# Information governance in dynamic networked business process management

International Journal of Cooperative Information Systems


# INFORMATION GOVERNANCE IN DYNAMIC NETWORKED BUSINESS PROCESS MANAGEMENT

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Received Day Month Day
Revised Day Month Day

Competition in today's globalized markets forces organizations to collaborate within dynamic business networks to provide mass-customized integrated solutions for customers. The collaboration within dynamic business networks necessitates forming dynamic networked business processes (DNBPs). Networked business processes need to be supported by high quality information that is exchanged in a trustworthy environment. Information governance (IG) is described as a holistic approach to different mechanisms that support high quality and secure information exchanges. However, dynamism of networked business processes causes IG issues like unsecured information access and low quality information products to emerge. In this paper a comprehensive list of the IG issues in DNBPs are identified through structured steps. The identified IG issues are characterized within four main categories, respectively, information product quality, information service quality, information security, and metadata issues. For the evaluation of the practical significance of the identified IG issues, a case study is conducted in a business network that provides mobility solutions. In this way, the paper closes the gap between studies on IG, which have mostly concentrated on IG within the borders of a single organization or IG in stable business networks, and studies on dynamic business networks, which have addressed the formation of dynamic inter-organizational interactions without paying rigorous attention to information artefacts that are exchanged.

*Keywords*: dynamic business network; information governance; networked business process; information quality; information security; metadata.

## 1. Introduction

Competition in today's globalized markets increasingly forces organizations to provide mass customized integrated solutions for their customers.[1, 2] To achieve competitive advantage, organizations need to concentrate on their core competencies and outsource others.[3] This situation increasingly stresses the importance of dynamic business networks to respond to emerging customer requirements.[4] This highlights the importance of information-intensive and dynamic networked business processes (DNBPs).[5] The information-intensity points to a dynamic evolution of networked business process to respond to environmental requirements.[6] The property of information-intensity is further increased by emerging paradigms like big data,[7] cloud computing,[8] and internet of things[9]

that enable organizations 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 [10-14]. These issues can strongly disrupt the performance of a business network.[10, 15] Therefore, they need to be recognized and dealt with by information governance (IG) mechanisms in an appropriate way.[10] IG in the context of business networks can be characterized as a holistic approach to different mechanisms that support high quality and secure information exchange.[16, 17] It should maximize the value of information for all stakeholders and safeguard information as an asset within its whole lifecycle.[18] In this way, IG addresses different domains including information quality (IQ), information security, and metadata.[19, 20] However, dynamic collaborations among parties in a business network through the formation of DNBPs lead to several issues in governing information assets that are not present in static business networks. For instance, syntactic and semantic inconsistency of information services provided by different parties, which can be countered by solutions like protocol adaptors in stable business networks, cannot be easily handled by syntactic and semantic interoperability solutions in dynamic situations. In addition, the ownership of information created collaboratively with different parties that are loosely coupled can result in different security issues in dynamic business networking. In this paper, we identify these emerging IG issues resulting from DNBPs. The research question that is addressed in this paper is: *"What are the IG issues resulting from DNBPs?"*

Previous research on IG has mostly focused on governing information within boundaries of a single organization (e.g. Refs. 19 and 20). Research studies that go beyond boundaries of a single organization and discuss cross-organizational interactions have investigated IG in stable business networks like conventional supply chains (e.g. Refs. 10, 15 and 21). However, IG issues resulting from the dynamism of inter-organizational interactions have not been addressed clearly. IG issues resulting from dynamic interactions in a business network need to be clearly recognized and dealt with; otherwise, the dynamism of inter-organizational interactions gets impeded, resulting in operations interruptions, which are caused by low quality information and untrustworthy relations.[10]

This paper extends a previous conference paper on IQ in DNBPs; i.e. Ref. 13. The extension is realized by enhancing the scope of the research, i.e., addressing different types of IG issues, strengthening the methodology for the identification of the IG issues, and enhancing the evaluation of the identified IG issues. While the previous conference version of the research has concentrated on a specific subset of IG issues, IQ issues resulting from DNBPs, this paper considers the IG issues from the domains of information security and metadata as well. The methodology for the identification of the IG issues is strengthened by following reliable and structured steps for the development of logic models. Also the construct, internal, and external validity of findings from the conducted case study have been enhanced. More precisely, complementary evidences have been gathered through a more structured approach within the conducted case study. Meanwhile, a more structured way has been used for the analysis of the gathered information using the developed logic models. A more well-established theoretical basis, which is presented through the developed logic models, strongly enhances the generalizability of the findings in comparison with the previous conference version of the paper.

Answering the research question necessitates the clarification of the key related concepts. For this purpose, IG and DNBPs are characterized in Section 2. The approach for the

identification and evaluation of the IG issues in DNBPs is described in Section 3. Based on this approach the identification of the IG issues resulting from DNBPs is addressed in Section 4. Section 5 presents the evaluation of the identified IG issues through a case study in a business network that provides mobility solutions. Related work is discussed in Section 6. The paper is concluded in Section 7.

## 2. Background concepts

We describe the two key concepts mentioned in the research question, information governance and dynamic networked business processes.

### 2.1. *Information governance*

The importance of information as a key enabling asset for business has been increasingly considered by main IT related developments like big data,[7] Internet of Things,[9] and cloud computing.[22] The importance of information as an asset necessitates using mechanisms to support IQ in order to create business value and also safeguard it from opportunistic behaviours.[18] IG addresses IQ, information security, and metadata domains.[19, 20] These IG domains are elaborated further.

#### 2.1.1. *Information quality*

IQ typically is defined by information "fitness for use.[23]" This definition of IQ states that the quality of information can be measured by the value which the 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.[24] The concept of quality is closely coupled with 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. Different research studies, which generally rely on empirical methods, have been conducted to explore IQ dimensions (e.g. Refs. 25-27). Though there are a number of differences between these different representations of IQ dimensions due to the contextual nature of quality, they are basically consistent.[28] Regarding the context of this research, which intends to investigate IQ issues in DNBPs, we rely on the framework for IQ dimensions proposed by Ref. 25. This framework characterizes IQ dimensions within information product and information service quality. The distinction between information product and information service quality dimensions, as proposed by the described model, allows distinguishing among the quality of information that is produced and stored by a party and the quality of information that is processed and exchanged as information services among collaborating parties.

Information product considers information as a product that needs to be produced by a manufacturing process with an end-product of information stored in a database. In this way, information product quality addresses dimensions like accuracy, completeness, consistent representation, and timeliness. On the other hand, information service focuses on the activities occurring after information is stored as an end-product in a databases to enable consumers to obtain and use information. Information products need to be converted to information services to be used by information consumers. This conversion

can be done by an automated application or by a manual procedure. Information service quality points out dimensions like relevancy, understandability, believability, and ease of manipulation.

The distinction between information product quality and information service quality is in line with the characterization of networked business processes within internal processes and external processes (as elaborated in Section 2.2.).[29] We rely on the IQ dimensions proposed by Ref. 25 since the logic behind this characterization of the IQ dimensions enables us to describe the relationship between different levels of dynamism of networked business processes and IQ dimensions (see Section 4.1).

#### 2.1.2. *Information security*

Information security domain underlines the protection of information confidentiality, integrity and availability.[30] Safeguarding information as an asset necessitates effective risk analysis to ensure that information is accessed by authorized parties. These risks can threaten the confidentiality and the integrity of information products and information services. Traditional security mechanisms such as identity, authentication, and authorization cannot sufficiently address security issues in dynamic business networks.[31] IG in this context requires aligning inconsistent security policies used by different parties, manage collaboratively created information ownership, and monitor the compliance with industry standards.

#### 2.1.3. *Metadata*

Metadata domain within IG reflects information about information that enhances the usability and understandability of an information service.[19] Metadata enhances semantics of information services that are exchanged among parties. IG by using related mechanisms, like collaborative ontology management[32] or domain specific standardization,[33] ensures consistent understanding and interpretation of information services by different parties.

### 2.2. *DNBP*

The shift towards networked structures in business that is explained by the theory that companies ought to focus on core competences[3] results in B2B collaborations that are orchestrated within networked (i.e. inter-organizational) business processes. A networked business process can be defined as "a business process that is enacted by two or more autonomous organizations, of which at least one organization exposes a transparent view of the explicit flow structure of a process to the other organization(s).[34]" 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[29] or external process.[35] 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.

Networked business processes occur in stable business networks (like conventional supply chains) and also dynamic business networks (like instant virtual enterprises).[4, 36]

In this research we concentrate on the investigation of networked business processes in the context of dynamic business networks. Dynamic business networks, which are adaptive collaborations among autonomous parties,[37] require the formation and execution of DNBPs.[4] Dynamism of networked business processes can be viewed from a strategic and operational point of view. The strategic view addresses dynamism of networked business process at the conceptual level of their formation. The orchestration of a business network to achieve a shared objective needs to conceptualize a networked business process that integrates capabilities provided by all relevant parties.[4, 5] Conceptualized networked business processes enable business networks to respond to an emerging environmental requirement by using capabilities of parties.[38, 39]

The operational view points out the flexibility for the realization of conceptualized networked business processes by the support of relevant technologies (e.g. see Refs. 40 and 41). Since in this research the intention is to investigate IG within the formation of dynamic business networks, we address the dynamism of networked business processes at the conceptual level.

The investigation of dynamism of networked business processes at the conceptual level necessitates the characterization of dynamism in business networks. For this purpose, the dynamic capabilities perspective, which describes high order routines for sensing and responding environmental changes,[42, 43] has been considered in previous research as a relevant basis to explore the dynamism of business networks (see Refs 38 and 44). Based on this perspective, the dynamism of business networks is due to the need to respond to sensed environmental changes. The sensed environmental changes need to be responded through the adaption of internal resources within a business network. Based on Ref. 38, the adaption of internal resources within a business network is realized by operating dynamism and partnering dynamism.

The operating dynamism reflects the need to change the business processes to respond to environmental requirements. Regarding the inter-organizational nature of business processes within a networked business this change can be done at the internal or external level of a networked business process.[29] 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[45] this change can be reflected in the business orchestration model of a party. But, the external level is of an inter-organizational nature and specifies the interaction with external parties within a business network. At this level, process models need to be aligned with arrangements within a business network. This means that business processes at the external level have to conform to standards and/or technology used in a specific network. Based on the BPEL standard, the external level of an inter-organizational process can be addressed by a network choreography diagram. The change in internal and external processes itself can be refined into different types (e.g. see Refs. 40, 41 and 46). We plan to study these more refined change types in future work.

On the other hand, dynamism in networked business processes can also result from dynamic partnering. This dynamism can be viewed as dynamic collaborations between interdependent parties in the form of instant virtual organizations to respond to an

emerging opportunity in the environment. This dynamism originates from the independence of parties within a networked business to decide about the participation in the collaboration.

According to the aforementioned description of the dynamic operating, to be able to investigate different sources of dynamism in DNBPs, we distinguish between dynamism in internal processes and dynamism in external processes; as proposed in Ref. 29. In this way, in this paper 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. A party within a business network, regarding its core capability, undertakes an activity within the related value chain to provide an integrated solution for customers. The dynamism of partnership in business networks can result from the autonomy of parties, the change in the requirements of customers, and inability of an existing party in supporting its undertaken responsibility.
- Dynamic external process that addresses the change of an external process by a party. This change might be because of the decision to participate in a new network, business process reengineering, or the change in standards or technologies used within a network.
- Dynamic internal process that points out the alteration of an intra-organizational process by a party. This change might 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.

We refer to these concepts in the next section, in which we define the research approach to answer the research question.

## 3. Research approach

To answer the research question described in Section 1, we conduct this research within two phases, respectively, the identification of the IG issues in DNBPs, and the evaluation of the identified IG issues, see Figure 1. For the identification of the IG issues in DNBPs we use logic models. Logic models have been increasingly used at recent years as useful analytical tools for the investigation of organizational changes.[47, 48] A logic model investigates outcomes of an intervention within a population by using cause-effect relations. In this research we intend to investigate effects of dynamism of networked business processes (as an intervention) on the IG domains (as population) in order to logically deduce the IG issues (as outcomes of DNBP). We conduct a case study research for the evaluation of the practical relevance of the logically deducted IG issues. The approaches for designing the intended logic models and their evaluation by a case study are further elaborated in the following of this section.

### 3.1. *Approach for the identification of the IG issues by using logic models*

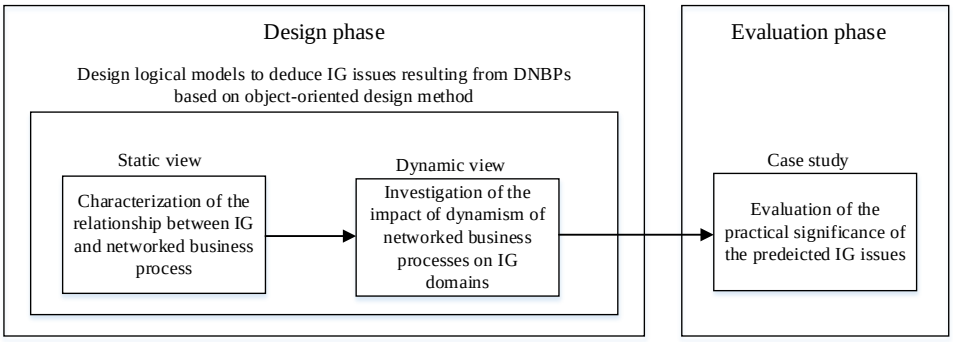


Figure 1- The design science based research approach to identify and evaluate the IG issues

Logic models are used as analytical tools in different contexts like health care programs, organizational change theories, and national policy making; see Ref. 47 for more details. Regarding characteristics of each of these contexts, different approaches are used to design a logic model. The context of this research, i.e. dynamic business networking, is conceived as a context with high complexity resulting from interactions among autonomous parties to provide an integrated solution for customers.[49] To deal with this complexity, we use a system design approach that is recognized as a proper approach to deal with complexity.[50]

In the context of system theory, different methods have been developed to support structured design and representation of a system like the viable system method,[49] viewpoint based system design methods,[51, 52] and object-oriented design methods.[53] In this paper, since we concentrate on information exchange issues, we use the object-oriented design method as starting point, since it provides many structured analytical tools and representation notations.

The object-oriented design method addresses two views for development of logic models, respectively, 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 for the development of logic models that enable us to identify the IG issues in DNBPs. The first step concentrates on the characterization of static relationship between DNBPs and the IG domains. This characterization is established upon on the theoretical description of networked business process and IG, as described in Section 2. It also describes the information exchange between parties within 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 the 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 DNBPs (i.e. dynamic partnering, dynamic external processes, and dynamic internal processes)

influences the IG domains. Logic models representing lines of reasoning link aspects of dynamism in networked business processes to the 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[54] to link between DNBPs and the IG issues; see Figure 4. Intermediate outcomes are sources of issues that threaten high quality and secure information exchange. Since there is a rich literature on the sources of IQ and information security issues, using the intermediate outcomes enables us to base our logical reasoning on relevant theories. Also to ensure the comprehensiveness of the developed logic models to cover a complete list of the relevant IG issues, we rely on findings from a systematic literature survey that has already been conducted; see Ref. 14. For the simplification of the representation, we show logic models pertaining to each IG domain separately (i.e. a separate logic model for information product quality issues, information service quality issues, security issues, and metadata issues). The outputs of this step are the concrete IG issues in DNBPs that are deduced from logical reasoning.

### 3.2. *The evaluation of the identified IG issues*

In this phase we evaluate the practical relevance of the identified IG issues. We aim to investigate *if the IG issues that are deductively identified through logic models are recognized in practice within real-life dynamic networked business processes.* To do so, two main alternative research approaches are a survey and a case study research. Due to the need for using structured questionnaires in a survey research, its ability to do a deep consideration to the context of a research is quite limited.[31] As we intend to deeply consider the desired context (i.e. DNBP) for the exploration of the IG issues, a survey is not an appropriate approach. Case study research allows in-depth consideration of the context of an observation.[31] In this way, it enables us to peruse why/how an observation is occurred within its contextual situation. This means that, a case study approach makes it possible to investigate how an IG issue results from the dynamism of a networked business process in a real-life situation.

To conduct the case study we select a business network that is formed by a car leasing organization to provide integrated mobility solutions for customers. Within this business network we concentrate on two dynamic networked business processes for the investigation of the predicted IG issues. This case study is described further in Section 5.

## 4. The identification of the IG issues in DNBPs

As described in Section 3.1, we follow two main steps for the identification of the IG issues (i.e. IQ issues, information security issues, and metadata issues) in DNBPs. The first step, considering a static view, aims to characterize IG domains (as described in Section 2.1) in networked business processes (as described in Section 2.2). The second step, considering a dynamic view, deduces the IG issues in DNBPs.

### 4.1. *Characterization of IG in networked business processes*

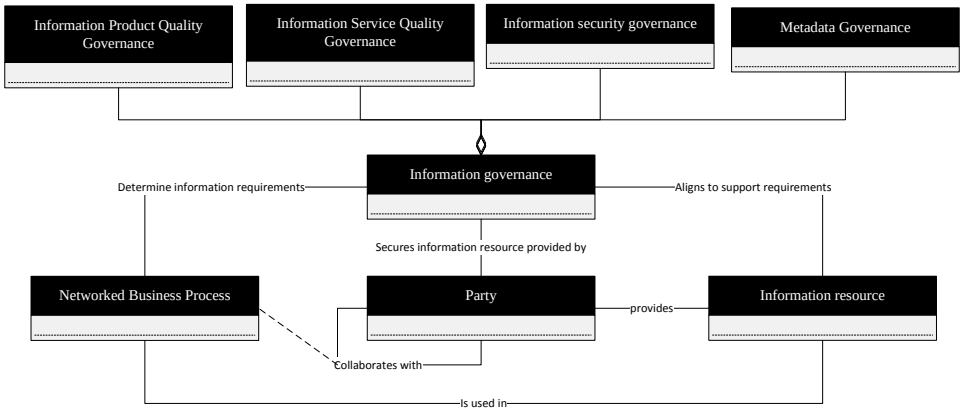


Figure 2- IG in the context of business networks

The aim of this section is the logical representation of relationship between IG and networked business processes. To do so, we rely on related theories on IG in the context of business networks. In this context, IG is seen as a part of network governance.[21, 55, 56] Network governance, as a dynamic capability, aims to align resources within a network that are provided by parties to achieve expected joint outcomes.[38, 57] In this way, IG in the context of business network concentrates on the alignment of information resources provided by different parties to support expected outcomes.[18] According to Refs. 4 and 6, expected outcomes in the context of business networks can be achieved through the formation and execution of networked business processes. 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 networked business processes, see Figure 2.

Regarding the IQ definition (i.e. fitness of information for use),[23] the alignment addresses the provision of high quality information. 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 of formed networked business processes. Information service quality governance aligns the conversion of information products to information services in a way that can be used within formed networked business processes (e.g. by information query schemes, or syntactic adaptions). Metadata governance enhances semantic exchange of information within formed networked business processes. Meanwhile, IG should safeguard information assets that are shared by a party through security governance mechanisms.

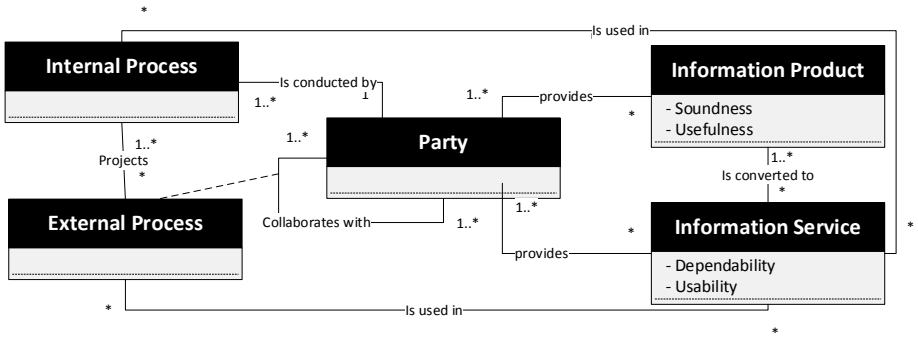


Figure 3- Information exchange within networked business processes ( a structure view)

Figure 2 clearly addresses IG as a dynamic capability supporting high-quality and secure information exchange. However, to be able to investigate the IG issues resulting from DNBPs, the logic of information exchange within networked business processes needs to be elaborated in more detail. For this purpose, we refine information exchange logic within networked business processes, see Figure 3. According to Section 2, we decompose networked business processes into external and internal processes. Information resources also are decomposed into information products and information services. Figure 3 states that information products are converted to information services to be used within internal and external business processes. The conversion can be realized by an automatic application, an information query, or by a manual procedure. Regarding the structure of a business network, the conversion can be realized by the party that provides information or the party that uses it (see Ref. 58).

### 4.2. *Investigation of the IG issues in DNBPs*

According to the research approach that is described in Section 2, in this step we intend to investigate the IG issues resulting from dynamism of networked business processes. Regarding the object-oriented design method, this step addresses a dynamic view on relationships between concepts that are characterized in Section 4.1. To do so, we rely on logical reasoning that is based on related theories from the literature. To enhance the reliability of the logical reasoning, it is established upon four facets;[59] see Figure 4.

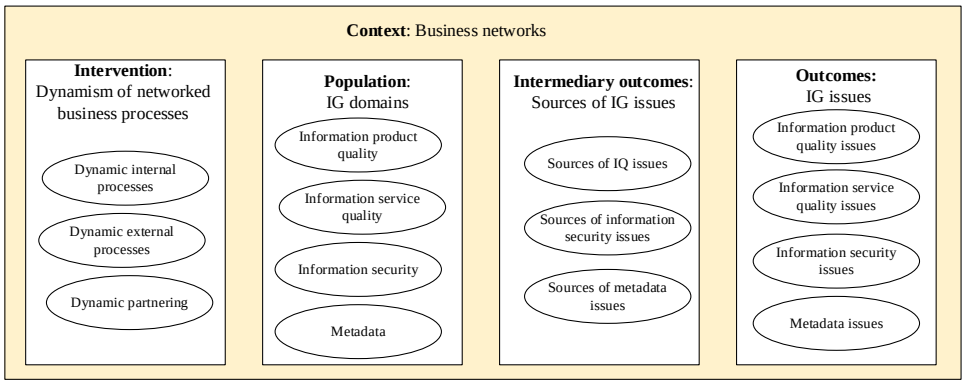


Figure 4- The logical reasoning schema

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). As described in Section 2, to be able to support our line of reasoning by 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. We describe the concrete IG issues that emerge because of DNBPs.

#### 4.2.1. *Information product quality issues*

Based on Refs. 60 and 61, sources of information product quality issues can be characterized within mapping-related issues and changes of underlying objects. Mapping-related issues arise when there are incomplete, ambiguous, inaccurate, inconsistent, or redundant information products in databases.[61-63] Indeed, mapping-related issues address intrinsic aspect of information product quality.[64] Changes of underlying objects, on the other hand, address issues resulting from changes of a real-world object that is represented by an information product. Figure 5 shows how DNBPs can trigger these two sources of information product quality issues. It also shows concrete information product issues resulting from DNBPs. We describe Figure 5 in the next paragraphs.

According to Figure 3, information is produced by parties in business networks. The production of information can be seen as mapping real-world objects by information products. Due to the autonomy of parties in business networks, each party can use different mapping schema for the production and storing information in databases. In stable business networks, this diversity can be handled by a global mapping schema. But dynamic partnering challenges the possibility of using a global schema. In this way, dynamic partnering can trigger mapping-related issues. According to Refs. 61-63,

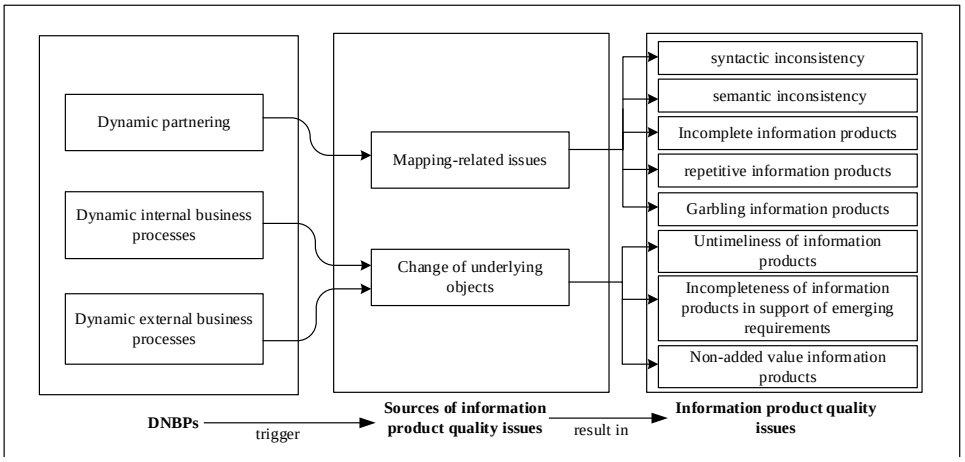


Figure 5- Information product quality issues in DNBPs

mapping-related issues lead to syntactic inconsistency, semantic inconsistency, incompleteness, repetition, and garbling of information products. Syntactic inconsistency refers to producing and storing information about the same facts within various formats by different parties. Semantic inconsistency means using different descriptions of real-world objects by collaborating parties. Incompleteness of information products points out the absence of an absolute representation of real-world objects by related information products. Repetitive information products refer to producing and storing information about the same facts by different parties. Garbling of information products relates to heterogeneous views on real-world objects by different parties.

On the other hand, according to Figure 3, information is used by internal and external business processes. This means that information production should produce information on objects that are related to internal and external business processes. The dynamism of internal and external business processes can result in relevance of emerging objects and outdate of current objects. Since the change of the information production process is time-consuming, the dynamism of internal and external business processes results in untimeliness of information products, incompleteness of information products in support of emerging requirements and also non-added value information products.

#### 4.2.2. *Information service quality issues*

According to Figure 3 information services are provided by parties within a business network and are used by networked business processes that are formed through collaboration between parties. In this way, where information product quality addresses intrinsic aspect of IQ, information service quality refers to relational and reputational aspects of IQ.[26, 27, 60] 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 like understandability and interpretability. Reputational aspect of information service quality in the context of business networks can be described in line with the trust concept. In this

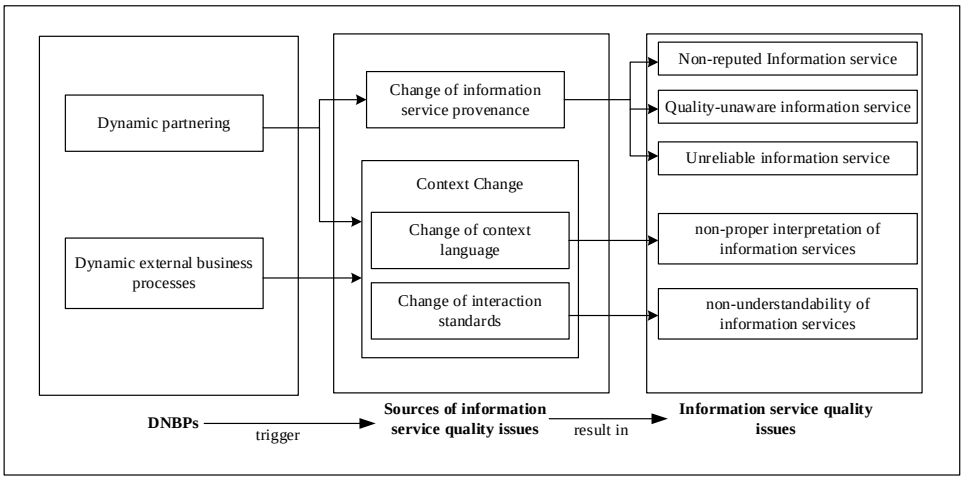


Figure 6- Information service quality issues in DNBPs

way, 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.[25, 26, 60] Context itself consists of two main components: context language (which is also addressed by context ontology, culture, or norms) and context interaction standard (like interaction protocols). Dynamic partnering in dynamic business networks leads to collaborations among parties from different contexts with different languages.[36] The variety of languages originating from different contextual cultures may cause non-proper interpretation of information services by information consumers.[65, 66] On the other hand, dynamism of external business processes leads to the need for change of interaction protocols in a way that be 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 of) parties; [67, 68] see the information service quality issues resulting from context change within Figure 6.

On the other hand, as described within the first paragraph of the current sub-section, reputational aspect of information service quality is strongly tied with the provenance of an information service. According to Figure 3, information services are provided by parties within a business network. Dynamic partnering leads to change of information services provenance. Change of information service provenance can result in non-reputed, quality-unaware, and unreliable information services; see information service quality issues resulting from provenance change within Figure 6. Non-reputed information services arise because reputation can be achieved through long-term interactions.[69] Since the assessment of information service quality is mostly based on the certification of its provenance,[70] the change of information provenance can also lead to

quality-unaware information services. Reliability of information service is basically depends on trustworthiness of its provenance. So change of information service provenance threatens trustworthy and reliability of information services.

#### 4.2.3. *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, especially in the context of cloud computing (e.g. see Refs. 71-73). Cloud computing is a relevant basis, because Figure 3 indeed characterizes an information as a service scenario.[74] Figure 3 declares that information that is produced and stored in a database within a party is converted to an information service to be used by another party. In this way, it can be said that the information production and storage (and possibly conversion) are outsourced by the information consumer to the information provider. In this basis, regarding related literature (see Refs. 71-73) we characterize four main sources of information security issues that can be triggered due to the dynamism of networked business processes, respectively, change of security policies, change of information provenance, change of information locality, and change of information segregation; see Figure 7.

In the context of business networks security policies need to be developed within two levels, respectively a party level and a network level. Party level security policy supports confidentiality, availability, and integrity of information assets within boundaries of a party. But, network level security policy cares about information that is exchanged between parties through networked business processes. The network level security policy should be aligned with parties' local security polices; but, 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

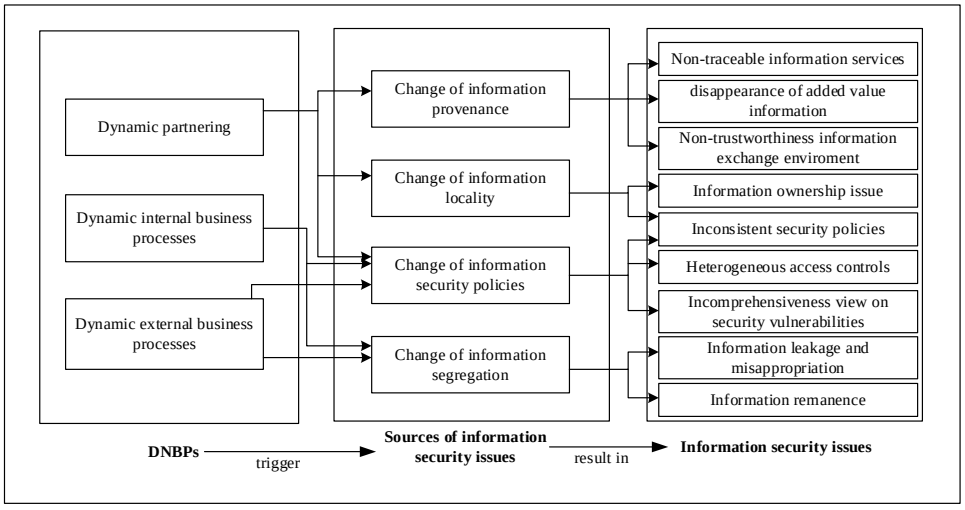


Figure 7- Information security issues in DNBPs

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 in Section 4.2.2. However, change of information provenance also causes issues within the security domain that need to be addressed by an information security governor.[75] 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.[76] Also change of information provenance can easily result in disappearance of added value information services.[77, 78] On the other hand, as aforementioned, the unclearness of information provenance resulting from the lack of information service traceability can threaten trustworthiness of information exchange environment that causes reluctance of information service providers to share their information assets.[79, 80]

According to Figure 3, information is stored in databases that are distributed among different parties within a business network. Due to the difference of compliance and information security policies in different organizations, the locality of information is important. Dynamic partnering causes the 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 the issues on the ownership of information that is created collaboratively.[70, 81]

The confidentiality of information requires segregating information that is used within a networked business from information that is used by another networked business process. This segregation is necessary to manage access for information within different networked business processes.[72, 82] Dynamism of internal and external business processes compels change of information segregation to be able to manage confidentiality within different networked business processes. However, the change of information segregation can result in information leakage and misappropriation[77, 83] as well as information remanence issues.[83]

#### 4.2.4. *Metadata issues*

Metadata reflects information about information that enhances the understandability of an information service by consumer.[19] Indeed, metadata governance supports semantic interoperability of information services provided by parties within a business network through the formation of a shared ontology about related concepts.[84] So, 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, the sources

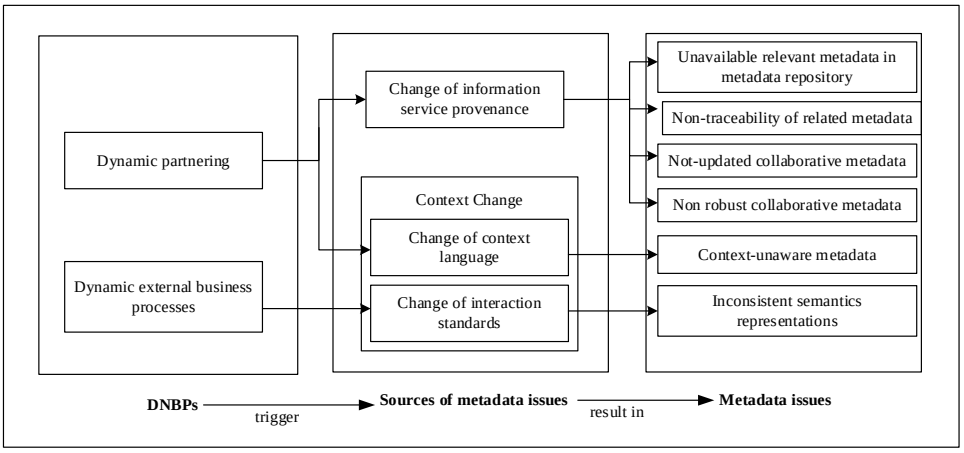


Figure 8- Metadata issues in DNBPs

of metadata issues in the context of dynamic business networks are changes of information provenance and context changes; see Figure 8.

In order to facilitate understandability of information services by different parties, metadata governance necessitates forming a collaborative repository of metadata used by different parties.[85, 86] An information service that is provided by a party to be used within a networked business process by another party (see Figure 3), should be referred to its related metadata in a collaborative metadata repository. Change of information service provenance that is triggered by dynamic partnering troubles the availability of a relevant metadata in a formed collaborative metadata repository.[86] It also troubles the traceability of metadata related to a provided information service.[87] A metadata governor, which is responsible to align 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 2). On the other hand, evolution of metadata necessitates changing semantic adaptors that are used by information service providers.[88] Since a reliable change of semantic adaptors needs considerable attention, used collaborative metadata needs to be as robust as possible.[89] In this way, metadata governance requires balancing between update and robust characteristics of a collaborative metadata.

As described in Section 4.2.2, context changes in dynamic business networks is triggered by dynamic partnering and dynamic external business processes. Collaborative metadata that is used to support semantic interactions among parties are usually context specific (like ebXML in the context of conventional supply chains).[90] 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.[68, 91] On the other hand, semantics representation of information services should be aligned with network interaction standards (e.g. an OWL based semantics representation). Dynamic external business processes, which addresses change of network-level standards (see Section 2.2),

trigger change of pre-determined semantic interaction standard. This leads to inconsistent semantics representations within DNBPs.[92, 93]

The logical reasoning within aforementioned steps has identified 28 information governance issues resulting from DNBPs. These identified information governance issues are evaluated in the next section.

## 5. The evaluation of the identified IG issues

According to the research methodology that is described in Section 3, in this section the logically identified IG issues are evaluated. The aim of the evaluation is to investigate the practical significance of the logically explored IG issues. Indeed, although the emergence of the identified IG issues in DNBPs is expected based on theoretically supported logical reasoning (as described in Section 4), we need to investigate that the identified IG issues are also recognized within real-life DNBPs. In this way, the research question that is answered in the evaluation phase is *"are the identified IG issues recognized in real-life DNBPs?"*

To answer this research question within the evaluation phase we need to conduct an empirical research. This empirical research is established on the investigation of experiences of the theoretically identified IG issues in real-life DNBPs. Indeed, we need to conduct an explanatory empirical research that investigates the relevance of the theoretically originated logic models in real-life situations. However, due to the context of this research, the investigation of experiences within the aimed empirical research is strongly threatened by biased experiences. Biased experiences in the context of our research point out reporting an experience (i.e. an IG issue) that is not originated from the dynamism of networked business processes. The biased experience is more likely in the context of our research, because most of the logically identified IG issues can also be experienced in conventional business networks (and not dynamic business networks). However, we intend to explore IG issues that result from the dynamism of networked business processes. The biased experiences issue strongly threatens the internal validity of findings in the intended empirical research. To counter this issue we need to ensure about the relevance of the experienced IG issues. The relevance of an experienced IG issue in the context of this research means that it originates from the dynamism of a networked business process. To support this necessity, we complement the aforementioned research question within the evaluation phase in this way: *"are the identified IG issues recognized in real-life DNBPs? If so, how does dynamism of the pertaining networked business processes result in an experienced IG issue?"*

### 5.1. *Case study design*

Based on the described research question, the case in this research is a dynamic business network that includes several parties collaborating together through DNBPs. The unit of analysis within this case is a networked business process. Based on the specified research question, a proper case study design for the evaluation of the practical significance of the identified IG issues should enable gathering evidences that sufficiently support internal

validity of the case study. This means that the gathered information should provide a well-established basis for the investigation of the developed logic models in Section 4 that are used for the deduction of the IG issues in DNBPs. The case study design should also enable to triangulate empirical evidences to ensure the construct validity as well as the internal validity of findings from the case study.[94] Based on these criteria, among possible case study designs (see Ref. 31), we conduct the intended case study within an embedded single case study (i.e. a single case with multiple units of analysis). In the context of our research, this means that we select a dynamic business network and focus on multiple networked business processes within the selected business network.

To do so, we select a business network that is formed in the financial industry in the Netherlands. This business network is orchestrated by a car leasing organization. Other parties are car dealers, maintainers, and insurance organizations. This business network is in a transition towards the provision of integrated mobility solution for customers. To do so, new parties are added to this business network like car rental companies, other transportation service providers, and fuel service providers. The mass customization of the integrated mobility solution by this business network requires dynamic interactions between parties through the formation and execution of DNBPs.

Based on the described case study design, within the mobility business network we select two networked business processes (i.e. units), including a customer invoicing process and a mobility solution offering process. As described further in Section 5.1.2, these two networked business processes sufficiently cover relevant empirical evidences to ensure the internal validity of findings in the case study.

A customer can receive services from different providers within the mobility business 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 for invoicing a customer for used mobility solutions within a specified time interval, the car leasing organization identifies all parties that have provided products or services for the customer within the specified time interval. Then, the customer invoicing networked business process is formed and executed to issue the requested invoice.

As a necessity for the mass-customization of mobility solutions, the car leasing organization within the business network is responsible to offer mobility solutions that fit expected customer experiences. 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. Then, an integrated package of mobility products and services that can be best fit with an expected customer experience is offered. To do so, 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.[31] These aspects of validity of findings in the designed case study are described further.

#### 5.1.1. *Construct validity of findings in the designed case study*

Construct validity points out using appropriate concepts and terms during data gathering.[94] Indeed, it addresses required consistency within data gathering and analysis activities in a case study. Since in this research we need to use a varied set of concepts from different related contexts - like IG, business process management, and business networks - we need to ensure that all concepts are used and interpreted consistently in all steps. To do so, based on Ref. 31 we use four main tactics within the data gathering and analysis. As described in Section 5.2, we use in-depth interviews supported by semi-structured questionnaires for gathering data. To ensure construct validity within in-depth interviews we apply these tactics:

- In the preparation phase for conducting case study we ensure that all interviewers have a thorough understanding and interpretation about all key concepts. For this purpose, the key concepts including the identified IG issues are described clearly within a document. The prepared document is discussed within joint meeting among all interviewers to ensure a unified comprehension of the key concepts.
- During in-depth interviews (as described further), the definitions of key concepts are presented for interviewees.

Also for analyzing gathered data we use these tactics:

- The found evidences are triangulated between different sources.
- The analyzed results are presented for interviewees to ensure all findings are interpreted correctly.

#### 5.1.2. *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 evidences.[95] In the context of this case study the internal validity of findings mainly depends on the empirically proved relationship between the experienced IG issues and the dynamism of inquired networked business processes. To ensure the internal validity of findings in this case study we apply two tactics, respectively, in data gathering and analysis steps.

In the data gathering step we require to ensure that sufficient relevant empirical data is gathered to be mapped into the logic models that are developed in Section 4. Indeed, the numbers of units (i.e. the selected networked business processes) in the multi-unit single case study design is determined based on the adequacy of found relevant empirical evidences. In this case study we can find sufficient evidences from the two selected networked business processes.

In the analysis step we need to explain why/how a mapped empirical evidence result in other mapped empirical evidence within a logic model. To do so we highlight transitions between mapped empirical evidences, see the description in 5.3.

#### 5.1.3. *External validity of findings in the designed case study*

External validity demonstrates the domain 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.[31] In statistic generalization, an inference is made on the basis of empirical data collected from a representative sample within a context. But, analytical generalization uses relevant theories to generalize findings from a case study (see Refs. [31, 96] for more details). In this way, to generalize empirical findings, we rely on theories that are used within the logical reasoning for the development of the logic models in Section 4.

### 5.2. *Data gathering*

Based on the designed case study, we need to gather data relating to IG issues within the two described networked business processes in the mobility business network. According to the three facets of the developed logic models (see Figure 4), data gathering is handled within three steps. In the first step we gather data about the mobility business network. In the second step, data for the characterization of the two selected networked business processes is gathered. In the third step, relevant data on arisen IG issues resulting from the dynamism of two characterized networked business processes is collected. These three steps are described further.

In the first step we concentrate on gathering data for the characterization of the mobility business network 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 business network (as described in Section 2). To do so, we use in-depth interviews as well as related archival records. The in-depth interviews are supported by a semi-structured questionnaire. The semi-structured questionnaire is developed based on a framework for the characterization of dynamic business networks (see Ref. 36). We conduct four in-depth interviews with key employees in the enterprise architecture, IT, marketing, and procurement departments of the car leasing organization. We also use data on the business model canvas and business service composition from "CoProFind" project that has already been conducted in the mobility business network (see Ref. 97 for more detail). These artefacts from "CoProFind" project are relevant sources because they characterize interactions among parties within the mobility value network in a structured way.

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 modeled in collaboration with a key employee from the financing department of the car leasing organization. The networked business process to offer a mobility solution for a customer is modeled in collaboration with a key employee from the marketing department. The developed models are documented within choreography and orchestration diagrams that are available on *http://is.ieis.tue.nl/research/bpm/raso15/*. The modelled networked business processes are used as a basis to explore the practical relevance of the identified IG issues. So they need to reflect the real-life logic of the selected processes properly. The conformance of the modelled networked business processes with their real-world domain is addressed by analyzing semantic quality of the modelled processes. In order to test the semantic quality of the modelled networked business processes, a workshop is organized with relevant domain experts, including experts from the enterprise

architecture, finance, marketing, IT, and procurement departments. The confirmation of the modelled networked business process by the selected domain experts reflects their validity within the context of the mobility business network.

The third step concentrates on collecting data about arisen 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 logically deducted IG issues. Indeed, items of the semi-structured questionnaire explores if the theoretically predicted IG issue is experienced in the selected networked business processes and if so, how the dynamism of the networked business processes result in the arisen IG issue. To do so, five in-depth interviews are conducted with key employees from the enterprise architecture, finance, marketing, procurement, and IT departments. The interview with the employee from the finance department is 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 is concentrated on the information product and information service quality issues within the mobility solution offering networked business process. In the interviews with the employees from the enterprise architecture and IT departments, information security and metadata issues within both of the networked business processes are attended. To test the construct validity of the gathered data in the in-depth interviews and ensure the consistency of the evidences, the results are presented within a two-hour workshop to the all interviewees.

### 5.3. *Analyzing evidences*

As described in the design of the case study, the analysis of the found evidences is based on the theoretically supported logic models that are developed in Section 4. Indeed, for analyzing findings from the case study we rely on theoretical propositions[31] that are stated within the developed logic models. In other words, it can be said that we match empirical evidences to theoretically predicted events, which is considered as the use of logic model as an analytic technique.[47, 98] In doing so, we investigate how evidences on the arisen IG issues are linked to the dynamism of the networked business processes.

Using logic models for analyzing case study evidences requires considering two critical principles, highlighting transitions as well as attending to contextual conditions.[31] 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 5, 6, 7 and 8. This principle, indeed, addresses the necessity for the explanation of why/how a mapped empirical evidence result 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 experienced IG issues. Although this explanation enhances the internal validity of the logic model based analysis of the found evidences, it also needs to be constrictively validated. To ensure the construct validity of the explanations, we

represent the derived explanations for domain experts (as described in Section 5.2) within a workshop. We also rely on the triangulation of the findings from different sources.
On the other hand, attending to the contextual conditions principle implies the necessity for investigation of rival explanations of the found evidences. In the context of this research two types of rival explanations can be considered as below:

- the explanation of empirical findings in a way that deny the relationship between the experienced IG issues and the dynamism of the networked business processes,
- and the 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 IG issues.

The explanation of empirical findings by logic models should be in line with theoretical foundations in the context.[31] However, the former type of rival explanations is opposed with theories that support the relationship between the dynamism of networked business process and the emergence of the empirically experienced IG issues. So, 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 can be considered by the exploration of other (new) sources of IG issues through findings from the case study. Since in this research we do not concentrate on the exploration of 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.

### 5.4. *Results of the case study*

The results of the conducted case study are reported in Table 1. As described in the design of the case study and the used analytical technique, the found evidences are reported in a way that explains how the dynamism of the networked business processes result in the IG issues. In order to highlight transitions between the found evidences (as described in Section 5.3) we explain empirical finding relating to each of the IG issues separately. The explanations for the 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 1.

Table 1. Findings of the case study research in a business network that provides integrated mobility solutions

| Logically identified IG issues | | Explanation of the empirical findings that represents the practical significance of the pertaining IG issue |
|---|---|---|
| Information product quality issues | syntactic inconsistency | Due to the variety of invoice formats that are used by different parties, some personnel in accounting department are employed to re-enter financial information that are received from other parties. Since parties in the business network are changed repeatedly, the car leasing organization cannot standardize invoicing formats within all parties. |
| | semantic inconsistency/ Garbling information products/ non-proper interpretation of information services | Different maintainers, which are dynamically selected by customers, use different terms that causes 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 regarded with all related parties that are dynamically interact within the mobility business network. Since maintainers are selected by customers dynamically, it is difficult to generalize using the clear definitions of the services consistently. |
| | repetitive information products | Due to the autonomous nature of parties, the same financial information that is stored by the car leasing organization, also are kept by car rental organizations. |
| Information product quality issues - continued | Incomplete information products / Incompleteness of information products in support of emerging requirements | Customers' experience related 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, the required information objects are not produced by relevant parties. 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 | It arises quite often that some provided services are unregarded in an invoice because of un-updated information by parties. Since parties collaborating within a networked business process for the provision of a mobility solution are dynamic, the car leasing organization cannot apply a predefined standardized procedure to be sure about the timeliness of information that are received from all parties. |

Table 1(Continued)

| Logically identified IG issues | | Explanation of the empirical findings that represents the practical significance of the pertaining IG issue |
|---|---|---|
| | Non-added value information products | There is a high amount of information relating to car deficiencies stored by car leasing organization. In a new business model that asset monitoring is undertaken by car rentals, this information would be useless. However, since car rentals 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 behaviour 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).<br>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. |
| | non-traceable information services | Handling customers' complaints about issued invoices necessitates the traceability of related information provenance. However, due the dynamic partnering in the business network, it occurs quite often that the provenance of the related information cannot be recognized easily. |

Table 1(Continued)

| Logically identified IG issues | | Explanation of the empirical findings that represents the practical significance of the pertaining IG issue |
|---|---|---|
| Information security issues | disappearance of added value information | Leaving the business network by parties that own critical information (e.g. car rentals) can interrupt the provision of mass customized solutions. |
| | Non-trustworthiness information exchange environment | Some of the parties that collaborate in the business network are competitors (like car rentals or car dealers). If competing parties be in doubt about the misusage 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 usage of information assets by all parties. |
| | Information ownership issue/ Information leakage and misappropriation/ Information remanence/ | Understanding of a customer's experience about a provided integrated mobility solution necessitates sharing and collaboratively usage of information stored in distributed CRM systems. The car leasing organization aims to form a central data warehouse to be able using decision support systems to offer a mobility solution for a customer. However, the storage of the information services provided by other parties that are dynamically changed 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 be misappropriated. The car leasing organization intends to segregate information provided by each party within the central data ware house, however, the dynamism of networked business processes to provide a mobility solution may result in the remanence of information. |
| Information security issues - continued | 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 customers experience that are stored in distributed databases. The alignment of these inconsistent security policies cannot be easily governed by the car leasing organization because of the dynamism of parties that collaborate also the change of information services that are required for offering 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 (like application services that are used by car rentals to provide customer related information) makes it difficult to ensure the effectiveness of the applied security procedures. |

Table 1 (Continued)

| Logically identified IG issues | | Explanation of the empirical findings that represents the practical significance of the pertaining IG issue |
|---|---|---|
| Metadata issues | Unavailable relevant metadata in metadata repository | However the car leasing organization uses a predefined definition of the services that are reported in customer invoices, it arise quite often that information sent by other parties (particularly car maintainers) are not matched with any predefined definition. The standardization of the terms in all parties within the business network cannot be easily realized 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 of 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, as described in above, it is possible that the financial information be interpreted in an inconsistent way than the first time. |
| | Not-updated 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 causes the necessity for the collaboration with 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 the change of external business processes within other collaborating parties. |
| Metadata issues- continued | Context-unaware metadata | Due to the context difference, the deficiencies terms used by car rentals are not matched by deficiencies terms by maintainers. The standardization of these terms within all related parties cannot be easily handled by the car leasing organization due to adding new parties (especially new maintainers) dynamically. |
| | Inconsistent semantics representations | For the alignment of the inconsistent metadata used by different parties within the mobility business network, the car leasing organization can use ontology matching tools to enhance dynamic evolution of relevant collaborative metadata. However, since different parties can use different ontology representation standards (e.g. OWL, WSMO, and METERO-S) the alignment of inconsistent metadata by using conventional ontology matching tools cannot be realized. |

The findings from the case study, as reported in Table 1, show the practical significance of the theoretically deduced IG issues in DNBPs.
Based on the presented explanations, all of 28 identified IG issues are practically significant. However, regarding the scientific rigorousness levels of evidences (see Ref. 99), the findings relating to different IG issues are not at the same level of the confidence. Although most of the findings are based on evidences that have been experienced in the case study, some others have not been clearly experienced yet due to limitations in the case study. The main limitation in the conducted case study is that however the mobility business network is in a transition from a stable supply chain towards a dynamic business network, but it currently does not meet all characteristics of a highly dynamic business network. This limitation is difficult to be handled because highly dynamic business networks that provide a complete package of integrated solutions for customers are quite rare in reality yet. 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. The replication of the strong expectations by different key employees provides a sufficient confidence about IG issues that have not yet been experienced in the studied case.

## 6. Related Work

The related literature to IG in the context of business networks can be categorized within the business-oriented and IT-oriented studies. The former studies focus on the characterization of information exchange in a business network in order to support business requirements (e.g. Refs. 100-102). The latter concentrates on solutions that support information exchange through different quality aware information integration approaches (e.g. Refs. 103 and 104). This research can be situated in the intersection of these two related types of studies. Indeed, this research, based on the characteristics of dynamic business networks, i.e. dynamic partnering and dynamic operating, addresses concrete issues that need to be handled by IG solutions. In this way, this research can be seen as a basis for an architectural design that links business characteristics with related enabling solutions. Indeed, although this research does not demonstrate a concrete solution for IG in dynamic business networks, it provides a well-established basis as well as a comprehensive view to develop and integrate different relevant solutions. In this way, it can be said that literature focusing on architectural designs in the context of dynamic business networks is most related to this study. In the sequel we discuss how the identified IG issues have been addressed in these architectural designs that aim to link the characteristics of business networks and relevant solutions, particularly within the inter-organizational business process layer.

In the context of inter-organizational interactions, since most of IQ issues originate from syntactic and semantic heterogeneity of information services provided by different parties, proposed solutions have been focused on these issues.[105] Most of these solutions, like standardization based middlewares to deal with syntactic inconsistency or ontology

matching solutions to deal with semantic inconsistency sufficiently respond to IQ issues in stable business networks.[106, 107] But, due to the difficulties resulting from dynamism in business networks - like short term partnering of parties coming from various contexts, distributed governance power between all parties and lack of centralized control- the effectiveness of aforementioned solutions in the context of dynamic business networks is doubtful. Particularly, the ontological alignment that enables semantic interactions between parties cannot be easily handled in dynamic networked businesses.[106] This means that most of IQ issues in the context of dynamic networked businesses, as identified in this research, are challenging issues and more research in relevant domains is need to be conducted to respond to these issues effectively.

In addition, most of the related works in the context of dynamic business networks have focused on the syntactic heterogeneity of information products and services within a business network,[106] while the semantics related issues have not been sufficiently addressed in this context. Meanwhile, due to the dominance of the service-oriented architecture, most of the relevant studies have focused on the information service quality issues (e.g. availability, and usability).[103] Information product quality issues ( e.g. handling information product repetition, or information product synchronization) have not sufficiently been considered.[108] Due to the dominance of the service-oriented architecture in the context of business networks, there is an implicit assumption in most of the related works that the information product quality need to be handled by each party and the network governor should only care about the information service quality issues. But, the findings in this research, that are also proved by the empirical evidences in the case study, demonstrate that most of the information product quality issues resulting from DNBPs cannot be responded by parties separately and need to be attended by a network governor centrally.

Although different solutions have been developed to support information security issues in the context of business networks (e.g. Refs. 109 and 110), a comprehensive view on the issues resulting from DNBPs is missing. For instance, the modification of inconsistent security policies established by autonomous parties cannot easily be responded by conventional dynamic trust management mechanisms. Meanwhile, because of the co-creation of information assets in dynamic business networks the management of the information asset ownership is quite challenging. This issue is intensified by the dynamic partnering and proposed solutions (e.g. Ref. 111) dramatically limit the agility of a business network.

Related work on the metadata domain of the IG issues in the context of dynamic business networks can be categorized within the studies on semantic business process management as well as on collaborative ontology management. The research on semantic inter-organizational business process management (e.g. Ref. 112) is mainly focused on the gap between business experts and IT experts in the business process management lifecycle. However, the identified issues in this research address another problem that is related to misalignment of the semantics between parties within a business network. In this way,

the identified metadata related IG issues highlight the alignment between heterogeneous information services among different parties participating in a networked business process, rather than the semantic alignment between business and IT experts within a business process. Meanwhile, the research on the technologies supporting the semantics-aware interactions is principally related to ontology technologies like WSMO, METERO-S, and OWL-S (see Ref. 113). These technologies enable semantic modeling, configuration, and execution of networked business processes.[114] But, the semantics-aware conceptualization of networked business processes is not addressed by these ontology technologies. The identified metadata related IG issues highlight the need for the development and evolution of a collaborative ontology to support the conceptualization of networked business processes in dynamic business networks.

A deep view on the relevant solutions for identified IG issues shows that some IG issues can be responded by well-established solutions embracing the structural, procedural, and relational mechanisms,[115-117] but some others cannot be countered easily. For instance, dynamic semantic interactions between parties collaborating from different contexts are difficult to be handled completely by related state-of-the-art solutions such as semantic interoperability technologies, or domain specific standardizations.[106] So, it seems that an IG program cannot counter all emerging issues in a dynamic business network. This means that moving towards a dynamic business network situation, which can lead to value for parties by exploiting market opportunities, can also result in risks originating from impossibilities to counter with all IG issues. Consequently, a business network has to make a trade-of between on the one hand value, that emerges from a transition towards more dynamic interactions within a business network, and on the other hand information exchange risks, emerging from the dynamism.

## 7. Conclusion

In this paper a comprehensive list of the IG issues resulting from the dynamism of networked business processes are identified. In this way, the paper closes the gap between studies on IG, which have been mostly concentrated on IG within the borders of a single organization or IG in stable business networks, and studies on dynamic business networks, which have addressed the formation of dynamic inter-organizational interactions without a rigor attention to information artefacts that are exchanged. In addition, the structured and reliable steps proposed for the identification of the IG issues can be used in different industries to explore domain-specific IG issues. The practical significance of the identified IG issues that are logically deduced based on relevant theories, is evaluated by conducting the case study in the business network that provides integrated mobility solutions for customers. The identified IG issues can also close the gap between business requirements for high quality and secure information exchange and IT based solutions that can respond these requirements. Indeed, the identified IG issues characterize requirements of IT based solutions that support dynamic business networking. IT based solution to respond the identified IG issues can be categorized within IT governance solutions, information system architectures, and computational solutions.

The identified IG issues in this research provide a well-established basis for business and information governors to predict and counter information sharing and exchange risks

within networked business processes. The identified IG issues help business governors to have a better view on causing information sharing and exchange risks from dynamic networked interactions among independent and globally distributed parties. This can lead to revising the dynamic business networking models in real-life situations in order to be able to handle resulting IG issues. The findings of this research help information governors to acquire a deep comprehension on the results of dynamism on the quality and security of information assets. In this way, it enables information governors to develop routines that can counter these issues. However the identified IG issues provide a comprehensive view on emerging information quality and security related risks, but they need to be complemented in real-life dynamic BNs considering domain specific information characteristics. For instance, more domain-specific IG issues may need to be addressed in dynamic interactions among health care providers, due to the characteristics of health information.

The main limitation of this research, as described in Section 5, is that the mobility business network that was investigated within the case study is not an extremely dynamic business network. Indeed, although this business network is in a transition from a stable supply chain towards a dynamic business network, it has not reached to its vision as an extremely agile and dynamic business network to provide mass-customized integrated mobility solutions yet. Due to this limitation, more empirical studies in other dynamic business networks can enhance the confidence of the empirical findings within the conducted case study research. In addition, as described in Section 2, this research concentrates on the dynamism of networked business processes from a strategic point of view. The future research can focus on operational point of view on the dynamism of networked business processes that addresses flexible execution of networked business processes. Future research also can concentrate on the development of organizational, architectural, or computational solutions that address the identified IG issues in the context of dynamic business networks.

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