressed in previous literature (Cappiello et al., 2003; Heinrich et al., 2007; Li and Osei-Bryson, 2010; Heinrich and Klier, 2011). The developed component for directing IQ factory services can be seen as an agent that adapts the quality measures within the pre-developed IQ factory services. This adaption can be supported by different stochastic or fuzzy algorithms that match quality requirements and quality measures.

The IQ notification direction component also indicates governing IQ notifications. The implementation of IQ notifications has been addressed in previous works by developing relating services (e.g. see (Marchetti et al., 2003). The synthesized component to direct IQ notification can be seen as an IQ notification service that is encapsulated into agent-oriented wrapper. The interaction of this agent with other IQ notification agents in collaborating parties in a value network can be handled by an intelligent algorithm. This algorithm monitors the dynamism of partnering within a value network and based on that directs the wrapped IQ notification service.

The realization of interoperability adaptors can be supported by different syntactic and semantic interoperability protocol adaptors (Benatallah et al., 2005; Seguel et al., 2010; Motahari Nezhad et al., 2010; Seguel et al., 2014).

The operational IQ factory direction within a SOC based platform can be supported by event-driven control algorithms. Combining event-driven techniques and SOC platforms has become increasingly important when developing emerging technologies and tools in recent years (e.g. see (Taylor et al., 2009; Juric, 2010)). Discovering IQ related events can be supported by business process compliance techniques. These techniques support the recognition of quality of services by their event logs. In addition, IQ related enhancement of business processes can be supported by algorithms which correlate and aggregate IQ related events (e.g. see relating services in GET service architecture (Baumgrass et al., 2014)).

The operational IQ notifications can be supported by event-bus technologies (Zang and Fan, 2007; Zang et al., 2008) that receive, aggregate and distribute events among integrated services within a SOC platform. The distribution of events for relevant parties, as well receiving relevant events from other parties, can be directed by an intelligent module. This module controls the subscriptions of services of relevant collaborating parties within event-buses.

Applicability of the developed reference architecture

ATAM/R states that applicability of reference architectures can be evaluated through the comparison between components of reference architectures and components of related concrete architectures (Angelov et al., 2014). This comparison shows how the proposed components, based on the developed reference architecture, can be applied in concrete systems. In this way, when evaluating the applicability of the developed reference architecture, pre-developed relevant concrete architectures are selected in the context of dynamic business process management.

Selected relevant concrete architectures may not clearly include the synthesized components due to the futuristic nature of the developed reference architecture. However, we need to show how the components within these concrete architectures can be complemented by the designed components in order to deal with IQ issues within composing and enacting dynamic networked business processes.

To do this, we need to select concrete architectures that have been developed to manage dynamic networked business processes. Also, we need access to detailed information about selected concrete architectures in order to be able to compare them with the synthesized components within the developed reference architecture. Based on these criteria, namely the relevance and the access to detailed information, we select four related concrete architectures. These selected concrete architectures have been recently developed to manage dynamic networked business processes. If we can show the applicability of the designed components within these four concrete architectures, based on replication logic, we can argue that it is applicable within other related concrete architectures.

The four selected concrete architectures that are used to evaluate the applicability of the reference architecture are described below:

- FINEST architecture (Metzger et al., 2012) has been developed to enhance access to operational data which opens up novel opportunities to monitor, control, and manage service-oriented business processes.
- GET service architecture (Baumgrass et al., 2014) has been developed in order to provide transportation planners and drivers of transportation vehicles with the means to plan transportation routes more efficiently and respond quickly to unexpected events during transportation.
- SIMPLI-CITY architecture (Husak et al., 2015) has been developed to enhance the use of full-fledged road user information systems. This helps drivers to make their journey safer, more comfortable, and more environmentally friendly.
- C-ITS architecture (van Sambeek et al., 2015) has been developed to support the integration of intelligent vehicles roadside/back-office infrastructures in the Netherlands. The aim is to implement smarter and more effective applications for traffic management.

Regarding the aggregation levels of the four concrete architectures, as shown in Appendix J, we investigate the applicability of the synthesized components of the developed reference architecture at the party level aggregation (see Appendix K for results). The comparison of the developed reference architecture with the four concrete architectures shows that it can be applied within concrete scenarios to support quality of information used for composing and enacting dynamic networked business processes. Although the findings from the comparison of the developed reference architecture with relevant concrete architectures can be considered a preliminary investigation of its applicability. More confidence on the findings requires the application of the developed reference architecture in different real-life SBNs to govern information assets in real-life networked business processes.

7.6 Discussions

The reference architecture developed in this chapter describes how information assets can be governed within SBNs to support and enable managing dynamic networked business processes. Regarding the reference model for the classification of inter-organizational interactions in collaborative networks (i.e. Figure 7.6), the synthesis of the reference architecture is based on the characterization of the structures of collaborations in SBNs within value networks. The CrossWork architecture is considered as a basis to derive the relevant components for managing dynamic networked business processes within the described collaboration structures. The DaQuinCIS reference architecture is used to describe relevant services to support managing IQ within inter-organizational interactions. In this way, the reference architecture developed in this chapter brings together information-centered approaches (as considered in DaQuinCIS architecture) to process-centered views (as considered in CrossWork architecture) in the context of SBNs.

The developed reference architecture improves previous architectures in a number of ways. Firstly it proposes a procedure that ensures high quality information is exchanged within composing and enacting networked business processes. It also describes how components used to compose and enact networked business processes in CrossWork architecture can be supported by high quality information. In this way, the developed reference architecture provides a well-established basis to exploit big data opportunities for automated/semi-automated management of control flows in rapidly changing environments. Meanwhile, it represents how businesses should care about quality of information to collaborate effectively by composing and enacting networked business processes.

In addition, in comparison with previous architectures that manage IQ, such as DaQuinCIS architecture, the architecture developed here builds up the IQ management scenarios. It does this by representing a process-centered networked scenario. More specifically, our reference architecture shows how the services proposed by the DaQuinCIS architecture can interact with components that support networked business process management. While previous architectures for managing IQ address conventional information exchanges among collaborating parties, our reference architecture proposes a procedure that supports the management of IQ within a process-centered collaboration. In this way, it shows how efforts to govern information assets can result in improved business value. This is achieved by supporting composing and enacting customer-centric networked business processes.

The overall contribution of the reference architecture developed in this chapter can be summarized as follows:

- It transforms descriptive relevant knowledge on IG (as developed in previous work like (Otto et al., 2011; Kooper et al., 2011; Tallon et al., 2013; Tallon, 2013)) towards a prescriptive model in the form of reference architecture. This, in turn, facilitates the application of these theories in real-life situations.

- It presents a comprehensive view on different directions of governing information assets, i.e., alignment and enablement directions. The alignment direction addresses concerns of scholars and practitioners who use business networking engineering tools to consider how information assets can be kept aligned with business-driven changes. On the other hand, the enablement direction is relevant to big data scholars and practitioners who aim to apply intelligence tools such as business process intelligence techniques to enhance networked interactions. In addition, the architecture developed here bridges the gap between data-driven and process-driven techniques by linking process and information aspects to govern information assets.
- It extends IG, which has been mainly addressed in the context of single organizations (e.g. see (Weber et al., 2009; Khatri and Brown, 2010) or conventional stable business networks (e.g. see (Otto et al., 2011; Hüner et al., 2011b; Falge et al., 2012b), to a novel emerging business situation that is refereed by SBNs. In this way, our reference architecture can be seen as an exaptation, which applies multiple disciplines of thought. It integrates relevant knowledge from the strategic management (i.e. dynamic capabilities perspective) with IG domains within an emerging business context (i.e. SBNs) by using a structured description language (i.e. architectural development).
- Our reference architecture bridges the gap between descriptive knowledge on IG and prescriptive knowledge that can be applied in real-life SBNs. In this way, it can facilitate service orientation transitions for BNs by countering IG issues resulting from dynamic inter-organizational interactions among collaborating parties. It also bridges the gap between business-driven and IT-driven approaches for conducting service orientation in BNs. Business-driven approaches concentrate on a top-down direction to conduct service orientation. This is initiated by developing a service-oriented strategy, a business model, and networked business processes (e.g. see (Grefen, 2015b)). IT-driven approaches for service orientation focus on opportunities that are provided by emerging IT developments such as cloud computing, big data, social media, and Internet of things. The reference architecture developed here enhances the combination of these two directions for service orientation by addressing the alignment and enablement directions for governing information assets.

Further research is needed in order to increase the adaptability of different integration and interoperability solutions within dynamic situations. Our reference architecture highlights the direction of the information integration solutions for collaborative decision-making. It also indicates the direction of interoperability protocols to support dynamic inter-operation among collaborating parties. In this way, it stresses the need to adapt the interoperability solutions presented here, as well as the need for novel solutions that can direct this adaptation in an automated/semi-automated way.

From a practical point of view, the reference architecture presented here provides a well-established basis to design context-specific concrete architectures to enhance IG in SBNs. It highlights the need to invest in solutions that support the direction of information management in SBNs. It also highlights that service orientation in BNs requires extending the ability for governing information (as dynamic capability) in addition to information integration and interoperability abilities.

In this research we conducted a preliminary evaluation of the completeness, conceptual integrity, buildability, and applicability of the developed reference architecture. However, more empirical validation needs to be conducted using relevant approaches such as ATAM/R.

The reference architecture developed here uses a top-down methodology. The most important limitation of this is its insufficient ability to address concrete solutions (or classes of solutions) that can be used within each of the developed components. Bottom-up approaches facilitated by the determined functionalities within the developed components can improve the developed reference architecture by incorporating more concrete components.

In addition, we do not consider customers specifications explicitly as co-producers and creators of value within the networked business processes. Customers in SBNs can be seen as collaborating parties within a value network, composing and enacting networked business processes. Therefore future research should incorporate customers' specifications to develop this area further.

8

Conclusion

Chapter 8

Conclusion

The core subject matter that has been addressed in this thesis is the governance of information assets within service-oriented business networks (SBNs). In doing so, the first part of the thesis concentrated on the characterization of SBNs in order to provide a clear understanding of the attributes of the emerging business landscape. This is a situation in which independent and geographically disperse organizations collaborate within highly dynamic BNs to co-create integrated solutions with customers.

In the second part of the thesis we identified a comprehensive list of the IG issues in SBNs. In order to address these IG issues, the third part of the thesis concentrated on developing a procedural solution in the form of a reference architecture that supports governing information assets within SBNs.

The main findings of the thesis are summarized and discussed in accordance with the three research question in Section 9.1. The main contributions of the research are clarified in Section 9.2. Section 9.3 describes theoretical and empirical implications of this thesis. The main limitations of the conducted research are reflected in Section 9.4. The thesis is concluded in Section 9.5 by offering several suggestions for future research.

8.1 Main findings

For summarizing the main findings of the thesis we refer to the three main research questions that have been introduced in Chapter 1. The findings relating each of the research questions, which have been reported in the three parts within the thesis, are described respectively in the following of this section.

8.1.1 An integrated framework to characterize service orientation in business networking

The first part of the dissertation concentrates on the first research question which states:

RQ1- What are the characteristics of SBNs which aim to co-create integrated solutions with customers?

interrelated matrices was developed. This integrated framework inclusively and coherently describes the characteristics of BNs that aim to respond requirements of competition in emerging globalized and customer-centered markets through co-creating integrated solutions. The inclusiveness of the developed integrated framework results from considering different dimensions of service orientation that have been addressed in emerging theories in the context of marketing, operations management, and networked e-business structures. The coherence of the developed integrated framework originates from a cybernetic system based view on different aspects of service orientation, respectively, the value aspect, the networked interactions aspect, and the network governance aspect.

Based on the developed integrated framework, SBNs need to co-create value-in-uses during usage of products and services by customers. Co-creating value with customers requires relational interactions with customers. The co-creation of value with customers through relational interactions shifts supply chains that are product/service driven, towards demand chains that are customer driven. In this way, co-creating value with customers requires BNs to be adapted on the basis of customer expectations.

On the other hand, SBNs are also required to provide more complete and integrated packages of relevant products and services that cover the whole product/service lifecycle. The provision of integrated products and services requires enriching BNs by parties that support producing new products and services. Fulfilling customer requirements within integrated products and services through autonomous and globally distributed parties requires handling dynamic networked interactions. These interactions need to be coordinated within distributed structures, in which parties collaborating within a BN can choreograph resources of other collaborating parties in order to fulfil customers' requirements within whole products/services lifecycle.

Regarding the developed integrated framework, the extreme point of service orientation within a BN can be characterized as a BN that co-creates integrated solutions with customers. In this situation, collaborating parties interact with customers regarding use of products and services in order to co-create proposed integrated solutions. On the other hand, customers actively participate in products/services production processes; e.g. through crowd sourcing scenarios. In this way, all parties within a value network (i.e. suppliers and customers) follow actor-actor interactions that are adapted in order to shape better experiences for all collaborating actors.

In order to evaluate the applicability and the usefulness of the developed integrated framework, a multiple-case study research was conducted in three BNs that had already planned for service orientation. The characterization of the current and future (i.e. planned) situations of the BNs from a service orientation point of view shows the applicability of the developed integrated framework in real-life BNs. The results from the case study show that the integrated framework also can provide useful insights for decision-makers to investigate service orientation transitions in real-life BNs. The discussion of the results of the characterization of service orientation with decision makers led to new insights for them in order to re-think their service orientation transitions. By presenting service orientation in a structured way, it enables decision makers to probe other service orientation directions to achieve competitive advantages in their environments.

The developed integrated framework also provides a coherent view on service orientation for managers from different functional domains. In this way, it can enable decision makers to align their marketing and procurement strategies to support service orientation transitions. It can also facilitate the alignment of information systems and IT possibilities with marketing and procurement requirements within service orientation transitions.

8.1.2 A comprehensive list of the information governance issues in SBNs

The second part of the thesis addressed the following research question:

> RQ2- What IG issues need to be addressed to ensure high quality and secure information exchanges in dynamic networked business processes within SBNs?

In order to answer this research question, a systematic literature review (SLR) was conducted in the second part of the thesis. The focus of the review was to identify the IG issues within managing dynamic networked business processes in SBNs. This SLR resulted in the identification of the 28 IG issues, which were classified into information quality product issues, information service quality issues, information security issues, and metadata issues. This review provides a comprehensive view on issues that need to be addressed within service orientation transitions of BNs.

Regarding the conducted methodology (i.e. the SLR), the identified IG issues are theoretically relevant. In order to investigate the practical relevance of the identified IG issues, a case study research was conducted in Part 2. This case study explored the IG issues within the two networked business processes in a SBN that intends to co-create integrated mobility solutions for customers. In order to support the generalizability of the findings from the conducted case study, an analytical generalization approach was followed. This analytical generalization is founded on the logic models that link the dynamism of networked business processes to the identified IG issues. The results of the conducted case study shows that the SLR based IG issues are practically relevant.

8.1.3 A reference architecture to support governing information assets within dynamic networked business processes in SBNs

The third part of the thesis concentrated on the following research question:

RQ3- How can information be governed through an architectural solution to ensure high quality information exchanges among collaborating parties within dynamic networked business processes in SBNs?

Among different mechanisms that can be used for governing information assets, in the third part of the thesis we developed a procedural mechanism that supports governing information assets within dynamic networked business processes in SBNs. This procedural mechanism was developed within a reference architecture. Two main steps were conducted to develop this reference architecture: architectural analysis and architectural synthesis.

Within the first step, by using a view point based approach for requirements engineering, the 36 functional requirements were identified. These requirements address aligning information assets with the requirements of dynamic networked business processes as well as enabling dynamism of networked business processes through IQ related possibilities within SBNs. Meanwhile, the four main non-functional requirements, as the required quality attributes of the developed reference architecture were determined.

In the second step, a reference architecture was synthesized in order to support governing information assets within dynamic networked business processes. To do this, the five architectural principles have been considered in order to direct architectural decisions regarding the characteristics of SBNs. Also the three reference models were used: a reference model on business networking, a reference architecture for managing dynamic networked business processes, and a reference architecture for managing IQ in cooperative information systems. Based on these reference models, the desired reference architecture was synthesized within the three aggregation levels: the market-level, the party-level, and the system level reference architectures. The synthesized components describe how autonomous parties in SBNs can ensure high quality information exchanges within dynamic networked business processes.

This reference architecture shows how changes within networked business processes can be supported by aligning information assets with emerging IQ requirements. It also shows how the IQ related possibilities can enable dynamism in SBNs in order to compose more well-established networked business processes. Meanwhile, the reference architecture developed here highlights how changes in enacted networked business processes can be managed. It also addresses how predictive IQ related possibilities can enhance enacted networked business processes within co-creating value with customers in SBNs.

According to the identified required quality attributes of the developed reference architecture, we discussed the quality of the reference architecture in relation to its completeness, conceptual integrity, buildability, and applicability. The discussion on the described quality attributes can be considered as a preliminary step for the validation of the developed reference architecture. The complete validation of the developed reference architecture can be conducted by applying ATAM/R method in future research.

8.2 Contributions

According to the design science based nature of this thesis, we elaborate the contributions of this research within this research paradigm. This paradigm underlines that design science research should clearly contribute to the scientific community, as knowledge contributions, but, also should make clear contribution to the real-world application environment (Straub and Ang, 2011; Gregor and Hevner, 2013). These two types of the research contributions are described in the following of this section.

8.2.1 Scientific contribution

The first part of the thesis, bridges the gap between descriptive knowledge on service orientation and prescriptive design theories and models for designing BNs. More precisely, the developed integrated framework links emerging descriptive theories that stress the need for service orientation in business, like theories on the service dominant logic of marketing(e.g. see (Vargo and Lusch, 2004)), theories on the servitization of manufacturing (e.g. see(Mont, 2002)), and theories on network governance (e.g. see (Jones et al., 1997)), and prescriptive knowledge for designing and implementing SBNs through models and tools, like models and tools represented in (Lüftenegger, 2014; Grefen, 2015b). The framework bridges the gap between emerging descriptive theories and prescriptive design tools and methods relating to service orientation in BNs.

The second scientific contribution of this thesis is the comprehensive identification of emerging IG issues in the context of SBNs. This adds to the knowledge base on governing information assets within SBNs. It extends the knowledge of the role of IG in support of service orientation in BNs and clarifies the concrete new problems that should be addressed in this domain. Meanwhile, the comprehensive list of IG issues identified can be seen as IG requirements within a problem domain. This connects theories that stress the need for service orientation in BNs and those that focus on using IS solutions to support and enable dynamism and agility in SBNs.

The third scientific contribution of this research is a description of a procedural mechanism in the form of a reference architecture. This can facilitate the governing of information assets within SBNs. Within the developed reference architecture theories on IG that are mostly descriptive (like IG theories developed in (van Grembergen, 2007; Weber et al., 2009; Kooper et al., 2011; Tallon et al., 2013)) are transformed into a prescriptive procedure that can be applied in real-life business situations. In addition, a dynamic capability perspective on IG is characterized that stresses the role of IG in dynamic and agile business situations (like SBNs) rather than stable environments.

Overall, this thesis enhances the knowledge to support emerging business situations in globalized and customer-centric markets by providing high quality information. It also adds to the knowledge base on mechanisms to exploit information-driven opportunities in order to improve business situations.

8.2.2 Practical contributions

The integrated framework developed in this thesis provides an inclusive overview on service orientation transition, which is a strategic need in globalized competitive markets. This overview can support decision-making in service orientation transitions in different real-life BNs. The framework developed also facilitates a coherent understanding of different aspects of service orientation, which are important for marketing, procurement, and IT. The framework also aligns different innovative business models, which are developed and used by different collaborating parties within service orientation transition. This investigation and alignment of different business models can help to ensure that service orientation transition is consistent across all collaborating parties within a SBN.

The IG issues identified provide a basis for business and information governors to predict and address information sharing and exchange risks within networked business processes. The IG issues identified here can help business governors to have a more comprehensive view on the causes of information sharing and exchange risks from dynamic networked interactions among independent and globally distributed parties. This information can lead to the revision of the developed service-oriented networked business models. The list of the IG issues also helps information governors to understand how service orientation impacts quality and security of information assets. Therefore, it can allow them to plan in order to prevent these issues.

The developed reference architecture also makes it easier for information governors to develop real-life concrete system in order to support high quality information exchange and sharing among collaborating parties in SBNs. The architecture also enables BNs to exploit business opportunities of information. This is increasingly relevant in the light of big data, social media, and Internet of things technologies.

Therefore, this dissertation helps real-life BNs to achieve competitive advantage in globalized and customer-centered markets through proposing and co-creating integrated solutions. This thesis shows how information assets can support and enable highly customized value propositions for customers by composing dynamic networked business processes that are adapted to customer experience. It also facilitates the co-creation of value with customers during the usage of provided integrated solutions by enhancing high quality information exchanges within enacted networked business processes.

8.3 Implications

In line with the described contributions, we outline the implications of the main findings of the thesis for academic researchers as well as practitioners respectively in the following of this section.

8.3.1 Scientific implications

Different theories in the context of marketing and operations management have been developed to stress the importance of co-creating integrated solutions. However, in order to realize these theories more attention needs to be given to mechanisms that can support and govern interactions among collaborating parties within SBNs. Inspiring business visions suggested by service-dominant logic and servitization theories need to be accomplished by further developments in the context of networked interactions management and governance theories. This is particularly important within design theories, which can support the realization of these inspiring visions in real-life scenarios. Although this research narrows the gap between the described inspiring vision and the difficulties realizing this ambition, more research is necessary to develop prescriptive models and tools to support the design and implementation of SBNs.

This research demonstrates the critical role of IG, as a supportive and enabler mechanism, in realizing business ambitions to co-create integrated solutions by collaborating with globally distributed parties. The findings of the research clearly show the emergence of the IG issues which threaten businesses ability to ensure high quality and secure information exchanges within dynamic interactions among collaborating parties in SBNs. These emerging issues need to be addressed, otherwise business ambitions will not be achieved, or it will lead enormous failures in real-life situations. The findings also suggest that computational intelligent solutions alone are not enough to create business value from big data. Utilizing the opportunities provided by big data, particularly for co-creating integrated solutions with customers, requires BNs to examine the IG mechanisms, which support quality and security of information.

There is an enormous amount of research in support of syntactic and semantic interoperability among collaborating parties, which are facilitated by different technological developments. However, dealing with the emerging IG issues in SBNs requires more attention to IG as a dynamic capability. The characterization and realization of IG as a dynamic capability needs to be considered in different research domains, ranging from policymaking and strategic management to operations management and IT developments.

This research introduces a procedural mechanism to govern information within dynamic inter-operations. However, IG needs to be facilitated through national information exchange policies as well as strategic directions to produce and provide strategic information resources.

8.3.2 Practical implications

The findings of this research indicate that BNs in real-life situations can follow different service orientation transitions. A service orientation transition within a BN needs to be thoroughly investigated to ensure it is in line with the competitive strategy of a BN to achieve sustainable competitive advantage in market.

In addition, a BN needs to be internally aligned in order to follow a service orientation transition consistently from different aspects. Networked interactions and related infrastructures should be aligned with the type of service-oriented value offered. For instance, providing integrated products and services may require dynamic inter-organizational processes through dynamic e-sourcing infrastructures. However, co-creating value with customers may require significant investment in solutions that support customer experience through mining data gathered by social media.

Meanwhile, based on our findings, service orientation in real-life BNs is often triggered by marketing departments. These departments can characterize the expected service-oriented value by customers. However, the provision of service-oriented values needs to be realized by production processes, such as new product/service development processes, manufacturing processes, and logistic processes, many of which are handled by other departments. In this way, service orientation transitions should be developed interactively by all relevant departments in order to avoid unfeasible or commercially irrelevant service orientation transitions. A joint vision on service orientation transition should also be shared with all (key) collaborating parties within a BN.

BNs aiming to co-create integrated solutions need to invest in IG mechanisms that allow them to use big date opportunities to manage customer experience. These mechanisms also should enable information exchanges within networked inter-operations. However, our findings show that IG as a key enabler of this has not been sufficiently valued or developed in real-life situations. More precisely, in many cases, the role of IG has been considered at the operational level, which should be addressed by IT departments. However, the increasing importance of information for strategic, tactical, and operational decision making, particularly in dynamic and agile business situations,, means that IG should be a concern within all enterprise levels and domains. Therefore information-awareness should be seen as a critical principal within the enterprise architecture of a BN.

8.4 Limitations

There are a number of limitations to this research relating to development limitations and evaluation limitations. Development limitations are those relating to the scoping of the design context, design approach, or the nature of the designed artefact. Evaluation limitations are those related to the reliability and the generalizability of the results.

8.4.1 Development limitations

The most important limitation of this research is that it has concentrated on B2B interactions to explore IG issues in SBNs. Issues relating to using customer information (like customer privacy issues) or using business information by customers (e.g. emerging open organizations concepts) have not been directly addressed. However, this limitation can be attenuated by the fact that the majority of customer information is gathered and processed via social media service providers, who handle issues such privacy issues within their businesses.

The reference architecture developed in this research to support IG in SBNs has also focused on B2B interactions. The adaption of composed and enacted networked business processes is handled by business parties via analysis of customer experience. However, the adaption of interactions by customers, for example through crowd-sourcing scenarios for value co-production and co-creation, has not been addressed by the reference architecture developed here.

Another limitation of the reference architecture to support governing information assets in SBNs is related to considering the management of networked business processes within the composition and enactment phases. Although the reference architecture can be adapted to be used within emerging business process management paradigms such as adaptive case handling approaches, it does not directly consider the emerging paradigm of business process management which highlights data-driven approaches.

In addition, the developed reference architecture concentrates on IQ and metadata within IG domains. However, other domains of IG, such as information security have not been covered. Focusing on information security in future research is important because solutions to support information security may influence the procedural mechanism developed as part of this reference architecture (e.g. through the limitation of IQ notifications distributions).

8.4.2 Evaluation limitations

The main limitation of the evaluation of the integrated framework developed in the first part of the thesis pertains to the investigation of its coherency. More precisely, the inter-relationship between service-oriented value, networked interactions, and network governance aspects needs to be empirically investigated further in future research. In addition, the consequences of misalignment among different aspects within service orientation transition have not been clearly addressed by the case studies conducted here.

The reliability and generalizability of the findings regarding practical relevance of the identified IG issues are sufficiently supported by the logic models developed in Chapter 6. However, because the selected SBN was in service orientation transition, it had not yet become a complete SBN, therefore some of the IG issues had not yet been directly experienced. In this way, although the not-directly experienced IG issues were strongly expected on the basis of the theoretical and practical insights, more empirical exploration of the identified IG issues in SBNs may enhance the confidence of the findings.

The evaluation of the developed reference architecture in Part 3 encounters with different limitations. These limitations results from the nature of the developed artefact, as a futuristic reference architecture that makes it difficult to evaluate its quality regarding existing relevant concrete architectures. These limitations are also due to time restrictions that we had for conducting the research within a PhD research. In particular, the conceptual integrity of the developed reference architecture to support IG in SBNs has been evaluated through the investigation of the relevance of the architectural principles and the architectural decisions. Although the conducted workshop for this investigation has provided a preliminary insight on the conceptual integrity of the developed reference architecture, more empirical investigation, especially through more concrete integrity related scenarios can enhance the findings.

Meanwhile, though the addressed relevant technologies and computational solutions may indicate the buildability of the developed reference architecture within real-life concrete architecture, its instantiation in different relevant contexts can increase the confidence in its buildability. In addition, the acceptability of the reference architecture within the related community has not been addressed in this research due to its futuristic nature.

8.5 Future research

Based on the results and limitations of the research conducted here, future research can focus the following areas:

- Develop prescriptive models to direct service orientation transitions for BNs who wish to co-create integrated solutions for customers. These prescriptive models can address a specific aspect of service orientation in BNs and can also offer a coherent view on different aspects of service orientation.
- Develop models and tools to align different aspects of service orientation within and among collaborating parties. These alignment models can improve alignment of BN strategies with service orientation transitions. They can also address operational alignments, for example aligning IT with networked interactions, in the context of SBNs.
- Investigate the relationships between service orientation decisions within different aspects of business networking.
- Explore IG issues within B2C interactions. Future research could focus on how collaborating business parties use customer information. This could focus on customer information related issues such as information privacy. In particular, exploring IG issues resulting from different privacy policies across different countries or different contexts (e.g. health care context) can be a relevant research direction. Future research could also focus on how customers use business information for example through crowd sourcing business models used by open organizations.
- Further empirical research exploring IG issues in real-life SBNs. This empirical research can enhance the confidence of the findings from the case study research represented in Chapter 6.
- Future research could consider relational governance mechanisms, such as trust based governance approaches to ensure high quality and secure information exchanges in SBNs. As described in Chapter 7, the developed reference architecture to support governing information assets in SBNs has been based on a procedural mechanism that originates from a dynamic capability perspective on IG. However, this reference architecture can be complemented by relational governance mechanisms.
- Consider other IG domains such as information security or compliance governance to build up the developed reference architecture. Regarding the described limitations resulting from scoping of the developed reference architecture, it can be extended by addressing other IG domains.
- Evaluate the quality of the developed reference architecture by using relevant methods like ATAM/R.
- Instantiate the developed reference architecture within concrete architectures in different business contexts. This can help to further refinement of the reference

architecture developed in this thesis. This may involve using a bottom-up direction to complement the top-down direction used to develop the reference architecture here. This could also enhance the investigation of the buildability and applicability of the developed reference architecture in real-life situations.

- Further research is needed to develop context-specific and concrete intelligent computational solutions to realize the components proposed within the developed reference architecture. However the addressed algorithms in Chapter 7 indicate the buildability of the developed reference architecture, but more research is needed for the development of context-specific and concrete intelligent computational solutions for the realization of the proposed components.

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Summary

About the author

List of publications

Summary

Information Governance in Service-Oriented Business Networking

Competition in current business environments forces organizations to focus on their core competencies and outsource other activities. Organizations focusing on their core competencies collaborate with globally distributed business parties to provide products and services for customers. This highlights the importance of business networking for achieving competitive advantages. In this way, nowadays competition is between business networks (BNs) rather than between single organizations.

On the other hand, customers' empowerment in globalized markets necessitates service orientation in BNs. Service orientation in BNs points out deep interactions with customers for value co-creation as well as dynamic and agile collaboration with suppliers to deliver mass-customized products and services. In this way, a service-oriented business network (SBN) is described as a collaborative network of independent parties within a market that co-create mass-customized packages of products and services in the form of integrated solutions.

Service orientation in BNs requires sensing of environmental changes (e.g. customer needs) and responding to these needs rapidly through agile orchestration of resources distributed among parties. Orchestration of distributed resources within a BN is realized by networked business processes. Service orientation in BNs highlights information-intensive networked business processes. The information-intensity implies dynamic evolution of networked business processes in order to respond to environmental requirements. The property of information-intensity is further increased by emerging paradigms like big data, cloud computing, and internet of things that enable to generate, store, access, and use globally distributed information. However, this situation results in emerging issues such as unsecured information access and low quality information products. These issues strongly threaten performance of BNs. So, they need to be recognized and countered by information governance (IG) mechanisms in an appropriate way. IG in the context of BNs can be characterized as a holistic approach to enable high quality and secure information exchanges among collaborating parties.

This dissertation concentrates on IG in SBNs. To do so, the dissertation is organized within the three main parts. The first part of the thesis characterizes SBNs within an integrated framework in the form of three-two dimensional matrices. The applicability and usefulness of the developed framework to characterize service orientation in real-life BNs is evaluated by a multiple-case study.

The second part of the dissertation concentrates on the identification of the IG issues resulting from service orientation in BNs. To do so, a systematic literature review is conducted that results in the identification of the 28 IG issues. These issues are categorized within information quality, information security, and metadata domains. The practical relevance of the theoretically identified IG issues is evaluated by a case study.

The third part of the dissertation describes synthesizing an architectural solution to deal with the identified IG issues. The designed architecture specifies components that support governing information assets that are exchanged to manage dynamic networked business processes in SBNs.

About the author

Mohammad Reza Rasouli was born on 29-03-1983 in Tabriz, Iran.

After finishing Industrial Engineering in 2004 at Amir Kabir University of Technology in Tehran, Iran, he studied Industrial Engineering at Shahed University in Tehran, Iran. In 2007 he graduated within the College of Engineering on Industrial Engineering. From 2013 he started a PhD project at Eindhoven University of Technology at Eindhoven, the Netherlands of which the results are presented in this dissertation.

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RASOULI, M. R., KUSTERS, R. J., TRIENEKENS, J. J. & GREFEN, P. W. 2014. Service orientation in demand-supply chains: towards an integrated framework. *Collaborative Systems for Smart Networked Environments,* 15th IFIP Working Conference on Virtual Enterprises,. Springer, 182-193.

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RASOULI, M. R., ESHUIS, R., TRIENEKENS, J. J., KUSTERS, R. J. & GREFEN, P. W. Under submission. A reference architecture to support information governance in service-oriented business networking.

Appendices

Appendix A- A summary of the characteristics of service orientation in BNs

		Service orientation dimensions within a value chain	
		Supply chain dimension	Demand chain dimension
Relevant aspects	Value	- Shift from the fulfilment of a product to fulfilment of its utility. - Shift from providing single products or services towards providing product service systems. - Time based extension of providers' responsibility to support product life cycle management. - Shift from providing out-put oriented products or services towards result-oriented packages.	- Shift from the G-D logic of marketing towards the S-D logic - Shift from a supplier-centric view on value (i.e. value in exchange) towards a customer centric view (i.e. value-in-use). - Shift from the focus on fulfilling a product or service, towards co-creating value during a usage of a product or service by a customer. - Shift from the role of product or service delivery towards the role of product or service usage facilitator.
	Networked interactions	- Shift from stable partnering towards dynamic B2B collaborations. - Shift from stable operations towards agile inter-operations. - Enrich BNs by deeper B2B collaborations on new product and service developments.	- Shift from transactional customer-supplier interactions towards relational interactions. - Shift from product-centered interactions to value-centered interactions. - Shift from supply chains towards value networks.
	Networked governance	- Shift the focus of BNs coordination from efficiency towards responsiveness. - Shift the focus for centralized coordination by using formal mechanisms towards distributed coordination by using trust-based mechanisms.	- Shift from supplier-centered adaption towards customer-centric adaption. - Shift the focus from internal legitimacy towards external legitimacy mechanisms.

Appendix B - The semi-structured questionnaire scheme supporting the in-depth interviews for the evaluation of the developed integrated framework for characterization of SBNs

1. A brief introduction (around 10 minutes)

As a first part of the interview meeting, the developed integrated framework and core concepts are represented by the interviewer. Based on that, the structure of the questions during the interview is elaborated for the interviewee. This enhances him/her to follow the line of the query during the interview meeting.

2. General Questions about the BN

- Who are the final customers of your business?
- What do you offer for these customers?
- Who are main actors (including key suppliers in up-stream and down-stream supply chain) that together form the BN that you participate in?

3. Questions about service orientation in the BN

3.1 The demand chain perspective on service-oriented value

- What are the customizable characteristics of products/services that are offered by the BN?
- How do you improve the value for the customer during the usage of the product/service? Do you have several meetings for example with the customer about value improvement? What is your structure for doing this?
- Two extreme points are described within the value co-creation spectrum. One BN focuses on mass-customized value propositions based on unique expectations of a customer. Another BN offers standard value propositions based on general customer requirement analysis. Where your BN can be positioned within this spectrum and how will this change in future?

3.2. The supply chain perspective on the service-oriented value

- What are the current product/services within whole product/service lifecycle (e.g. after sale service)? What are new product/service development projects to enrich this lifecycle?
- Regarding the servitization spectrum, does this BN offer physical products (i.e. product-oriented) or the functionality of products (i.e. result-oriented)? For instance, does a customer pay for a product or pay per use of product?
- How the risks of product/service usage within whole lifecycle are distributed among

suppliers and customers? For instance if the risk of failure of a physical product is undertaken by suppliers, or by customers, or is shared?

3.3. The demand chain perspective on the service-oriented interaction

- How customers are involved in the process of the development of new products/services? How will this change in future?
- Two extreme situations are described. A BN has only transactional interactions with customers, where the BN advertises its product/service and the customer decides to buy it or not. In the other situation the customers are active and are in dialog with suppliers in the BN to create value for themselves. Where is this BN now and in future?

3.4. The supply chain perspective on the service-oriented interaction

- The BN already has a set of parties that participating together. How this BN is enriched by adding new parties to provide new products/services? Is there, for instance, a predefined process in this BN for discovering new parties that can offer new relevant products/services?
- How the collaboration mechanisms are defined in this BN to support collaborative new product/service development?
- Is the relationship between parties within this BN is stable or the parties and the relationship between them change continuously to support new offers for customers?

3.5. The demand chain perspective on the service-oriented governance

- How customer experience relating to the offered products/services by this BN is gathered and analyzed?
- How the CRM analytics is linked with new product/service development process in this BN?
- Is the logic behind the new product/service development in this BN is technology-oriented or customer-oriented?

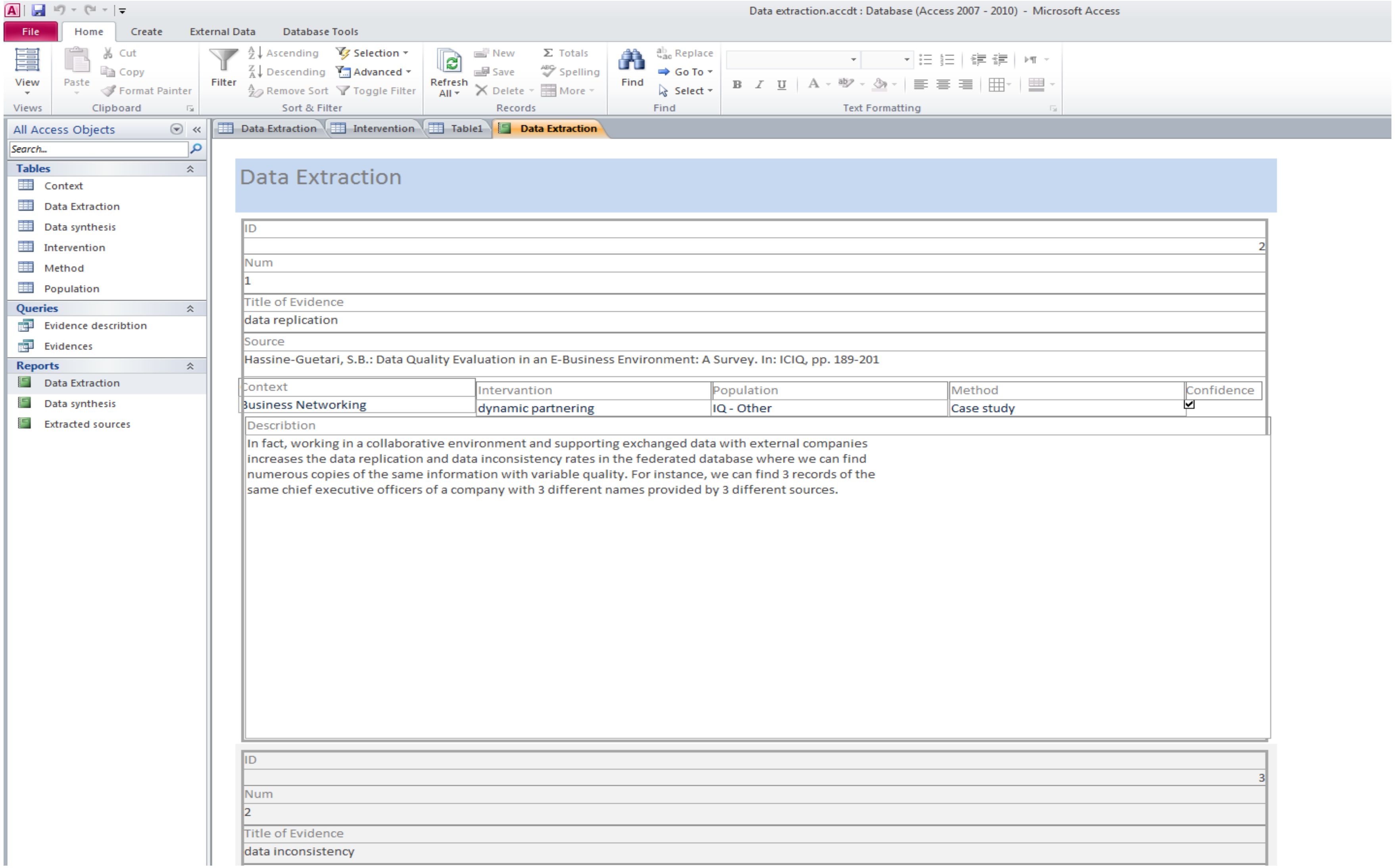
3.6. The supply chain perspective on the service-oriented governance

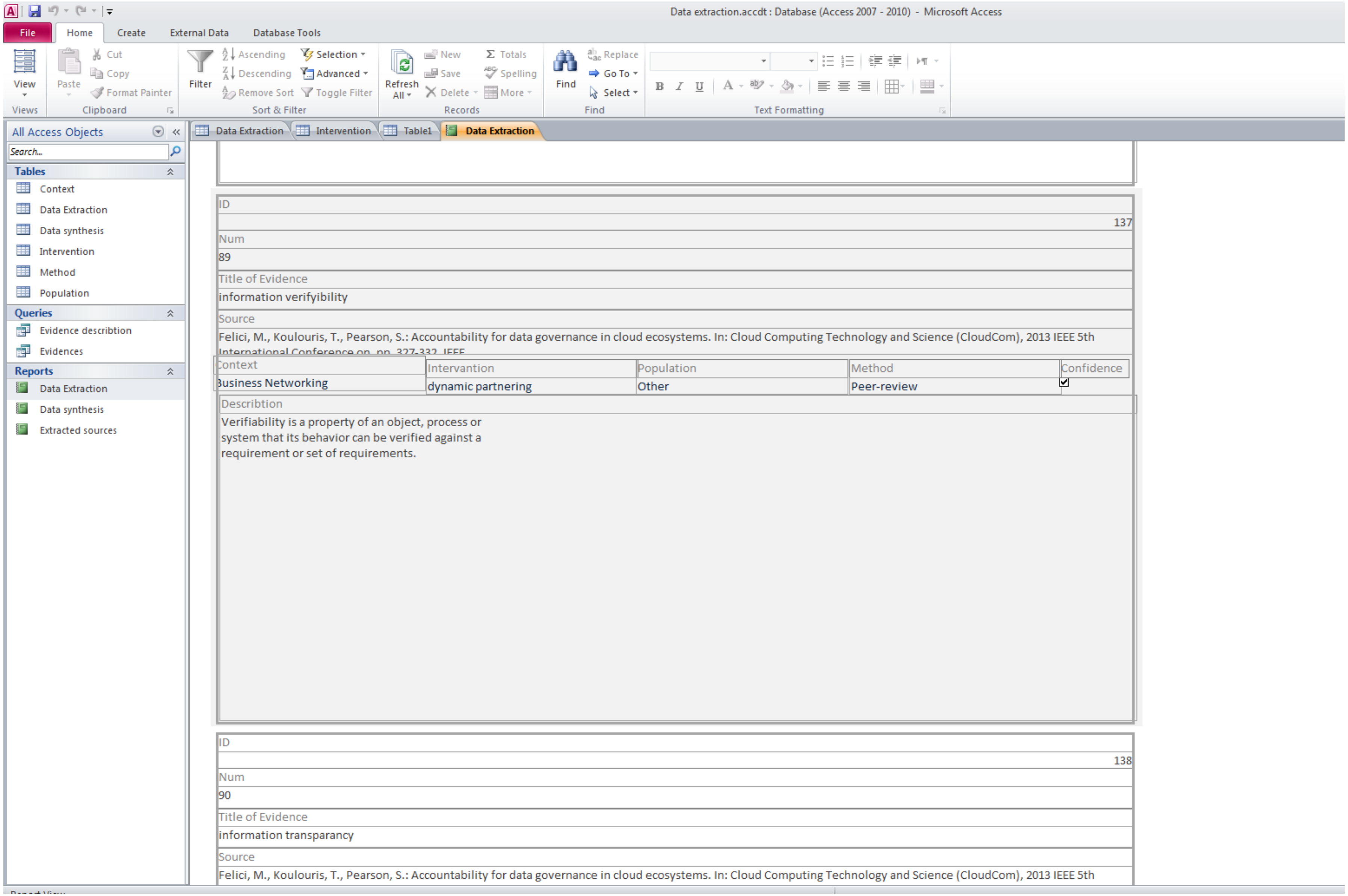
- How supply chain activities (e.g. transportation, production, and inventory management) are coordinated among parties in this BN?
- Is there a central coordinator in this BN or it is shared between different parties?
- Is the relationship between parties is formal and based on the predefined rigid contracts or it is informal and based on relational mechanisms (e.g. trust)?

Appendix C- Data Extraction Form

<table>
<tr><td colspan="6">General information</td></tr>
<tr><td>Num. of evidence:</td><td></td><td>Title of evidence:</td><td colspan="3"></td></tr>
<tr><td>Source:</td><td colspan="5"></td></tr>
<tr><td colspan="6">Evaluation of the extracted evidence</td></tr>
<tr><td colspan="6">a) Relevance</td></tr>
<tr><td>Context</td><td>☐ Business networking</td><td>Intervention</td><td>☐ Dynamic partnering
☐ Dynamic operating</td><td>Population</td><td>☐ Information quality
☐ Information security
☐ meta data</td></tr>
<tr><td colspan="6">b) Scientific rigorous</td></tr>
<tr><td>Method</td><td colspan="2"></td><td>confidence</td><td colspan="2"></td></tr>
<tr><td colspan="6">Description</td></tr>
<tr><td colspan="6"></td></tr>
</table>

Appendix D- An overview of the extracted evidences stored in the designed database




Data extraction.accdt : Database (Access 2007 - 2010) - Microsoft Access
File
Home
Create
External Data
Database Tools
View
Paste
Cut
Copy
Format Painter
Filter
Ascending
Descending
Remove Sort
Selection
Advanced
Toggle Filter
Refresh All
New
Save
Delete
Totals
Spelling
More
Find
Replace
Go To
Select
Views
Clipboard
Sort & Filter
Records
Find
Text Formatting
All Access Objects
Search...
Tables
Context
Data Extraction
Data synthesis
Intervention
Method
Population
Queries
Evidence describtion
Evidences
Reports
Data Extraction
Data synthesis
Extracted sources
Data Extraction
Intervention
Table1
Data Extraction
ID
137
Num
89
Title of Evidence
information verifyibility
Source
Felici, M., Koulouris, T., Pearson, S.: Accountability for data governance in cloud ecosystems. In: Cloud Computing Technology and Science (CloudCom), 2013 IEEE 5th
International Conference on, pp. 327-332. IEEE
Context
Business Networking
Intervantion
dynamic partnering
Population
Other
Method
Peer-review
Confidence
Description
Verifiability is a property of an object, process or
system that its behavior can be verified against a
requirement or set of requirements.
ID
138
Num
90
Title of Evidence
information transparancy
Source
Felici, M., Koulouris, T., Pearson, S.: Accountability for data governance in cloud ecosystems. In: Cloud Computing Technology and Science (CloudCom), 2013 IEEE 5th

Appendix E- The list of the extracted quality evidences in the conducted SLR

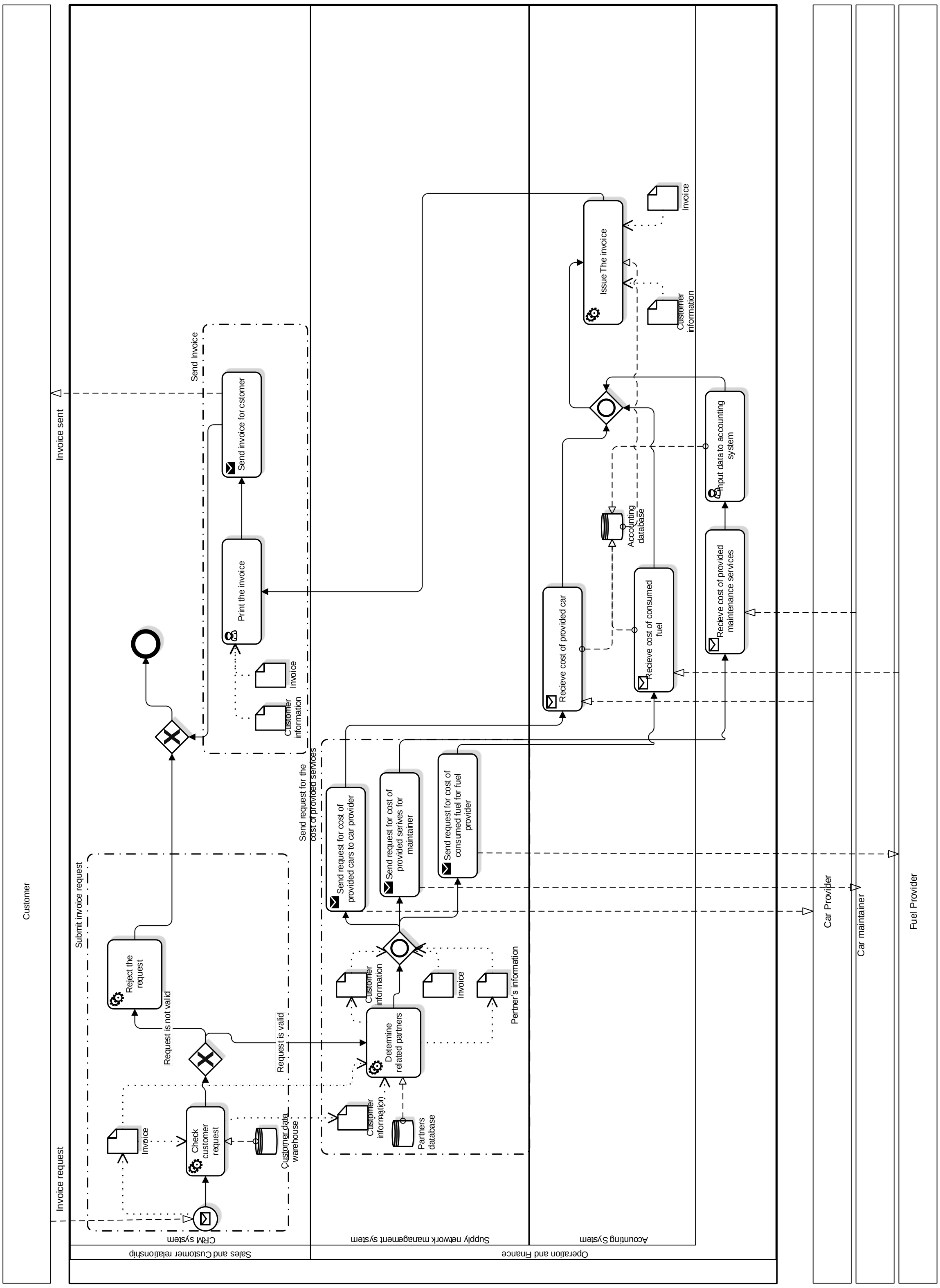
Number	Extracted Evidence
1	data replication
2	data inconsistency
3	data provenance
4	data integration
5	un-necessary data accumulation
6	Information leakage and misappropriation
7	data intrusion
8	data loss
9	Reduced availability
10	compromised information reliability
11	lack of data quality certification
12	data quality certification
13	Exchange quality information
14	distributed data quality accountability
15	semantic heterogeneity
16	data replication
17	data inconsistency
18	data quality brokery
19	information quality repository
20	information quality notification
21	information quality certification
22	information quality adequacy assessment
23	heterogeneous data generation
24	openness of information service description
25	portable data exchange
26	distribution of data environment
27	information service uncertainty
28	absence of up-to-dated information
29	lack of information
30	selection of best matched information source
31	information privacy (ownership)
32	diversified access control
33	diversified ontology
34	information intermediary (data pooling)
35	master data inconsistency
36	data alignment (meta data updating)
37	global data synchronization
38	information misuse
39	The Willingness and Trust to Use Shared

Number	Extracted Evidence
40	decrease reciprocal relations
41	semantic heterogeneity
42	incompleteness of ontology-based domain information model
43	missing semantic mapping rules between information entities
44	missing information
45	wrong syntactical format
46	information inaccuracy
47	not timely available information
48	information untimeliness
49	inconsistency of identity related information
50	multiple identities per user
51	syntactical identity variation
52	dissemination of identity information changes
53	diversity of protocols to communicate identity-related information
54	Identity federation
55	mediation for identity information
56	securing data provenance
57	data remanence
58	information heterogeneity
59	not trusted data
60	data replication
61	Schema robustness
62	data schema flexibility
63	context awareness
64	data synchronization
65	context based standardization
66	pooling master data
67	distributed identity management
68	data redundancy
69	data quality ownership (accountability) issue
70	lack of data quality control (distributed)
71	information access security
72	information overload
73	decentralized data quality control
74	Cross-links between metadata (to deal with meta data redundancy)
75	Standardized metadata format
76	Flexible user interface
77	Integration with portals and intranets
78	Multilanguage capability of software and metadata
79	Support of usage and maintenance processes
80	Change history
81	Flexible metadata structure
82	Single-sign-on support
83	Single-sign-on support
84	semantic heterogeneity

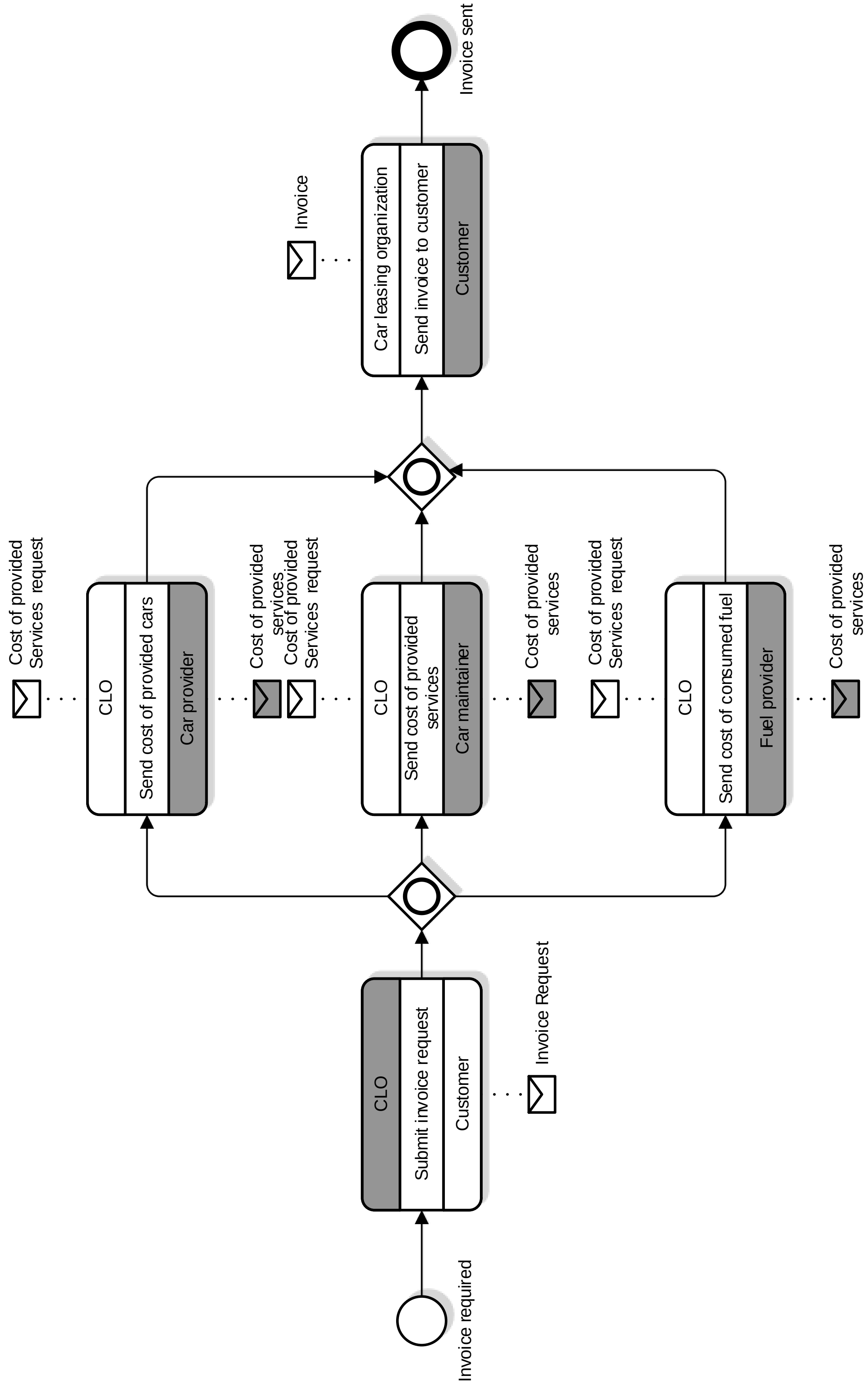
Number	Extracted Evidence
85	metadata evolution (adaption)
86	metadata traceability (provenance)
87	information accountability
88	information observability
89	information verifiability
90	information transparency
91	inconsistent information format
92	Lack of necessary recourses
93	information inconsistency
94	information repetition
95	semantic inconsistency
96	syntactical inconsistency
97	distribution of information asset after dissolution
98	ownership of information crated collaboratively
99	ontology issue
100	information syntactical inconsistency
101	information duplication
102	semantic inconsistency
103	information provenance traceability
104	syntactic inconsistency
105	semantic inconsistency
106	semantic master data quality
107	semantic inconsistency
108	information security
109	information provider traceability
110	information provider anonymity
111	semantic heterogeneity
112	information security
113	inconsistent security policies
114	data centralization
115	standardization
116	privacy and data protection
117	syntactical inconsistency
118	semantic inconsistency
119	standardization and flexibility conflict
120	meta data independence
121	security and trustworthiness
122	limiting transparency
123	diversified B2B protocols
124	trust dependencies of composit service
125	semantic inconsistency
126	data reputation
127	data ambiguity
128	missing information
129	data timeliness
129	data inconsistency

Number	Extracted Evidence
130	global standardization
131	data redundancy
131	proprietary representation
132	networkability
133	data standard conformity
134	data accuracy
135	data timeliness
136	information compliance to business rules
137	data security
138	data completeness
139	data consistency
140	invaluable information accumulation
141	loss of valuable information
142	inter-organizational standardization
143	quality aware information exchange
144	diversity of information quality among parties
145	master data maintaining responsibility
146	lack of roles and responsibilities
147	lack of data quality owners
148	ownership
149	Lack of rewards for ensuring valid master data
150	Lack of master data control routines
151	Syntactic and semantic inconsistency of information products
152	2. Repetitive information product
153	Incompleteness of information product to support emerging requirements
154	Long-winded information product
155	Lose of relevant information product
156	Garbling information product
157	Accumulation of irrelevant information product
158	Information leakage
159	Information ownership
160	Decrease of information service continuity
161	Unknown information service provenance
162	Semantic misalignment of information services
163	syntactic misalignment of information services

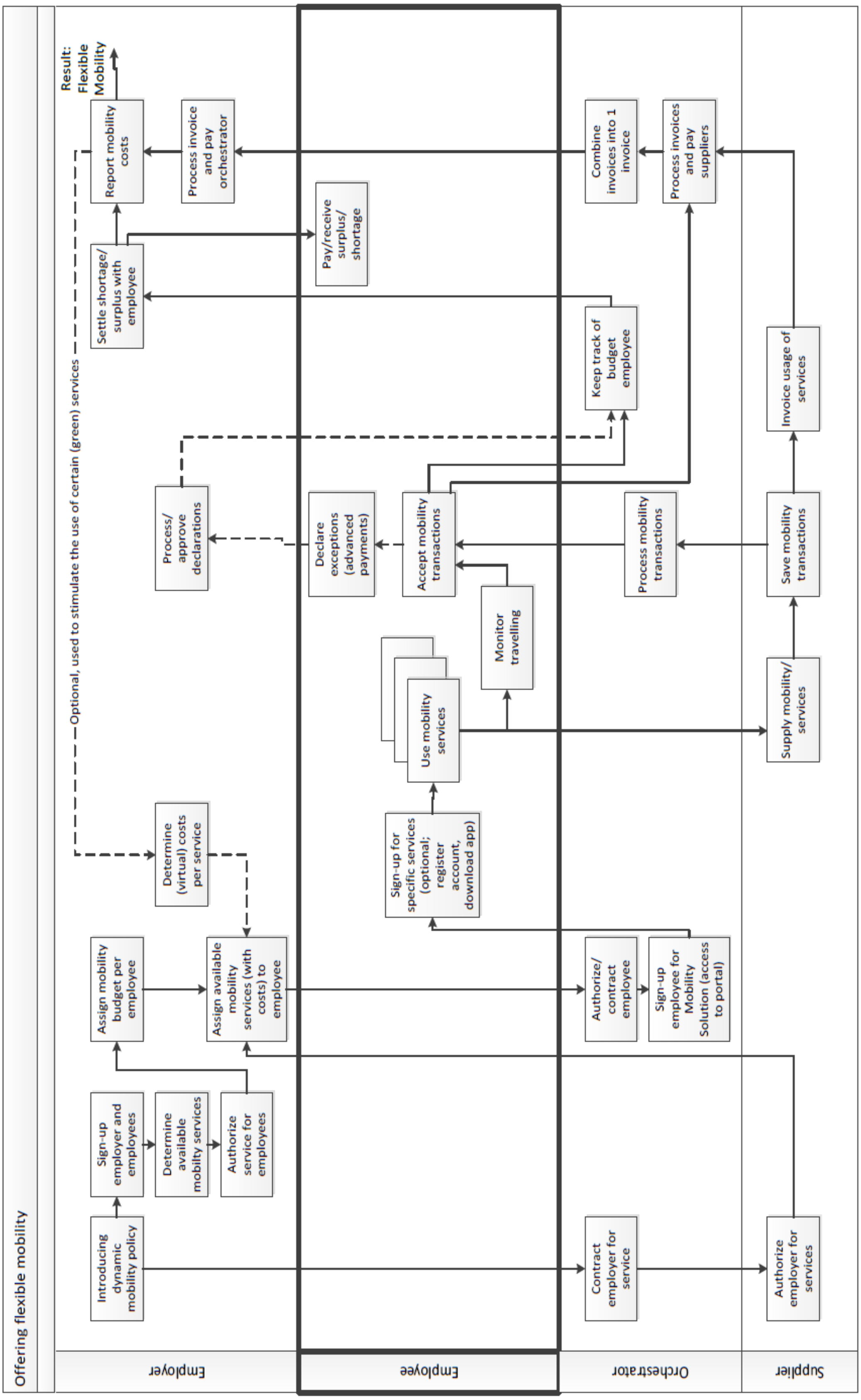
Appendix F- The investigated networked business processes within the mobility solution business network



The orchestration diagram of the customer invoicing process that is orchestrated by the car leasing organization



The choreography diagram of the networked business process for customer invoicing within the mobility business network



An overview of the process for integrated mobility solution offering by the car leasing organization

Appendix G- The semi-structured questionnaire that is used for conducting in-depth interviews for gathering evidences on information governance issues within the dynamic networked business processes in the mobility solution business network

Num.	Semi-structured question	Related IG issues
Q.1	In your future business model, for invoicing customers you need to integrate financial information from different parties from different partners. These partners can use different information formats. Do you already deal with this issue? How do you think this issue can be arisen in future business model?	Syntactic inconsistency
Q.2	In your business environment information is produced (for example during the invoice process) by different actors (e.g. customers, car dealer, OEM's). Your suppliers can use different languages. For instance, a car repairer uses the term 'flat' tire repair and the other use the term 'broken' tire. An explored IG requirement is that Athlon should modify this semantic inconsistency. How do you think Athlon will do this in an even more dynamic mobility environment?	Semantic inconsistency
Q.3	In your future business environment, due to the more independence of parties, they may intend to product and keep customer experience related information personally. This can result in ask about a customer's experience about a provided solution by different parties (see service selection process). How the distribution of the customer experience information within independent parties is handled by Athlon and how do you think emerging dynamism can make this more difficult?	Repetitive information products/ Incompleteness of information products/Not-added value information products
Q.4.	Within the service offering process you need to bring together different information relating to a customer's experience (or instance within a data warehouse). How do you think Athlon is going to respond this need in the future business model?	
Q.5.	Within the process for service offering for customers the information about disused information need to be terminated, since old products and services can repeatedly be replaced by new developed products and services. Is this requirement relevant according to you? If yes, why?	
Q.6.	For the provision of an invoice for customers Athlon needs to synchronize (and update) financial information from different partners who have contributed in the creation of an integrated mobility solution. How Athlon is going to handle this requirement? Can you imagine a problem that a database is not up-to-dated?	Untimeliness of information products

Num.	Semi-structured question	Related IG issues
Q.7.	a. Due to the need for compliance with financial rules, information production process by each collaborating party within the customer invoicing process should be transparent. How Athlon aims to make processes conducted by other parties more transparent? b. How is Athlon going to ensure the soundness and reliability of financial information provided by parties?	Information quality certification
Q.8.	Since all parties need to share information with together (for instance for collaborative new product/service development to support the service offering process), Athlon as a broker requires to share related information between all parties. Is this relevant for Athlon? How this role is going to be realized?	Quality-aware information service brokery/ Handling information networkability
Q.9.	How do you make sure an information service of Athlon is reliable? If a customer request information of a service that was used one year ago, a party might already be left. In other words; how do you make sure you get information about his service before a party leaves the network?	Continuity of information service
Q.10	a. Do you think that suppliers in your business environment can have value information about customer's experience and that there might be a problem when such a supplier leaves the network? See for example the service selection process. In other words: what do you think about a requirement that states that Athlon should prevent information leakage? c. Do you think you should align the information sharing/security policies of your partners? Why/How it can enhance the safe and secure access for information among parties? d. The access to shared information about customer experience (e.g. in an integrated data warehouse, as is shown in service selection process) needs to be managed by Athlon. The dynamic nature of the service ecosystem shifts this access control towards trust based information resource sharing. How Athlon, as the orchestrator of this network, is going to manage trust between parties?	Information leakage and misappropriate /dynamic trust management/ aligning diversified security ontologies/ creation of trustworthy information exchange environment/ modification of inconsistent security policies/ Aligning diversified security ontologies/ prevention of data remanence/ preserving added value information
Q.11.	There might be situations that you create valuable information collaboratively. For example, you conduct together a customer experience review. How will Athlon manage information ownership issues in the future? Who can use it and has a license to use it? What do you do with information you do not own anymore? Do you delete it? Or do you pay for it?	Information asset ownership management/ Preserving added value information/ Creation of trustworthy information exchange environment

Num.	Semi-structured question	Related IG issues
Q.12.	If you look at the cost overview request process, you get all information products of you partners and you want to integrate it for your customer. How do you make sure this information can be traced to the source?	Traceability of information provenance/ Identity federation
Q.13.	In order to integrate financial information provided by different parties, you need to be aware of meaning of information. So you need metadata (supported by relevant interactions protocols) for each party that enhances interpretation of provided information. How is Athlon going to handle this metadata handling requirement within the formed mobility network?	Metadata collaborative repository
Q.14	If Athlon decides to adapt the used interoperability protocols with other collaborating parties, other parties need to follow this adaption. So how do you balance between the robustness of the interactions (especially in the formed mobility business network) and the flexibility that you need?	Modification of collaborative metadata inconsistency / metadata evolution/ collaborative metadata robustness
Q. 15	For invoicing customers about provided solutions that are integrated from different contexts, you need to be aware of the context of provided financial information. Consistent interpretations of information depend on this context awareness. How are context-aware information services going to be handled by Athlon within the formed mobility network?	Metadata context awareness/ Metadata traceability

Appendix H- The confidence levels of the empirical findings about the practical relevance of the identified IG issues

IG issue	Level of confidence	
	Experienced within the networked business processes	Highly expected by employees involved in the real-life networked business processes
Modification of information product syntactic inconsistency	✓	
Modification of information product semantic inconsistency	✓	
Aligning information production processes	✓	
Linkage of relevant information products that are distributed among loosely linked collaborating parties	✓	
dismission of not added value information products	✓	
Information product synchronization	✓	
Evolution of pooled master information products in support of emerging requirements		✓
Clarifying garbling information services	✓	
Information service quality certification	✓	
Quality aware information service brokery		✓
Handling information networkability		✓
Continuity of information service	✓	
Prevention of information leakage and misappropriation	✓	
Information asset ownership management	✓	
Prevention of data remanence		✓
Preserving added value information	✓	
Traceability of information provenance		✓
Dynamic trust management	✓	
Aligning diversified security ontologies	✓	
Creation of trustworthy information exchange environment	✓	
Modification of inconsistent security policies	✓	
Identity federation	✓	
Metadata collaborative repository	✓	
Metadata traceability	✓	
Modification of collaborative metadata inconsistency	✓	
Metadata evolution		✓
Collaborative metadata robustness		✓
Metadata context awareness	✓	

Appendix I- The findings from the workshop to investigate the conceptual integrity of the developed reference architecture

The investigation of the considered architectural principles

	Interactions among collaborating parties are dynamic	Interactions support whole PSS lifecycle	Coordination of networked business processes is handled distributively	Interactions are adapted by customers within value co-creation processes
Principle 1: IG responsibilities are distributed among all collaborating parties	**Sensitivity point:** Highly distribution of IG responsibilities in highly dynamic BNs can result in difficulty for managing customers' experience within whole PSS lifecycles		**Non-Risk:** the principle clearly covers this characteristic. **Risk**: The reference architecture does not address a situation in which IQ requirements of composed and enacted networked business processes by different coordinators are conflicting.	**Trade-off point**: A high degree of the adaptability by customers can make difficult ensuring high quality information within highly distributed structures. So, it seems that there should be a balance between the ability for the customer-centric adaptability of BNs and distribution of IG responsibilities among all collaborating parties.
Principle 2- Collaborating business parties autonomously self-govern information artefacts that are used within composing and enacting networked business processes by them	**Sensitivity point:** Self-governing of information assets by collaborating parties within highly dynamic interactions can lead to the different conflicting views on customers experience within whole PSS lifecycles and so conflicting offers by parties within a value network	**Risk:** The reference architecture does not address the situation that a networked business process composer or enactor leaves a SBN		**Non-Risk**: the principle clearly addresses the characteristic.

Principle 3- Decision-oriented and work process-oriented interactions among collaborating parties are separated	**Non-risk**: The principle addresses the required characteristics.	**Risk:** The developed reference architecture does not address a situation that the enactor of a composed networked business process changes in run-time. In this way, the link between run-time and design time IG need also to be adapted.	**Non-risk**: the principle enables customer-centric adaption of a composed networked business process within run-time (value co-creation).
Principle 4- Activities relating to executing and governing interactions are separately handled	**Non-risk**: the specification of IG as a dynamic capability enables to deal with issues resulting from the dynamism of networked business process.		
Principle 5- Information is exchanged together with its quality and related metadata			

The architectural decisions

The investigation of the architectural decisions according to the architectural principles

	Principle 1: IG responsibilities are distributed among all collaborating parties	Principle 2- Collaborating business parties autonomously self-govern information artefacts that are used within composing and enacting networked business processes by them	Principle 3- Decision-oriented and work process-oriented interactions among collaborating parties are separated	Principle 4- Activities relating to executing and governing interactions are separately handled	Principle 5- Information is exchanged together with its quality and related metadata
Interactions among collaborating parties for governing information assets are handled through IQ notification services	-	**Non risk:** the decision enables independence of collaborating parties. **Risk:** monitoring the commitment of collaborating parties to announce other parties about the sensed IQ issues is not addressed. **Sensitivity point**: highly independence of collaborating parties that enables them to participate in competing value networks can result in the leakage of critical strategic notifications.	**Risk:** the distinction between decisional and operational IQ notifications can be difficult for collaborating parties.	-	-

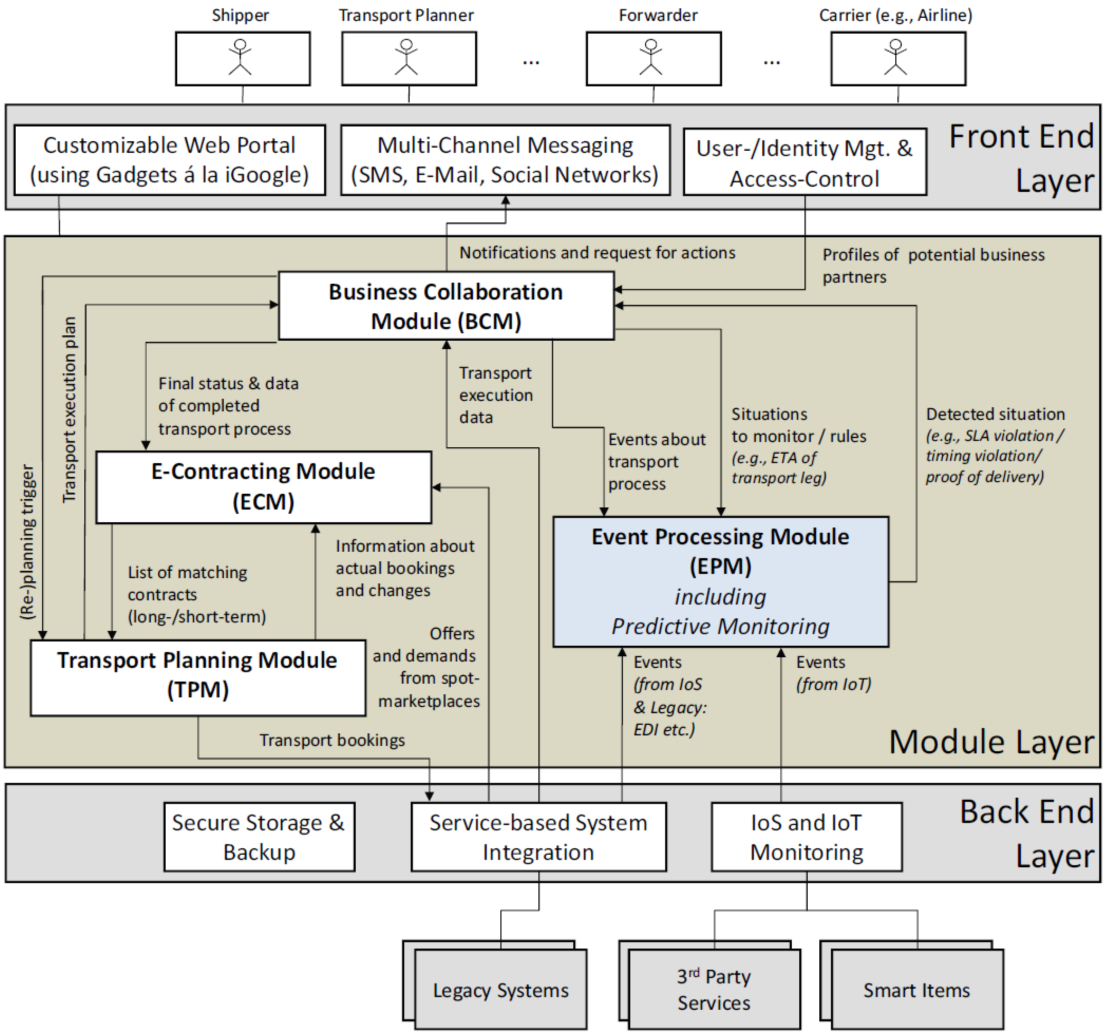
	The architectural decisions				
	Principle 1: IG responsibilities are distributed among all collaborating parties	Principle 2- Collaborating business parties autonomously self-govern information artefacts that are used within composing and enacting networked business processes by them	Principle 3- Decision-oriented and work process-oriented interactions among collaborating parties are separated	Principle 4- Activities relating to executing and governing interactions are separately handled	Principle 5- Information is exchanged together with its quality and related metadata
Knowledge systems supporting the composition of networked business processes are distributed among all collaborating parties	**Non-risk:** the distribution of the IG responsibilities enables collaborating parties to ensure quality of information that is stored within distributed knowledge systems. **Risk**: Highly distribution of knowledge systems with highly distributed IG mechanisms that are independently handled can result in conflicting IG procedures within SBNs.	**Trade-off point**: highly distribution of knowledge systems that are independently governed can limit the possibility of collaborative decision making for composing customer centric networked business processes. So, in order to be able to offer more complete packages of related products and services that make better experiences for customers, parties collaborating in value networks need to balance between complete independence and also pooling related knowledge.			**Sensitivity point**: Aligning IQ measurements among collaborating parties that are independently govern knowledge systems can result in inconsistent IQ measurements.
Collaborating parties independently govern the quality of information stored in knowledge bases through IQ direction services	**Non-risk:** the architectural decision enables distributed coordination of highly independent collaborating parties by well-established decisions that are supported by high-quality information \		**Risk:** The developed reference architecture does not clearly address how collaborating parties can distinguish among decisional and operational quality notifications that are	Non-risk: The decision supports the alignment of IQ improvements by IQ factory services are aligned with changes in SBNs.	

	The architectural decisions				
	Principle 1: IG responsibilities are distributed among all collaborating parties	Principle 2- Collaborating business parties autonomously self-govern information artefacts that are used within composing and enacting networked business processes by them	Principle 3- Decision-oriented and work process-oriented interactions among collaborating parties are separated	Principle 4- Activities relating to executing and governing interactions are separately handled	Principle 5- Information is exchanged together with its quality and related metadata
			received in SBNs		
Global integration schemas are adapted by collaborating parties independently	**Risk:** Composing networked business processes to offer integrated solution on the basis of knowledge provided by global integration schemas that are distributively governed by autonomous collaborating parties can result in conflicting value propositions for a customer at the time that he/she co-creates value by some other collaborating parties. Indeed, alignment between run-time and design-time interactions with customers has not been addressed by the developed reference architecture. **Sensitivity point:** Highly distribution of the formulation of global integration schemas (e.g. formulation of integration schema to analyze customers' experience in a value network) that is	**Non-risk**: the ability of adapting integration schemas supporting information required for composing networked business processes increases the independence of collaborating parties.		**Risk**: the developed architecture focuses on governing the adaption of integration schemas regarding environmental changes (i.e. the received IQ announcements), but these adaptions can result in the formation of process cubes that are not in-line with what decision makers expect. Indeed, the developed architecture has a completely exogenous approach for adapting the integration schema and endogenous	

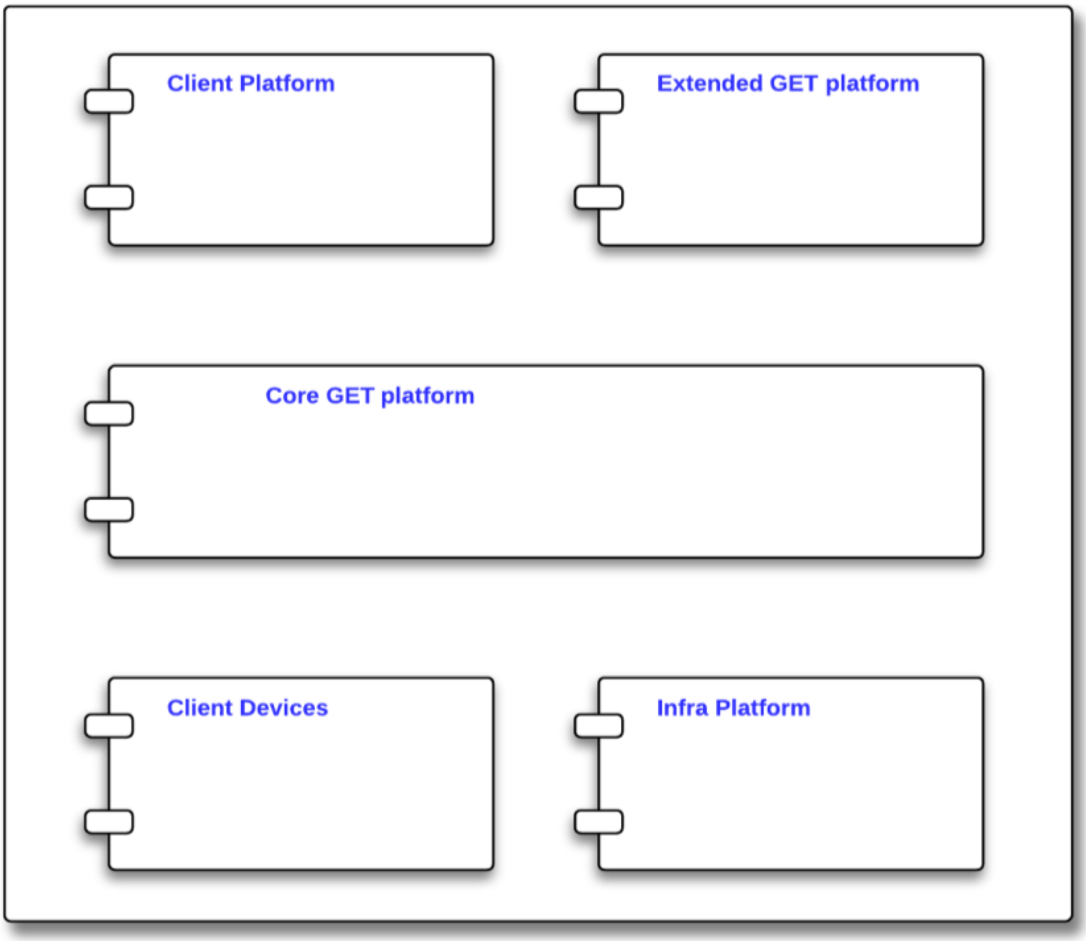
	The architectural decisions				
	Principle 1: IG responsibilities are distributed among all collaborating parties	Principle 2- Collaborating business parties autonomously self-govern information artefacts that are used within composing and enacting networked business processes by them	Principle 3- Decision-oriented and work process-oriented interactions among collaborating parties are separated	Principle 4- Activities relating to executing and governing interactions are separately handled	Principle 5- Information is exchanged together with its quality and related metadata
	handled by independent parties can lead to inconsistent decision making in SBNs.			factors are not considered clearly.	
Adaption of interoperability protocols is handled by collaborating parties independently	**Non risk**: The ability for adaption of interoperability protocols by all collaborating parties enhances the distributed coordination of networked business processes	**Trade-off point**: Highly autonomy of collaborating parties (which are able to repeatedly change their interoperability protocols) can result in difficulties for integration of interoperability protocols. So, there should be a balance between the ability of a BN to handle various interoperability protocols and autonomy of collaborating parties.	Risks: Run-time limitations regarding inconsistent interoperability protocols are reflected to design-time by the link between announcement services in run-time and design-time. However, the developed reference architecture does not guarantee the possibility regarding interoperability protocols for run-time agility to support co-creation of value with customers.		**Non-risk**: all collaborating parties exchange their protocol (e.g. used formats for interfaces and ontologies) to enhance adaption of interoperability protocols.
Component-based style is used for	**Non-risk**: the used style for the development of the reference architecture supports distributed				

	The architectural decisions				
	Principle 1: IG responsibilities are distributed among all collaborating parties	Principle 2- Collaborating business parties autonomously self-govern information artefacts that are used within composing and enacting networked business processes by them	Principle 3- Decision-oriented and work process-oriented interactions among collaborating parties are separated	Principle 4- Activities relating to executing and governing interactions are separately handled	Principle 5- Information is exchanged together with its quality and related metadata
architectural synthesis	operating within autonomous collaborating parties.				
Notification services interact based on event-based integration pattern			**Risk**: the exchanged events within design-time are responded by the adaption of the integration schema and metadata, but in run-time are responded by the adaption of inter-operability protocols. However, the developed reference architecture does not clearly address how the difference among these events can be recognized in a cooperative gateway.		
Market-level interactions are specified within cooperative gateways within each collaborating party	**Sensitivity point**: Since cooperative gateways within SBNs need to be standardized (to enable collaborating parties to easily integrate IQ related events), highly dynamism of autonomous collaborating parties may make the realization of standardized cooperative gateways difficult.				
Run-time IG components are separated from the design-time components					
Interactions among internal components are based on request/response pattern.					

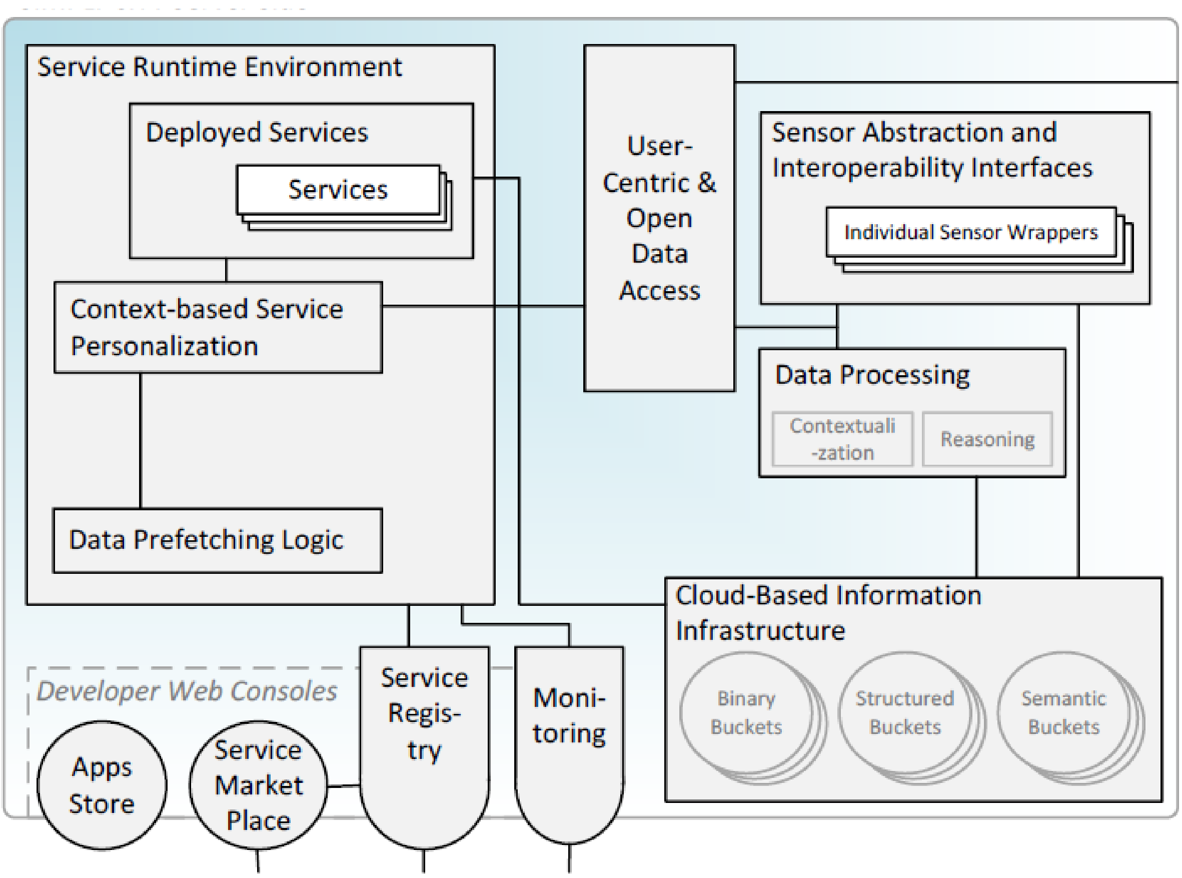
Appendix J- The concrete architectures that are used for the preliminary investigation of the applicability of the developed reference architecture



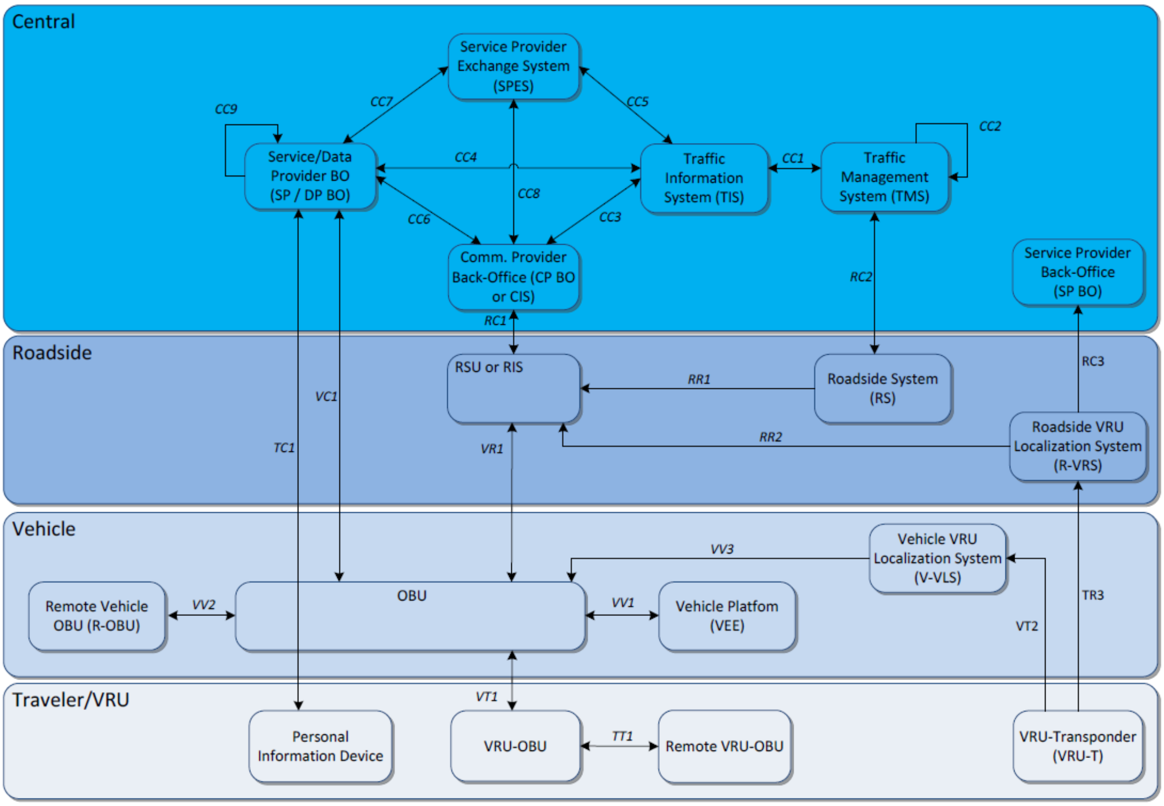
Conceptual architecture of FINEST platform



Major components of the GET service architecture



SIMPLI-CITY service side architecture



Architecture of C-ITS applications

Appendix K- The preliminary investigation of the applicability of the developed reference architecture based on its comparison with the relevant concrete architectures

Descriptions of the applicability of the developed reference architecture regarding relevant concrete architectures

	Relevant concrete architectures			
	FINEST architecture	GET service architecture	SIMPLY-CITY architecture	C-ITS architecture
Networked business process composition	Composing transport processes are conducted through the three components within the module layer: Business Collaboration Module, E-Contracting Module, and Transport Planning Module	Since this architecture is manly concentrated on run-time phase, the composition of networked business processes in design-time is not directly addressed. The backend system within the Client Platform component is responsible for manage the transport orders.	Like GET service architecture, it does not address composing networked business processes. The composed networked business processes are deployed through the Service Runtime Environment component.	The composition of networked business processes is not directly addressed within the scope of this architecture.

Descriptions of the applicability of the developed reference architecture regarding relevant concrete architectures

	Relevant concrete architectures			
	FINEST architecture	GET service architecture	SIMPLY-CITY architecture	C-ITS architecture
Decisional IQ factory direction	Change of transport processes by Business Collaborating Module can require updating IQ related rules within Event Processing Module. This service ensures that this required updating of IQ related rules is conducted. On the other hand, IQ related events (e.g. events that are created due to a late response by Smart Items or 3rd Party Services) can require changing composed transportation processes through reporting detected situations. This service ensures that re-composing transportation processes is conducted in order to respond to these IQ related events.	IQ related events (e.g. low quality information sent by a client device) can be recognized through dynamic rules by Event Aggregator within GET Service Core Platform. These IQ related events are reported to the proposer to re-compose transportation processes. On the other hand, changes of composed transportation processes can require updating dynamic rules relating to IQ. This service ensures that the IQ related issues are recognized and reported by updated dynamic rules.	Changes of Services within Deployed Services module (as composed business processes) may require changes of IQ requirements of information stored within Cloud-Based Information Structure. On the other hand, detected IQ issues within Cloud-Based Information Infrastructure my result in the necessity for changing Services. This service ensures that Services keep Aligned with IQ related changes within Cloud-Based Information Infrastructure.	Changes of services provided by SPs or changes of TMS Traffic Monitoring requirements can require adaptions within Sensing Support including in-vehicle or road-side sensors. On the other hand, the issues on gathering relevant data by Sensing Support (e.g. failure of road-side sensors), need to be responded by adapting provided services and TMS control. This service ensures that quality requirements of the provided services and TMS are met by Sensing Support and also required adaptions of services regarding IQ issues are handled.

Descriptions of the applicability of the developed reference architecture regarding relevant concrete architectures

	Relevant concrete architectures			
	FINEST architecture	GET service architecture	SIMPLY-CITY architecture	C-ITS architecture
Quality aware decisional information integration adaptor	Due to the dynamism of collaborating parties and so their related legacy systems, events that are sent to Event Processing Module may use different metadata. Meanwhile, in order to be able to detect a situation (e.g. timing violation), the event integration logic needs to be updated. This service handles adapting metadata and also integration logic that is used within Event Processing Module.	Logics used for aggregating and correlating events within Event Aggregator and Event Correlator components need to be adapted regarding the new types of events that are received. Meanwhile, changes of transport processes within Backend system of Client Platform can require the adaption of logics used within Event Aggregator and Event Correlator components. This service addresses adapting Event Aggregator and Event Correlator regarding changes of Client Devices and Infra Platform.	Regarding the dynamism of information stored in Cloud-Based Information Infrastructure (due to the dynamism of collaborating parties that provide information services), the logic used within Data Processing and also interfaces defined by Sensor Abstraction and Interoperability Interfaces need to be adapted. In this way, this service addresses the adaption of the aforementioned components regarding the IQ related changes within Cloud-Based Information Infrastructure.	Regarding dynamism of Service/Data Providers and their required information, as well as IQ issues resulting from failures of Sensing Support, processing and aggregating collected data by Traffic Information System needs to be adapted. To do so, this service addresses the functionality to direct adapting processing and aggregating collected data within TIS.

Descriptions of the applicability of the developed reference architecture regarding relevant concrete architectures

	Relevant concrete architectures			
	FINEST architecture	GET service architecture	SIMPLY-CITY architecture	C-ITS architecture
Decisional IQ notification direction	This architecture addresses a centralized structure for composing transport processes. So the sensed IQ related events that are processed by Event Processing Module only need to be notified to Business Collaboration Module. However, considering a situation that different parties able to compose transport process (i.e. an distributed architecture), this service addresses the direction of notifying relevant Business Collaboration Modules within different parties that are dynamically collaborate within transport service ecosystem.	IQ related events need to be notified for relevant Backend systems that collaborate within related value network. GET Service architecture like FINEST architecture considers a centralized structure for composing networked business processes. However, considering a situation that different parties can compose networked business processes (i.e. distributed structure), the notification of IQ related events need to be notified for all Client Platforms of collaborating parties. Due the dynamism of these collaborating parties, this service directs this notification in order to ensure that IQ notification is conducted for all relevant parties.	IQ issues within Cloud-Based Information Infrastructure need to be notified for all Services within Deployed Services module. Regarding the dynamism of Services, the notification needs to be directed in order to ensure all related Services are notified. This service addresses the direction this notification.	IQ related changes that are sensed by the sensing system need to be distributed among all relevant systems (e.g. TMS or external systems like a SP BO. This service addresses that regarding the dynamism of collaborating parties, the distribution of the relevant information (e.g. failures of road sensors) is adapted regarding the dynamism.

Descriptions of the applicability of the developed reference architecture regarding relevant concrete architectures

	Relevant concrete architectures			
	FINEST architecture	GET service architecture	SIMPLY-CITY architecture	C-ITS architecture
Networked business process enactment	The enactment of the transportation processes is conducted by Service-based System Integration module.	The enactment of networked business processes is handled by Orchestration Engine within Extended GET Platform.	The enactment of composed Services is handled by Service Runtime Environment.	The enactment of the networked processes is conducted by Service/Data Provider BO. Indeed, the distribution of Traffic Information triggers the execution of services by service providers.

Descriptions of the applicability of the developed reference architecture regarding relevant concrete architectures

	Relevant concrete architectures			
	FINEST architecture	GET service architecture	SIMPLY-CITY architecture	C-ITS architecture
Operational IQ factory direction	Run time IQ issues can be sent as IQ related events from Service-based System Integration to Event Processing Module as well as Business Collaboration Module. These IQ related events can result in the adaption of transport processes. In addition, predictive monitoring within Event Processing Module can lead to IQ related events that predictively enhances enacting transport process. This service ensures that the adaption of enacted networked processes is conducted regarding the IQ related events. It also ensures that Event Processing Module (especially Predictive Monitoring logic within that) keeps aligned with the changes of Service-based System Integration.	Information relating to a dynamic enacted networked business process is stored in Process Store. IQ issues notified by other collaborating parties, or IQ related issues resulting from changes of enacting networked business process (e.g. changes by Proposer) need to be responded by updating Process Store. In addition, changes within Process Store can enable Proposer to adapt running networked business process. This service, ensures that information within Process Store are updated regarding IQ issues notified and also changes of running networked business process. It also ensures that IQ related adaptions within enacting networked business process are handled by Proposer.	Pre-buffered information by Data Prefetching Logic component needs to be updated regarding changes of data services or media information. In addition changes of Services within Deployed Services can require the adaption of logic for data prefetching. This service ensures that information buffered by Data Prefetching Logic is updated regarding changes in data services and also requirements of Services.	Traffic Information System needs to respond IQ notifications that are recognized within Sensing Support. In addition, emerging IQ requirements of Traffic Information System in order to better support Traffic Management System need to be fulfilled by collecting relevant quality-aware information from Vehicle and Traveler. This service ensures that Traffic Information System is updated regarding IQ related events that are sensed. It also ensures that data collection from Vehicle and Traveler keeps aligned with the requirements of Traffic Management Service.

Descriptions of the applicability of the developed reference architecture regarding relevant concrete architectures

	Relevant concrete architectures			
	FINEST architecture	GET service architecture	SIMPLY-CITY architecture	C-ITS architecture
IQ aware interoperability protocol adaptor	Regarding the dynamism of collaborating parties within an enacted transport process, Service-based System Integration need to use different interoperability protocols in order to integrate heterogeneous Legacy Systems. This service ensures that the adaption of interoperability protocols in support of Service-based System integration keeps aligned with the dynamism of executed networked business process.	The Log Manager component within GET Service Core Platform provides interfaces for logging and listening messages from collaborating parties within enacting a networked business process. Changing collaborating parties can require updating these interfaces in order to support syntactic and semantic consistency of exchanged messages. This service ensures that adaption of interfaces is conducted regarding changes within enacting networked business processes.	Regarding the dynamism of data services and media information, buffering their content in a way that can be used by Context-based Service Personalization requires handling syntactic and semantic interoperability adaptions. This service ensures that interoperability protocols used to buffer information are adapted regarding the dynamism of data services and media information.	Regarding the dynamism of service/data providers as well as dynamism of Personal Information Devices, collecting and distributed information requires adapting syntactic and semantic interoperability protocols that are used. This service ensures that the adaption of interoperability protocols is handled regarding changes of service/data providers as well as changes of Personal Information Devices.

Descriptions of the applicability of the developed reference architecture regarding relevant concrete architectures

	Relevant concrete architectures			
	FINEST architecture	GET service architecture	SIMPLY-CITY architecture	C-ITS architecture
Operational IQ notification direction	IQ changes within Legacy systems need to be notified for all related collaborating parties. In FINEST architecture, since Service Based Integration is centralized, these notifications only need to be sent to this centralized component. But in decentralized structures that there are different Service-based System Integrations by different parties, notifications need to be sent for different related parties. This service ensures that IQ changes within Legacy Systems are notified for all relevant Service-based System Integrations, but also ensures that IQ related changes within Service-based System Integration is notified to all related Legacy Systems.	IQ issues within Process Store need to be notified for all collaborating parties within enacted networked business processes. Especially in distributed structures (i.e. different collaborating parties use Extended Platform to enact networked business processes), information stored within distributed Process Store among different collaborating parties need to keep updated. This service ensures that IQ related notifications that support updating Process Stores within different parties is conducted in line with changes within dynamic BN.	Changes of quality of buffered information within Data Prefetching Logic can result in a need for notifying Services on these IQ issues. On the other hand, changes of Services may require notifying data service providers in order to provide data services that fulfill quality requirements of Services. The operational quality notification direction service ensures that the notification of relevant services on changes of quality of buffered information, as well as notifying data service providers on IQ requirements of Services is handled properly.	Detected IQ issues regarding information provided by data providers or information from Vehicle or Traveler need so be notified for all relating service/data providers. Also emerging IQ requirements regarding changes of Traffic Management System should be announced for all relating service/data providers. Regarding the dynamism of service/data providers, the operational IQ notification direction service ensure that all relevant parties are announced about emerging IQ notifications.