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**Abstract.** The need for co-creating integrated solutions with customers through deep collaborations with globally distributed suppliers in the current business environment increasingly highlights the importance of service orientation in business networks (BNs). Service orientation in BNs stresses the need for composing and enacting dynamic networked business processes to support rapid responses to market opportunities. Well-established decisions for composing dynamic networked business processes and their constant enactment require high quality information exchanges among collaborating parties. Information governance (IG) is a holistic approach comprising different mechanisms that supports high quality information exchanges. In this paper the IG functionalities are identified that support ensuring high quality information exchanges among collaborating parties in service-oriented BNs. The practical relevance of the identified IG functionalities is discussed in a BN that intends to provide integrated mobility solutions. In this way, from a governance point of view, the paper intends to close the gap between information and process aspects of inter-organizational interactions among parties collaborating in dynamic value networks.

**Keywords:** Information governance, service orientation, business network, information quality, dynamic capability

## 1 Introduction

In the current business environment, organizations focusing on their core competencies collaborate with globally distributed business parties to provide products and services for customers [1]. This highlights the importance of business networking for achieving competitive advantages [2]. In this environment, competition is between business networks (BNs) rather than single organizations [3]. At the same time, emerging service-dominant logic of marketing [4] forces BNs

towards service orientation through providing integrated solutions that are co-created with customers [5]. A service-oriented BN can be 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 [6]. Service orientation in BNs requires sensing environmental changes (e.g. customer needs) and responding to these needs rapidly through agile orchestration of resources distributed among parties. The orchestration of distributed resources is handled by networked business processes. Well-established collaborative decisions for composing dynamic networked business processes and constant interoperations through enacting composed networked business processes requires high quality information exchanges among collaborating parties. On the basis of IQ definition by [7], high quality information exchange in a BN points out providing information (by a collaborating party) that can be used properly by consumers (other collaborating parties).

Information governance (IG) is a holistic approach comprising different mechanisms that support providing high quality information [8]. In the context of service-oriented BNs, from an operational point of view, high quality information is required for decisions that support composing networked business processes. Also high quality information needs to be exchanged through networked business processes in order to prevent disruptions in operations. Although IG has been increasingly considered in recent research, it has been mainly regarded within boundaries of single organizations (see e.g. [9, 10]). On the other hand, research studies on IG in the context of BNs have been concentrated on stable BNs like conventional supply chains (e.g. [11]), and consequently emerging IG issues in dynamic BNs have not been sufficiently addressed. In order to close the described gap among the research in the context of IG and dynamic BNs, in this paper we address this research question "how IG can ensure providing high quality information for decision making and operations in service-oriented BNs?"

In this paper, to answer this research question, we characterize the functionalities of IG to enhance IQ in service-oriented BNs. To do so, we use a viewpoint based framework that enables analyzing the required functionalities within the relevant set of viewpoints. This framework is described in Section 2. The identified IG functionalities are explained -at a highly aggregated level- in Section 3.The practical relevance of the characterized IG functionalities is discussed based on a case study in Section 4. We discuss about the implications of the research in Section 5. The paper is concluded in Section 6.

## 2 A Viewpoint based Framework for Identifying the IG Functionalities in Service-Oriented BNs

For the identification of the IG functionalities in service-oriented BNs in a structured way, we use a framework that is developed based on a viewpoint based approach (see [12]). To do so, we distinguish among two types of viewpoints, respectively, viewpoints relating to *what* needs to be governed, and viewpoints relating to *how* it can be governed. The relevant viewpoints within these two types are described in the following paragraphs.

The research question in this paper addresses governing information that is exchanged within dynamic networked business processes management. In that basis, within viewpoints relating *what* needs to be governed, we distinguish among the two relevant aspects; respectively, the information aspect and the process aspect. Differences between information and process aspects has been clearly described in the context of enterprise architecture (see e.g.[13]). The relevance of the information aspect for the identification of IG functionalities is clear. The process aspect is also relevant, because based on the research question in this paper we intend to govern information within networked business processes. In other words, governing information can require different functionalities within different steps of networked business process management (this is discussed in more detail further).

For the identification of the relevant viewpoints on *how* information can be governed, we point out two relevant views, respectively, a direction-oriented view, and a mechanism-oriented view. The direction-oriented view addresses different top-down and bottom-up approaches that can be used for governing information. Within this view, in line with governance directions proposed in related theories (see e.g. [14-16]) we consider the two main directions as an alignment direction (i.e. top-down) and an enablement direction (i.e. bottom-up). The mechanism-oriented view addresses different routines that can be used for governing information. Based on [15, 17] the three main mechanisms that can be used for governing information are characterized within structural (e.g. centralization or decentralization of roles), procedural (governance tasks), and relational mechanisms (e.g. mutual involvement practices). In this paper, based on the research question that addresses IG functionalities, we concentrate on procedural mechanisms.

In this way, the four relevant views are considered for the identification of the IG functionalities in the context of service-oriented BNs. These four views are illustrated in the following.

**Information aspect**

This aspect points out information assets that are produced, stored and provided by collaborating parties in service-oriented BNs. Regarding the described research question and based on [9], the relevant domains that are considered within this aspect are specified as information product quality, information service quality, and metadata. Information product quality points of the quality attributes like completeness, accuracy, and timeliness for the information that are stored in databases. Information products are converted to information services (by software systems or manually) to be used by consumers. Information service quality addresses usefulness and usability (e.g. understandability and interpretability) of information services. Metadata, which reflects information about information, enhances semantics of information services that are exchanged among parties.

**Business process aspect**

Regarding the research question in this paper, this aspect points out networked business processes in service oriented BNs. Information services that are provided by collaborating parties are exchanged within networked business processes. Within this aspect we concentrate on managing networked business processes in the context of service-oriented BNs that embraces the two main phases, respectively, the formation and enactment of networked business processes (see[18, 19]). The formation phase reflects design-time decisions in order to set a shared objective (i.e. an expected integrated solution by a customer in service-oriented BNs), select parties that can collaborate to achieve the targeted objective, and compose networked business processes that should be executed. These decisions are supported by knowledge systems that enable to share and use accumulated knowledge and expertise within BNs (see design-time architecture in [18]). The enactment phase addresses run-time executions of networked business processes that have been composed. The enactment is supported by process systems that enable to execute intra and inter-organizational business processes.

The consideration of the process aspect is relevant in the context of the described research question, because IG functionalities differ in the design-time and the run-time phases for managing networked business processes. More precisely, the distinction of design-time and run time phases within this aspect is relevant due to the two reasons as states in the following.

Firstly, this distinction enables to distinguish between information within knowledge and process systems. The difference between these two systems has been deeply described in previous work (see e.g. [20]) and has been regarded in relevant architectures (e.g. [18]). Information in knowledge systems is shared, integrated and analyzed (e.g. within data warehouse systems) to support decision making. But, in process systems information is exchanged (e.g. among services in service oriented computing paradigm) in order to fulfil a work process (like supply chain processes). According to the CrossWork architecture (see [18]), in design-time phases knowledge systems are used to make decisions for composing networked business processes (by using agent-based technologies). Within the run-time phase process-oriented systems are applied in order to enact composed networked business processes (by using service oriented computing technologies).

Secondly, the distinction between design-time and run-time phases within the business process aspect enables distinguishing between vertical and horizontal alignment between parties and also their assets (particularly information assets). According the alignment based perspective on IG (as described above), both of the vertical and horizontal alignments need to be considered in the context of BNs [21]. Design-time alignment of information assets implies coordination within a value network for the production of required information and also representing these information assets in way that can be used for collaborative decision making. Run-time alignment of information assets implies syntactic and semantic interoperability of information objects that are exchanged among parties.

**Governance directions view**

As described, enterprise governance theories address two main directions for governance, respectively, an alignment direction and an enablement direction. In the context of this research, an alignment direction implies the adaption of information assets in order to support formed networked business processes (i.e. top-down direction. An enablement direction, on the other hand, points out the enhancement of networked business processes regarding the possibilities that are recognized within information assets (i.e. bottom-up direction). In the context of this paper, which considers dynamic interactions within service-oriented BNs, both of the mentioned directions need to be considered for governing information assets. Indeed, 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 consider, because of the increasingly consideration of information as the driver of networked business processes in dynamic business situation (i.e. information-intensive business processes) (see e.g. [22]).

**Governance mechanisms view**

As aforementioned, in this paper we rely on procedural mechanisms that can be used for governing information. According the research question in this paper, within different procedural mechanisms that can be considered, we concentrate on required functionalities that need to be realized for governing information (like [23] that proposes a set of tasks as procedural mechanisms for IG in the context of single organizations). Regarding [24], IG can be seen as higher-order abilities that direct lower-order activities for information integration and exchange. In this way, in line with [8, 24, 25] we use a dynamic capabilities perspective as a basis for the characterization of IG abilities. A dynamic capability perspective points out abilities in systems in order to govern internal resources in accordance with environmental changes [26]. It addresses the three main abilities, respectively, sensing, responding, and improving (or reconfiguring) [27]. In this way, considering the alignment and the enablement views on IG (as described above), IG abilities based on a dynamic capability perspective can be described as the ability to sense IQ related issues and possibilities, respond to these issues and possibilities in order to undergird IQ, and improve IQ based on the sensed and responded issues and possibilities.

The described views are summarized in Table 1. In order to identify IG functionalities based on these determined relevant views, firstly the information and the process aspects are integrated. The reason for this integration is that we aim to identify IG functionalities that govern information that is exchanged within networked business processes. Also, as described before, governing information in different phases of the networked business process management requires different functionalities. The integration of these two aspects results in the 6 (i.e. 3*2) sub-aspects that need to be considered for the identification of the IG functionalities.

Table 1- The views for identifying the IG functionalities

| | | | | **How** it can be governed | | |
|---|---|---|---|---|---|---|
| | | | | Governance directions | Governance mechanisms | |
| | | | | | Sensing, Responding, Improving | |
| | | | | Alignment | 3*2=6 views | |
| | | | | Enablement | | |
| **What** needs to be governed | | Process Aspect | | | | |
| | | | Design-time, Run-time | | | |
| | Information aspect | Information product quality<br>Information service quality<br>metadata | 3*2=6 views | 6 *6 = 36 IG functionalities | | |

On the other hand, the governance direction and the governance mechanisms views are also inter-related. This means that the described dynamic capabilities perspective based governance abilities can support both of the alignment and the enablement directions. In this way, regarding the characterization of the governance directions and mechanisms, we need to consider the 6 (i.e. 2*3) routines for governing information assets within networked business processes. The combination of the "what" and the "how" related views results in 36 (i.e. 6*6) functionalities that support governing information in service-oriented BNs. These identified IG functionalities are reported in *http://is.ieis.tue.nl/research/bpm/raso15/?page_id=77*. In the next section an aggregated set of the identified IG functionalities are described.

## 3 Aggregated IG Functionalities to Enhance IQ in Service-Oriented BNs

In this section the identified IG functionalities are briefly described within six aggregated IG functionalities. For aggregating the identified IG functionalities, we focus on the three IG mechanisms (i.e. the governance mechanisms view) that need to be applied within design-time and run-time networked business process management (i.e. the process aspect). Therefore we aggregate the remaining information aspect and the governance direction view. This leads to three design-time and three run-time IG functionalities. The design-time IG functionalities refer to the quality of information that is stored and used by knowledge systems for the detection of market opportunity, the formation of a service-oriented BN (e.g. in the form of instant virtual enterprise) and the composition of networked business processes to respond to detected market opportunities. The run-time IG functionalities pertain to the quality of information that is exchanged among process systems (e.g. global workflow management systems or e-sourcing middlewares) to enact a networked business process. The first three IG functionalities that are elaborated in the sequel of this section address IQ in design-time. The second three IG functionalities point out IQ in run-time.

*Sensing IQ issues and possibilities in design-time knowledge systems:* according to [28] examples of conventional IQ issues that can arise in knowledge systems due to the dynamism of service-oriented BNs are inaccuracy of information on a customer experience stored in a knowledge base (resulting from the change of customer expectations) or incompleteness of information due to the disappearance of a relevant

information product (resulting from dynamic partnering). An information governor should be able to sense these issues to prevent low quality decisions.

*Responding IQ issues and possibilities in design-time knowledge systems*: sensed IQ issues and possibilities need to be respectively encountered and exploited. Encountering sensed IQ issues requires adapting information integration approaches including evolving collaborative metadata, updating integration schemas, or updating quality requirements of information services that are provided by collaborating parties. Exploiting sensed IQ issues points out redesigning composed networked business processes based on higher quality information on environment (e.g. parties or customers).

*Improving design-time knowledge systems to support quality decisions*: knowledge systems (including knowledge bases and decision making agents) that are used for the composition of a networked business processes require to be improved based on the sensed IQ issues. This improvement need to be conducted in used knowledge bases, e.g. by information refreshment, and also in decision support systems that are used, e.g. the decision making logic that is used for adaptive partnering.

*Detecting IQ issues and possibilities in run-time process systems*: run-time quality issues are usually arisen due to the violating the design-time quality agreements, but it also can result from run-time changes in environment (like changes of customer expectations during the usage of services). IQ possibilities also can arise due to the provision of higher quality information by a collaborating party (e.g. fresher information on customer expectations in run-time).These quality issues and possibilities need to be detected during the enactment of networked business processes.

*Reacting on detected IQ issues and possibilities in run-time process systems*: this reaction can imply reconfiguring running networked business process (e.g. through run-time switching parties), but also can be handled through interaction protocol adaptions (e.g. to handle syntactic and semantic inconsistencies among information services) or by adjusting run-time information services that are exchanged.

*Enhancing process systems to handle quality networked business processes*: based on the sensed IQ issues and possibilities, this functionality addresses the enhancement of the networked business process patterns repositories and also the refreshment of business rules that are regarded during run-time process systems.

## 4 Evaluation of Practical Relevance of the Identified IG Functionalities

In this section the practical relevance of the described IG functionalities in service-oriented BNs is evaluated. Indeed, we investigate “why service-oriented BNs need to

fulfil the described IG functionalities in order to make-quality decisions and access quality information within networked business processes?" In other words, we probe if the described IG functionalities address recognized IQ issues resulting from service-orientation in real-life BNs. This means that, for the evaluation of the practical relevance of the IG functionalities we need to investigate the recognition of according IQ issues in real-life service-oriented BNs. To do so, we conduct a case study research in a service-oriented BN that has been formed by a car leasing organization in order to provide customer-centric mobility solutions. Within this BN that is orchestrated by the car leasing organization different mobility experience related parties like car dealer, car rental organizations, car manufacturers, car insurers, public transportation service providers, and car maintainers collaborate. The objective is to provide a mass-customize mobility solution for a customer (i.e. service-oriented value) rather than providing a car.

According to the distinction between design-time and run-time IG functionalities in Section 3, we select the two units of analysis within the described BN. The first unit, which is related to design-time phase, addresses a collaborative decision making for offering a mobility solution for a customer. In this collaborative decision making, the car leasing organization uses information that are gathered and shared by all collaborating parties to shape the most attractive mobility proposition for a customer. The second unit, which is related to run-time phase, points out the enactment of customer invoicing process. This process is executed in order to issue an invoice for a customer including all services that have been provided by all collaborating parties during a specific time period.

Regarding the case study objective, we intend to identify IQ issues resulting from the dynamism that is required for service-orientation in the BN. To do so, we conduct three in-depth interviews with the IT-manager, the enterprise architect and the mobility business model developer of the car leasing organization. These three in-depth interviews are based on a semi-structured questionnaire. According to the IQ domains, questions are classified within information product quality, information service quality, and metadata. Within each of these domains we investigate the practical relevance of the theoretically explored IQ issues resulting from service-orientation that are reflected in the citations [28, 29].

For the investigation of the practical relevance of the IG functionalities, we discuss how these functionalities enable to deal with the practically recognized IQ issues resulting from service-orientation in the BN. According the run-time and the design-time phases, the next two paragraphs respectively discuss the relevance of the IG functionalities to counter IQ issues within the decision making for proposing a mobility solution for a customer and also the networked business process for customers invoicing.

As mentioned above, the car leasing organization requires to integrate information relating customers' mobility experience to be able propose tailored mobility solutions. Since a customer interacts with different parties within the mobility BN, information on customer experience is distributed among parties (e.g. in CRM systems that are used by car rental organizations or by car dealers). Because of the dynamism in the BN, collaborating parties within this BN are loosely coupled. In this way the car leasing organization is not able to use a shared database for gathering and integrating all information relating customers' experiences. Due to this nature of the BN different

IQ issues are recognized like inaccuracy of information on customer experience (usually is recognized though mobility propositions those are not exciting for customers) and incompleteness of information (usually is recognized when a customer has more mobility requirements than what have been reflected by existing information). Sensing these IQ issues resulting from changes in the BN enables the car leasing organization to deploy a relevant reaction. For instance, when a customer reflects dissatisfaction about a proposed mobility solution, the sensing functionality enables the identification of IQ issues within the knowledge base that supports proposing the mobility solution. Also, the sensing functionality supports tracing changes on customer experience that are recognized by other parties. The car leasing organization uses an integration schema for integrating information on customer experience that has been based on the conceptualization of mobility solutions (see examples in [30]). Responding sensed IQ issues addresses updating these integration schemas in logical and physical views. The improvement functionality implies refreshing the knowledge base that is used by the car leasing organization in order to avoid occurrence of the same low-quality decision (e.g. proposing the same mobility solution for the customer that previously has reflected his/her dissatisfaction).

The customer invoice networked process is enacted by the car leasing organization. In doing so, according to different mobility solutions that are proposed, there is a different composed networked process (because collaborating parties and engaged services are different within each proposed mobility solution). However, due to service-orientation, customers can change the proposed and agreed mobility solution during the usage of solution (i.e. run-time customer dynamism). Also, it happens that some parties (especially car rental organizations) cannot provide the planned facilities or services on time, which necessitates switching parties in run-time. These changes necessitate run-time adaption of the customer invoice process. However, this adaption results in IQ issues like inconsistency of financial information formats that are used by switching parties, or untimeliness of financial information due to the lack of synchronization with new collaborating parties. These IQ issues can lead to invoices that are objected by customers or omit provided services. The run-time IQ detection functionality enables to discern emerging IQ issues resulting from run-time changes of the enacted customer invoice process. The detected run-time IQ issues can be reacted by the adaption of the enactment of the customer invoice process. This adaption can be handled by event-driven process control approaches or by updating business rules that are considered. The detected and reacted IQ issues enable to improve customer invoice networked process composition in design-time, which enhances customer invoice patterns that are defined in the process repository.

The findings from the conducted case study clearly shows that countering the IQ issues resulting from the dynamisms in the service-oriented mobility BN requires applying the identified IG functionalities. However, our findings mostly concentrate on the alignment view of the IG functionalities, which implies countering with the IQ issues resulting from the service-orientation. The enablement view on the IG functionalities is not considered in this case study, because data-driven approaches for decision making, e.g. BI solutions for offering mobility solutions or data-driven service composition tools, have not been yet used in this BN.

## 5 Discussions

The described IG functionalities enable dealing with emerging IQ issues in dynamic inter-organizational interactions in service-oriented BNs. Indeed, although service-orientation in BNs raises the ability for offering more competitive value propositions, it causes emerging risks from information exchange point of view (i.e. IQ issues) [31]. However, regarding our implications from the case study, since service-orientation is mainly triggered by innovative business models developed by marketing experts, the relating risks -especially from information exchange point of view- are neglected. This can lead to un-managed emerging risks that can disrupt operations in service-oriented BNs. IG, as described within concrete functionalities in this paper, enables to exploit service-orientation business advantages without damaging from resulting risks arisen by emerging IQ issues.

However, the realization of the IG functionalities is tough in real-life BNs. The difficulties of the realization of IG within the boundaries of a single organization, due to its multi-disciplinary nature, have been clearly reported in previous research (see e.g. [23]). These difficulties are intensified in the context of BNs, particularly service-oriented BNs, because of the independence of parties, lack of a central governance power, and the engagement of collaborating parties from various business contexts.

From a structure point of view, the implementation of the IG functionalities directly depends on the structure of networks governance. According to network governance structures, IG can be organized within centralized, decentralized, and hybrid structures. Governing information in centralized structures may be easier, because the authorities and responsibilities to apply relevant mechanisms, like standardization, can be clearly defined. However, service-orientation leads network governance from centralized structures towards distributed structures (i.e. actor to actor relations [4]). Implementing IG in distributed structures with high independence of parties that are loosely coupled seems more difficult. This situation highlights the need for IT-enabled distributed solutions that support the realization of IG functionalities. However, IT-enabled solutions supporting dynamic business networking do not clearly address IQ issues[32]. On the other hand, IT-enabled solutions for managing IQ do not consider concretely dynamic business networking requirements.

According to the technological basis for managing dynamic networked business processes in CrossWork architecture [19], the identified IG functionalities can be fulfilled by using a multi-agent system (MAS) platform as the basis for fulfilling design-time functionalities and service-oriented computing (SOC) technology as the basis for realizing run-time IG functionalities. The buildability of the component for networked business process composition (by using a MAS platform) and the component for networked business process enactment (by using SOC through employing technology from the Web service stack) is described elsewhere [19]. In this way, the identified IG functionalities can be considered as a basis to enrich the described architecture by adding components supporting quality of information for collaborative decision-making for composing networked business processes and global enactment of composed processes.

## 6 Conclusions

In this paper, IG functionalities to enhance IQ in service-oriented BNs are identified in a structured way. The practical relevance of the identified IG functionalities is discussed in a BN that intends to provide integrated mobility solutions for customers. The identified IG functionalities enable to handle risks concerning emerging IQ issues in service-oriented BNs. They also enable to exploit business opportunities through quality information sharing within collaborative value networks. These functionalities also provide a well-established basis for in-depth considering IG as a critical necessity within architectural solutions supporting dynamic business networking.

The findings from the mobility BN sufficiently support the practical relevance of the identified IG functionalities. However, since this BN is in transition from product-centered business model towards completely service-centered business model, we deal with limitations for the evaluation of the identified IG issues based on the observed facts. In this way, more empirical research, especially in BNs that are more service-centered, can enhance the confidence of the practical relevance of the identified IG functionalities. The future research can concentrate on the development of architectural solutions that enhance IG in service-oriented BNs based on the identified functionalities.

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