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VALUE OF INFORMATION LOGISTICS INTEGRATION IN DIGITAL BUSINESS ECOSYSTEM

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ABSTRACT

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Digital business ecosystems (DBE) are becoming an increasingly popular concept for modelling and building distributed systems in heterogeneous, decentralized and open environments. Information- and communication technology (ICT) enabled business solutions have created an opportunity for automated business relations and transactions. The deployment of ICT in business-to-business (B2B) integration seeks to improve competitiveness by establishing real-time information and offering better information visibility to business ecosystem actors. The products, components and raw material flows in supply chains are traditionally studied in logistics research. In this study, we expand the research to cover the processes parallel to the service and information flows as information logistics integration. In this thesis, we show how better integration and automation of information flows enhance the speed of processes and, thus, provide cost savings and other benefits for organizations. Investments in DBE are intended to add value through business automation and are key decisions in building up information logistics integration. Business solutions that build on automation are important sources of value in networks that promote and support business relations and transactions. Value is created through improved productivity and effectiveness when new, more efficient collaboration methods are discovered and integrated into DBE. Organizations, business networks and collaborations, even with competitors, form DBE in which information logistics integration has a significant role as a value driver. However, traditional economic and computing theories do not focus on digital business ecosystems as a separate form of organization, and they do not provide conceptual frameworks that can be used to explore digital business ecosystems as value drivers—combined internal management and external coordination mechanisms for information logistics integration are not the current practice of a company's strategic process.

In this thesis, we have developed and tested a framework to explore the digital business ecosystems developed and a coordination model for digital business ecosystem integration; moreover, we have analysed the value of information logistics integration. The research is based on a case study and on mixed methods, in which we use the Delphi method and Internet-based tools for idea generation and development. We conducted many interviews with key experts, which we recoded, transcribed and coded to find success factors. Qualitative analyses were based on a Monte Carlo simulation, which sought cost savings, and Real Option Valuation, which sought an optimal investment program for the ecosystem level.

This study provides valuable knowledge regarding information logistics integration by utilizing a suitable business process information model for collaboration. An information model is based on the business process scenarios and on detailed transactions for the mapping and automation of product, service and information flows. The research results illustrate the current cap of understanding information logistics integration in a digital business ecosystem. Based on success factors, we were able to illustrate how specific coordination mechanisms related to network management and orchestration could be designed. We also pointed out the potential of information logistics integration in value creation. With the help of global standardization experts, we utilized the design of the core information model for B2B integration. We built this quantitative analysis by using the Monte Carlo-based simulation model and the Real Option Value model.

This research covers relevant new research disciplines, such as information logistics integration and digital business ecosystems, in which the current literature needs to be improved. This research was executed by high-level experts and managers responsible for global business network B2B integration. However, the research was dominated by one industry domain, and therefore a more comprehensive exploration should be undertaken to cover a larger population of business sectors. Based on this research, the new quantitative survey could provide new possibilities to examine information logistics integration in digital business ecosystems. The value activities indicate that further studies should continue, especially with regard to the collaboration issues on integration, focusing on a user-centric approach. We should better understand how real-time information supports customer value creation by imbedding the information into the lifetime value of products and services.

The aim of this research was to build competitive advantage through B2B integration to support a real-time economy. For practitioners, this research created several tools and concepts to improve value activities, information logistics integration design and management and orchestration models. Based on the results, the companies were able to better understand the formulation of the digital business ecosystem and the importance of joint efforts in collaboration. However, the challenge of incorporating this new knowledge into strategic processes in a multi-stakeholder environment remains. This challenge has been noted, and new projects have been established in pursuit of a real-time economy.

Keywords

Strategy of supply chain, transaction cost economics (TCE), resource-based view (RBV), B2B integration, information logistics integration, Monte Carlo simulation, Real Option Value, digital business ecosystem,

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Becoming a researcher after many years of operational business experience was a privilege. Climbing up to the “shoulders of the mammoth” (from a letter written by Isaac Newton in 1676; in Latin, *nanos gigantum humeris insidentes*) became reality to me in 2011, when I started my doctoral studies. Thank you, Prof. Veli-Matti Virolainen, for all your encouragement to start doctoral studies and for being my supervisor. I would like to express my very great appreciation to my first supervisor, Prof. Jukka Hallikas, for his valuable and constructive suggestions during the planning and development of the research work. His willingness to share his time so generously during the different research phases and the academic work has been very much appreciated.

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Lappeenranta, December 2014, *Kari Korpela*

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PUBLICATIONS

1. Kari Korpela*, Usva Kuusiholma, Ossi Taipale and Jukka Hallikas (2013) A framework for exploring digital business ecosystems, System Sciences (HICSS), 2013 46th Hawaii International Conference
2. Kari Korpela*, Jyri Vilko and Jukka Hallikas (2012) Assessing information logistics development in supply networks, International Journal of Business and Economics (IJBE), Vol. 4, No. 2, 2012
3. Kari Korpela*, Paavo Ritala, Jyri Vilko and Jukka Hallikas (2013) A management and orchestration model for integrating digital business ecosystems, International Journal of Integrated Supply Management, Vol. 8, No. 1-23, 2013
4. Kari Korpela*, Christer Carlsson, Markku Heikkilä, Jukka Hallikas Karri Mikkonen and Xiaolu Wang (2013) Supporting the integration of digital business ecosystems with real option valuation, LUT Scientific and Expertise Publications, No. 28, 2014
5. Kari Korpela*and Jukka Hallikas (2014) Improving the value of the information logistics in supply chain integration, The 18th Working Seminar on Production Economics 2014 (IJPE 2014), Innsbruck, February 24-28, 2014

CONTRIBUTIONS OF THE AUTHOR IN THE PUBLICATIONS

Publication 1 (A framework for exploring digital business ecosystems)

Responsibilities in the research: Participated in the research process as a researcher.

Data collection and analysis: Carried out part of the literature review, in which digital business ecosystem integration models are discussed.

Participated in the construction of the results.

Writing the paper: Lead author. Wrote most of the paper.

Publication 2 (Assessing information logistics development in supply networks)

Responsibilities in the research: Participated in the research process as a researcher.

Data collection and analysis: Carried out part of the literature review, in which information logistics development are discussed.

Participated in the construction of the results.

Writing the paper: Lead author. Wrote most of the paper.

Publication 3 (A management and orchestration model for integrating digital business ecosystems)

Responsibilities in the research: Participated in the research process as a researcher.

Data collection and analysis: Carried out part of the literature review, in which management and orchestration models are discussed.

Participated in the construction of the results.

Writing the paper: Lead author. Wrote most of the paper.

Publication 4 (Supporting the integration of digital business ecosystems with real option valuation)

Responsibilities in the research: Participated in the research process as a researcher.

Data collection and analysis: Carried out part of the literature review, in which real option valuation was modelled and discussed. Co-authors build a real option model for valuation.

Participated in the construction of the results.

Writing the paper: Lead author. Wrote most of the paper.

Publication 5 (Value creation through information logistics integration in the supply chain)

Responsibilities in the research: Participated in the research process as a researcher.

Data collection and analysis: Carried out the literature review, in which service models are discussed.

Participated in the construction of the results.

Writing the paper: Lead author. Wrote most of the paper.

PART 1: OVERVIEW OF THE THESIS

1 INTRODUCTION

This chapter begins the thesis by describing the research area and by setting out main objectives and research questions in order to give an indication of the expected contribution. Thereafter, the key concepts are introduced and the relations between them explained.

1.1 Background and research gap

Brynjolfsson & McAfee (2014) noted “Everything that can be digitized will be digitized. Everything that can be automated will be automated“. Traditional business strategy, IT strategy and digital business strategy will merge (Bharadwaj et al., 2013). Information logistics integration is about the digitization of business information, which is delivered electronically to users (Dinter, 2012), increasingly in a real-time manner. Information in global trade is about the quality and accessibility of information (Berente & Vandenbosch, 2009). We are moving towards a real-time economy. These statements and visions are obvious; in this study, we try to establish the current state of understanding and to produce new knowledge regarding information logistics integration.

The strategic decision to establish Electronic Data Interchange (EDI) operating businesses was made as early as the 1970s. Generally, EDI operators are system integrators, which convert and transfer business process data using standards. EDI technology was first used in military operations in the early 1970s. Due to the standardization of EDI Internet protocols, development increased during the 1980s to cover logistics information data transfers in the fields of airports, shipping ports, railways, road transportation and others. Many different EDI standardization units were established in the 1990s in North America and Europe. Finally, a joint agreement to establish UN/EDIFACT to coordinate international EDI standardization emerged. In addition, the Extensible Markup Language (XML) technology was developed, and the Universal Business Language (UBL), which established OASIS and Core Component Technical Specifications (CCTS), was established by UN/CEFACT. Finally, after all these development activities, UN/CEFACT was able to introduce the Cross Industry Invoice (CII) in 2010.

Strategic decisions made by the financing sector in the early 1990s introduced electronic payments (e-payments). In the early 2000s, e-payments were followed by electronic invoicing (e-invoicing) processes. E-payment has been the biggest success story: it established interoperable payment system within the financing network, connecting users of inter-organizational public and private networks, including consumers. The European banking industry has defined common standards for the structure of e-payments, organized by the Single Euro Payment Area (SEPA), which consists of the 28 EU member states. The financing sector was early to understand the value of using standards as process of integration of payments. This e-payment structure changed the financial sector's entire business model for private customers, businesses and the public sector. The benefits of this integration of payments have been obvious through the entire business ecosystem. In Scandinavia, the implementation of electronic payments started in the early 1990s, and penetration reached its high level (over 90%) in twelve years.

An e-invoicing network was established by the financial sector and EDI operators in Scandinavia in the early 2000s. It offered customers interoperable e-invoicing transfers as an e-invoicing network service. This network used jointly designed e-invoicing specifications (no standards were available at that time, since this collaboration started ten years before UN/CEFACT introduced the Cross Industry Invoice (CII)). E-payment and e-invoicing form the key processes used by any business-to-business (B2B), business-to-consumer (B2C) or business-to-government (B2G) organization. During the late 2000s, other European countries also developed their own e-invoicing specifications. It is estimated that, just in Europe, in 2012, there were more than 150 e-invoicing specifications (some as standards), transmitted by more than 600 different intermediates (e.g., EDI operators or other XML business process document operators) (Koch, 2014). It is commonly recognized that the "momentum" of e-invoicing standardization should have been better organised and coordinated in early 2000s.

The volume of invoices was estimated to be, at a minimum, 350 billion invoices worldwide and 33 billion in Europe in the year 2012. Table 1 describes the current penetration and the growth rate of e-invoices (Koch, 2012).

Annual invoicing volume (in billions):

World	Invoices	E-invoice penetration	E-invoicing growth rate
Consumer (B2C)	200	5 %	5%
Business (B2B) & Government (G2B)	<u>150</u>	5 %	5%
Total	350		
Europe			
Consumer (B2C)	17	12 %	20%
Business (B2B) & Government (G2B)	<u>16</u>	18 %	29%
Total	33		
Scandinavia			
Consumer (B2C)		15-40 %	
Business (B2B) & Government (G2B)		> 40 %	

Table 1 Invoicing volumes, current penetrations and growth rates of e-invoicing in 2012.

Invoicing involves two transactions: the processing of sales invoices by a supplier (as sales invoices) and the receiving of sales invoices by a buyer (as purchase invoices). Most studies focus on estimating cost savings by lead-time and materials by comparing processes that have switched from manual to electronic and automated invoicing. Several studies by large buyer organizations are available for Scandinavia. The Finnish State Treasury, as a buyer, estimates the processing cost of a paper invoice at 30 euro, the cost of an e-invoice at 10 euro and the cost of automated processing at 1 euro. Finnair, the Finnish airline company, estimates (as a buyer) the processing cost of a paper invoice at 40 euro, while Electrolux, the Swedish consumer electronics company, estimated its paper invoice cost at close to 50 euro (Penttinen, 2008). Billentis has estimated, from

a large population of world organizations, that the cost savings of supplier-side sales invoices are smaller than those of buyer-side purchase invoices: a supplier's paper invoice is estimated to cost 11.10 euro and an electronic one 4.70 euro, whereas, on the buyer side, a paper invoice is estimated to cost 17.60 euro and an electronic one 6.70 euro. The hourly working cost reflects directly as cost savings (e.g., in Europe compared to China). This makes the integration issue very relevant to developed countries.

Users of e-payment and e-invoicing; business networks, ecosystems or even countries, have realized the benefits. Public and private sectors have understood the importance of leveraging B2B integration, but there exists little common understanding or knowledge regarding how to speed up integration in other purchasing and sourcing processes.

This research is based on an empirical case study of 40 companies operating in the bio-refinery business network. This industry network is an interesting case due to the economics of scale and the multiple levels of operations in regional and global trade, which covers various types of B2B (service and product) transactions. In our case study of 40 companies in 2012, the transaction volume was found to total 11 million transaction, comprising 2,5 million invoices. When comparing invoicing volumes to other transaction volumes in percentages, we discovered that the volumes of other transactions were: catalogs at 3%, quotations at 8%, orders at 230%, deliveries at 103% and services at 3%. Figure 1 presents the major process transactions and illustrates that there are more than four times the number of other business transactions as there are of invoices (not including payments and cross-border customs transactions). Figure 1 also shows the current penetration of electronic transactions in different processes. This better explains the current potential that exists in the global trade of business transaction volumes.

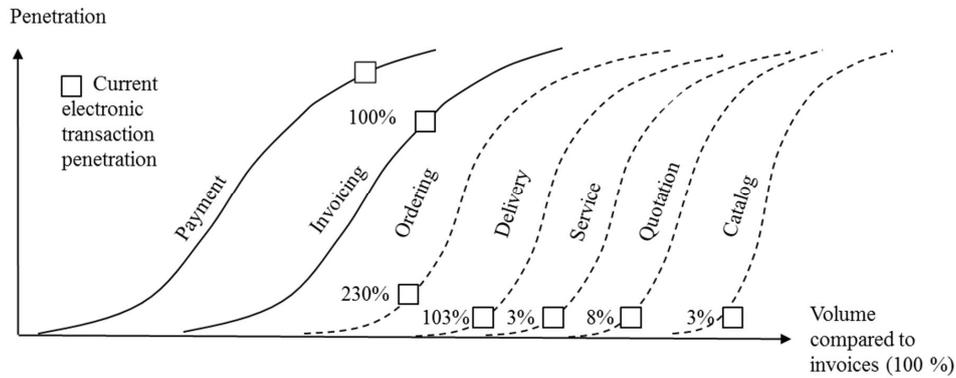


Figure 1 Case study of 40 companies' business transaction volumes, compared to invoicing and current electronic transaction penetration.

The hub organizations strategy (for large, multinational industries) has pointed out the importance of having better information for decision-making. Hub organizations have expanded their business operations through mergers and acquisitions across continents. In consequence, Hub organizations came to a situation in which they were operating businesses through many different legacy software systems and services. The massive internal integration of business information was executed through Enterprise Resource and Planning (ERP) systems. This has been a key interest in the industry over recent decades, and the integration work has often been outsourced to *value-added IT service providers*. During this period, ERP service providers have gained good revenue growth through software licensing and consulting. ERP service providers are mostly developing internal integration for customer requirements or focusing on their ERP ecosystems, without really paying attention to designing end-to-end interoperability architectures. Internal integration is defined as information integration within a firm's boundaries and across a firm's business functions (Richey, 2010; Chen, 2009; Daugherty, 2006). This development of internal ERP integration has created a new market for those service providers focused on external business network integration. This business of process data mapping, or of conversion and transfers, is completed by specialised *intermediates or EDI operators*. In the 2000s, this has been fast growing

business sector in Europe and North America. The main motivation for business networks has been the need to gain cost savings and better real-time information to manage businesses and build better competitiveness across entire networks.

Information logistics integration strategy is a new phenomenon in business and academic fields. It is related to the so-called Big Data issue, the Digital Business Ecosystem (DBE), cloud computing, the Internet of Things (IoT), Internet security and many other related phenomenon. According to Dinter et al. (2010), information logistics can be defined as “the planning, implementation, and control of the entirety of cross-unit data flows as well as the storage and provisioning of such data”. Information logistics should provide value to the whole business network, not only through benefits, but also through cost reduction and the elimination of risks (Dinter et al., 2010; DeLone, 2004). ICT is typically considered an enabler to (re)design, manage, execute, improve and control business processes, both within and between organizations (Melao, 2009). In this research, we consider information logistics integration in its wider context, as a concept that is related to business network value activities, practiced through common business concepts and used by different stakeholders. By choosing this wide context, we seek to establish an understanding of how information logistics integration should be implemented as part of strategic planning within inter- and intra-organizational boundaries.

For this study, we have defined common business process models based on major standards (GS1/RosettaNet, OASIS/UBL and UNCEFACT/EDIFACT) to design our work and data collection. This design was done through close coordination with key experts (the “Expert Group”) in standardization organizations. In our case study of 40 companies and their managers (the “Focus Group”), we have collected transaction volumes based on the process model and have made a valuation of the processes.

This thesis will produce new knowledge within the academic field by establishing a well-conducted case study, including reliable research groups, a well-designed research framework to collect and analyse data, several methods for data validation and quantitative analysis and, finally,

some interesting findings. In terms of business operations, this research will contribute to the current understanding of integration knowledge, tools and concepts. Particularly, this will establish an understanding of how value activities need to be designed and coordinated in a multi-stakeholder environment. As a result, we will have improved knowledge of how competitive advantages can be established by joint efforts.

1.2 Research objectives and questions

The research objectives arise from the value activities studied here. We have established the main question and two sub-questions to cover the value activities in information logistics integration. The research is done in a large network that describes the Digital Business Network (DBE). The first research objective concerns how information logistics integration creates value through product and service delivery to customers and how this value is delivered through a company's network, creating competitiveness. The related main question is: *What is the customer value of information logistics integration and how does this improve a company's competitiveness (Why - as main motivation)?* The second research objective is related to the business process data design and the business process design, which, together, form sub-question one: *How should the information data flow be arranged (What - as information) in business processes (How - as process)?* The third research objective relates to the issue of designing the management and coordination mechanisms to manage the core capabilities (human resources) to facilitate information logistics integration, thus constituting sub-question two: *How should networks be designed (Where - as network) and how should they involve core capabilities (Who - as core capabilities) to manage and coordinate information logistics integration?* Figure 2 explains how the research objectives and the questions are related to the literature.

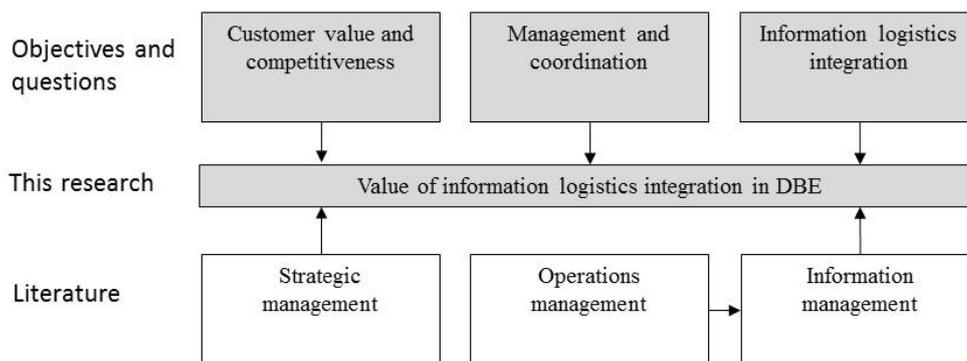


Figure 2 Research objectives and questions related to the literature review

Given the research gap discussed above, there is a clear need for more studies regarding information logistics integration in a digital business ecosystem. Both academics and practitioners need new case studies that combine highly fragmented knowledge and integrate it into a new structure. The objective of this study is to narrow the gap by studying information logistics integration from three perspectives: namely, strategic management, information management and operations management. By studying the extensive literature on this phenomenon, we try to narrow the knowledge to create a more meaningful explanation for the research. The case study method with systematic combining was adopted in order to bring in new insights from the field. In the following sections, we will focus on the current literature from the three afore-mentioned aspects (strategic, information, and operations management), as it relates to the research objectives.

1.2.1 Strategic management

Strategic management involves the design of a company vision and the implementation of the major goals and initiatives taken by executives, on behalf of owners, to achieve long-term performance and to reach targets (Ansoff, 1965). The main concern has been with how firms optimally use their core competencies, key assets and resources to extend their product and market reach (e.g., Amit & Schoemaker, 1993; Barney, 1991; Conner & Prahalad, 1996; Wernerfelt, 1984, 1995). Osterwalder (2004) notes that strategy combines information technology and business

organization by forming an environment into a business model. Just recently, competitive strategy under digital conditions has raised the question of how strategy management is embedded into digital technologies. Digital business strategy is different from traditional information technology (IT) strategy, which largely supports the functional areas (such as marketing, procurement, logistics, operations, and others) and various IT-enabled business processes (such as order management, customer service, and others). Bharadwaj (2013) argues that, over time, as firms and industries become more digital and rely more on information, communication, and connectivity functionality, digital business strategy will be the only business strategy.

In this study, we explore the strategy view, in particular, to understand the how information logistic integration creates value for customers and how companies, as part of business networks, are able to improve their competitiveness. This knowledge is needed to implement this phenomenon of strategy processes and, therefore, contributes the main research question: *What is the customer value of information logistics integration and how does this improve a company's competitiveness (Why)?*

1.2.2 Information management

Information management is a structure and a design for the management of business intelligence. It explains how data are structured and managed to secure quality and accessibility. Information delivery at both intra- and inter-organizational levels requires detailed designs for business processes and data structures. There are various frameworks and models, and even standardized architectures, to guide information management. The focus of information management is to provide true end-to-end solutions for information users.

Given the complexity of information systems and the latest developments in cloud computing technologies, software is only one of the components in an information system. Researchers have various definitions and explanations for information architecture, and these differ in terms of their approach and level of detail. Some have provided specific guidelines, whereas others follow specific methodologies and aspects. Further design is required in diverse areas within the

requirements for modelling network infrastructures, server configuration and middleware technologies (Tang et al. 2010). Tang et al. provide a model for understanding enterprise architecture by analysing the goals, inputs and outcomes of six architecture frameworks (CADM, RM-ODP, the 4+1 View Model, TOGAF, DoDAF and the Zachman Framework). Models should take into account the requirements of different business stakeholders for designers; that is, the architecture must be usable by end users, acquirers, the system's owner and operator, etc. Therefore, the architecture should be able to support technical, cost and programmatic decisions (Emery et al., 1996). Geary et al. (2002) have presented a supply chain integration maturity framework, which consists of four stages: Baseline, Functional, Internal and External integration. In this framework, the focus is on the evaluation of integration maturity and supply chain effectiveness.

The information model is a “blueprint” for how information is collected, analysed and shared within systems and how it is transferred, according to business processes, over the Internet through the use of structured data. (Toh, 2009; Nurmilaakso, 2008). The building blocks for B2B integration are the business process models, which are also called process scenarios. This information management knowledge is related to research sub-question one: *How should the information data flow be arranged (What) in business processes (How)?*

1.2.3 Operations management

Operations management is concerned with designing and controlling the process of production and redesigning business operations in the production of goods or services. It involves the optimization of business operations in terms of using resources and capabilities. The production of products and services in a global business network requires operations management to involve inter- and intra-organizational coordination mechanisms.

There are several conceptualizations of how networks and ecosystems are coordinated. In this study, following a recent study by Ritala et al. (2012), we aim to investigate network coordination mechanisms that encompass the full range of various activities, processes and resources within the

ecosystem. Furthermore, network coordination is seen here to consist of two different, yet complementary, mechanisms: management and orchestration. Management mechanisms can be viewed as “coordination by commanding,” and orchestration mechanisms as “coordination by enabling” (Ritala et al., 2012). Therefore, management mechanisms in digital business ecosystems relate to concrete management activities in the network, such as the delegation of roles and responsibilities, scheduling and contracting, throughout the ecosystem members. On the other hand, ecosystems are often hard to manage concretely due to the independency of different actors and the heterogeneity in their motivations and goals (Dhanarag & Parkhe, 2006). Therefore, orchestration-type coordination mechanisms are also needed. These relate to “softer” mechanisms, such as the communication of a joint vision, motivating activities, and the facilitation of actors’ participation in various joint activities.

The aforementioned mechanisms of management and orchestration will be used as the basis for the analysis of coordination mechanisms in the empirical part of the study. Therefore, for the analytical purposes of this research, we divide management mechanisms further into two categories, based on the existing literature on business ecosystems and their coordination (Dhanarag & Parkhe, 2006; Ritala, 2009; Ritala, 2012). The first category relates to delegating roles and tasks among ecosystem members and to setting up schedules. The second category relates to controlling the efficiency of various processes in the network, including those that affect supply and demand. Similarly, orchestration mechanisms are also divided into two categories. The first category includes motivating members to join the network, ensuring knowledge sharing and mobility, and communicating vision. The second category relates to enabling activities, which ensure the stability and longevity of the ecosystem’s processes and actors. All of these four categories are discussed throughout the remainder of the thesis, and this relates to research sub-question two: *How should the network be designed (Where) and how should it involve core capabilities (Who) to manage and coordinate information logistics integration?*

1.3 Positioning the research

The value of information logistics integration in a digital business ecosystem is a multidisciplinary and broadly defined research issue with many streams. The thesis title and research questions imply a wider scope of understanding the phenomenon. Some scholars do not even recognise digital business ecosystems as a separate discipline; moreover, information logistics is also a rather new discipline. These issues complicate the explicit positioning of the research. In the first phase of this research, we paid special attention to the research framework design, which helps to establish different scientific perspectives for positioning the research.

The research contributes to the intersection of three disciplines: namely, strategic, information and operations management. The chosen approach links to these disciplines with its emphasis on the value activities of information logistics integration. The research objectives and related questions have been chosen as: customer value and competitiveness, information logistics integration and the management and coordination linking value activities. The chosen approach links the research objectives to the literature, building a holistic view of the value of information logistics integration in digital business ecosystem. Figure 3 illustrates the research positioning.

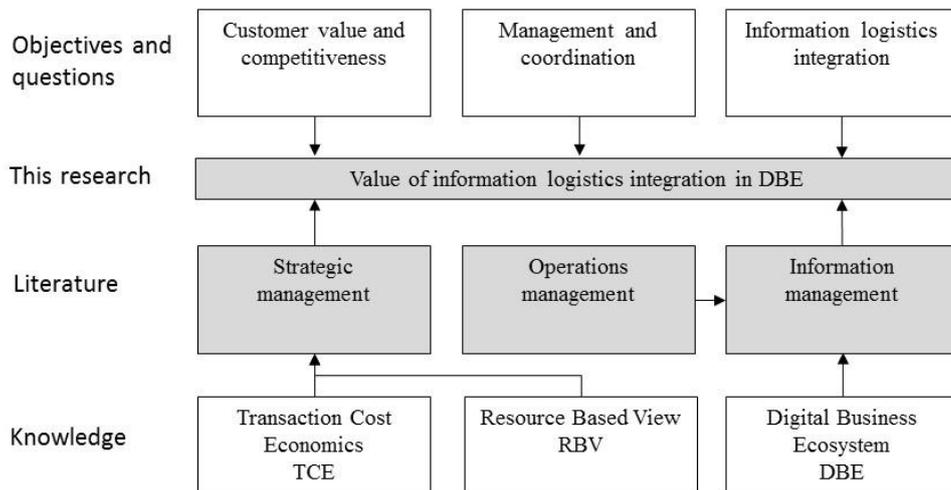


Figure 3 Positioning the research

The perspectives regarding knowledge and theories that we will discuss through the main disciplines are: transaction cost economics and the resource-based view, contributing to strategic management, and the digital business ecosystem and operations management, contributing to information management.

All these research elements are studied throughout the research framework as value activities and common business concepts used by stakeholders. Through this approach, we are able to combine results and narrow the scope, thus allowing us to produce results that are also relevant to our operative partners.

1.4 Definition of the key concepts applied in the research

In this section, we will explain two concepts that will help to structure current understanding and future options to produce knowledge. Business ecosystems have many stakeholders, who use common business concepts to design and manage internal business through joint activities to

establish information logistics integration within external networks. For this inter- and intra-organizational integration, we will describe i) the framework for digital business integration, which serves as the structure for the research design. For the technology options, we will describe ii) the integration models, which build understanding regarding the analysis, especially in business network investments and payback calculations.

1.4.1 The framework for digital business ecosystem integration

In the literature, there exist very few methods to design and analyse digital business ecosystems (DBE). Based on the Zachman Enterprise Architecture (Sowa, 1992; Zachman, 1999), the researchers formed a DBE framework for integration with six horizontal layers (rows) and six vertical layers (columns). The horizontal layers describe the different common business elements used by the stakeholders involved. The six vertical layers describe the joint value activities (columns) to optimize information value delivery.

The horizontal layers are the base for common business elements used by different stakeholders in organizations and business networks, which are: strategies, business models, information models, standardization, integration channels and service portfolios.

A strategy is a tool used by executive managers. It provides the company's vision, which is a set of goals and objectives comparing the internal strengths and weaknesses of a company with its external threats and opportunities (Malhotra et al., 2007; Hoyer, 2008), and which positions the company in the market (Moore, 1998; Gossain, 1998). According to Hoyer (2008), strategy is a giant, and we can only grab on to part of it. Business strategy is a large domain in which limited consensus exists and variation can be found across different business domains over time. Strategy emphasizes the overall direction of a firm's market positioning, its interactions across organizational boundaries, its growth opportunities, its competitive advantages and its sustainability.

A business model is a tool for operating business managers. There is an on-going discussion regarding the difference between a strategy and a business model (Santos & Eisenhardt, 2005). A

generally accepted definition for the term “business model” has not yet emerged. However, three general categories of definitions exist: strategic, operational and economic, each of which consist of a unique set of decision variables. A business unit is about the "material" and workflows, and a business model explains a company's money-earning logic as a set of concepts (Cooper & Tracey, 2005). At an operational level, the model represents an architectural configuration. The focus is on internal processes and the design of infrastructure, which enable the firm to create value. The decision elements concern product or service delivery, administrative processes, resource flows, knowledge management, and logistic streams. A business model describes how an organization (e.g., an enterprise or business unit) creates, delivers and captures value. The process of business model construction is part of a business strategy. The business model must be evaluated against the current state of the business ecosystem (Malhotra et al., 2007).

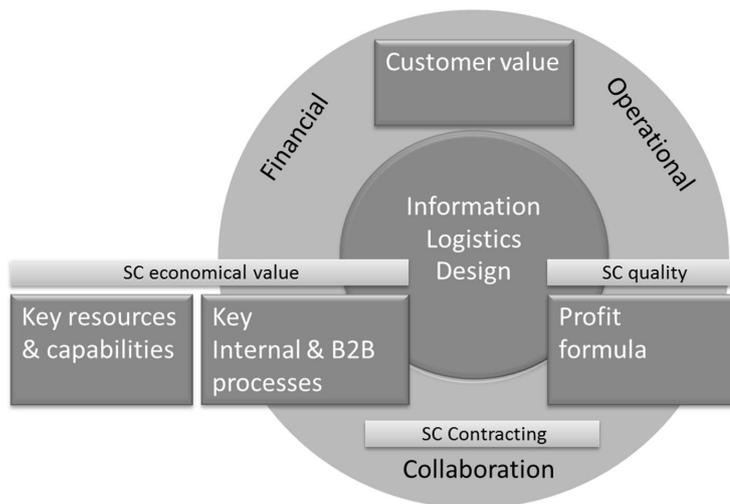


Figure 4 Business model design applied (Zott, 2010)

An information model is a description of the structure of an enterprise, which comprises enterprise components (i.e., business entities), the externally visible properties of those components and the relationships between them. The process of designing an information model is part of the business

model. Both buyer and supplier agree to use suitable business processes based on the business model. Figure 5 explains the business processes scenario used by networks using logistics service providers.

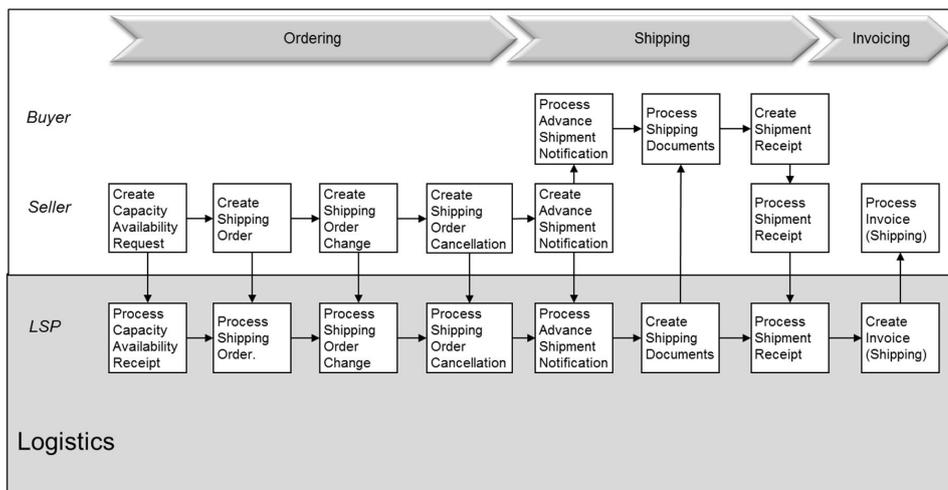


Figure 5 Example of business process scenario for logistics

The standards of business processes have been under development in several international standardization groups. Standardization allows trading partners of all sizes to connect electronically in order to process transactions and move information within their extended supply chains (e.g., UBL, RosettaNet) (Corallo et al., 2007; Nachira, 2002). Business process standards have the basic elements of processes and data definitions, and some standards also offer code lists. Each standard uses different definitions, and a consolidated understanding of data elements does not exist. The objective of standardization is to facilitate accurate information and to share information throughout the supply chain in real time. (Nachira & Nicolai, 2007).

In Figure 6, we have established a holistic picture of the timeline for transaction network technology development for organizations involved in EDI- and XML-based standardizations.

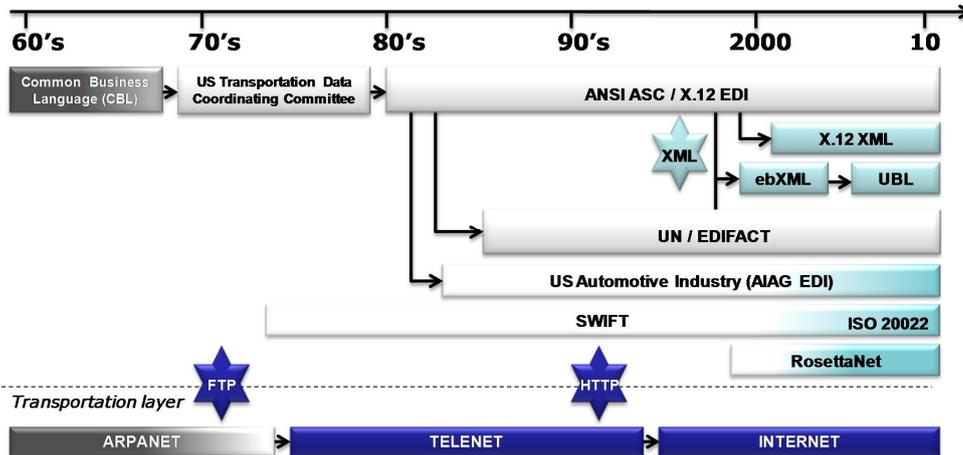


Figure 6 Transaction network technology and standardization for organizations involved in EDI- and XML-based business process integration

An *integration channel* is based on interoperable business process services or systems. ICT and e-business have made it possible to offer completely new products and services, many of which have important information components and which are frequently provided by multiple companies in collaboration (Santos & Eisenhardt, 2005). The interoperability of services has made it possible to reach customers in new and innovative ways and through a multitude of channels. The Internet has made it easier to conduct business on a global basis and, theoretically, to reach and serve customers in the most remote places. Finally, based on Internet and web services, a range of new pricing and revenue mechanisms have found their way into business practices (Jansen & Cusumano, 2012; Corallo et al., 2007). The process of designing interoperable services is a part of implementing standardized business processes.

In Figure 7, we have established a holistic picture of general business processes and their relations to form an integration model. The business processes use different messages, defined by standardization organizations. The B2B integration layer explains the messages, named according to the different standards, and thus illustrates the role of intermediate companies that implement the mapping when transferring transactions between organizations using different standards.

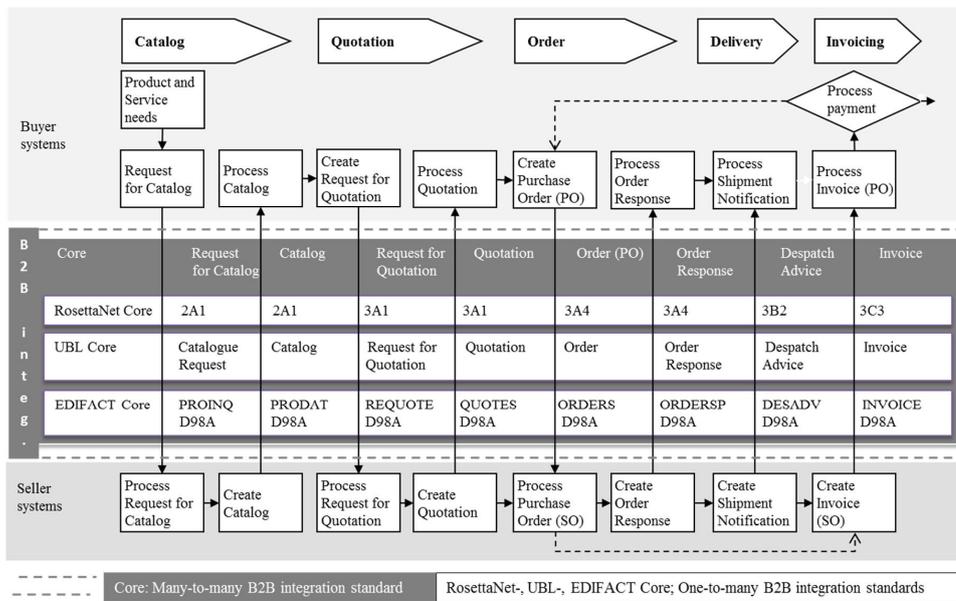


Figure 7 B2B integration: Business process models based on standards

A *service portfolio* represents a complete list of the services managed by a service provider. Some of these services are visible to customers, and others are not. The service portfolio contains present contractual commitments, new service developments and on-going service improvement plans. It also includes third-party services, which are an integral part of service offerings to customers. The service portfolio is divided into three phases: the service pipeline, the service catalogue, and retired services. The process of designing a service portfolio is dependent on the structure of the interoperable service deployment. The service portfolio also includes the testing services for processes and data. These common business elements are summarized as a DBE integration framework (Table 2).

DBE integration framework	Definition for common business concepts and stakeholders
Strategy Executives	Strategy: is a tool for executive managers and provides a company's vision, the set of goals and objectives, comparing the internal strength and weakness and external threats and opportunities.
Business Model Managers	Business model: explains how to create, deliver, and capture the value. A business model is part of business strategy and it must be evaluated against the current state of the business ecosystem.
Information Model EA. Experts	Information Model: explains how information is collected, stored and delivered internally and externally. It is a compact graphical drawing, explaining how customer and supplier business processes are integrated in internal information systems.
Process Standards St. Experts	Process Standards: describes how a company and its trading partners of all sizes are connected electronically to process transactions and information moved within their extended supply chains.
Integration Channel Intermediates	Integration Channel: describes how information is channeled through the internet, according to the IP registers of business systems and in an end-to-end, machine-readable way.
Service Portfolio Users	Service Portfolio: represents a complete list of interoperable services that have been tested and validated for B2B integration.

Table 2 Common business concepts and stakeholders as vertical layers (rows) in a DBE integration framework

The framework for digital business integration has six vertical layers that describe the joint value activities (columns) to optimize information value delivery.

The vertical layers are based on value activities used in intra- and inter-organizational operations, such as: customer value, network value competitiveness, data models, process models, network

collaboration and people capabilities. These form the overall key questions that need to be solved by stakeholders at different horizontal levels. By their nature, they form an ontological and epistemological reasoning, through which we can find methodologies to explain and produce knowledge.

Customer value (Why) is the key question for any business stakeholder and the basis for common business elements. This column describes how information enables the addition of value to products and services used by customers. All other value activity questions could be combined into one, ultimate question about how this information value is collected, stored and distributed in business networks.

Network value competitiveness (Why) explains how each organization captures the value of integration, either by creating new revenues or by cutting costs. The question concerns profit formulation at all levels of organizations.

The data model (What) in integration concerns the design of information (i.e., data), its quality and its accessibility. It also questions the level of transparency and visibility arranged between business partners and customers. This is one of the most demanding activities in modern digitalized economy and widely discussed by standardization and in business networks.

The process model (How) concerns how business processes are designed and how they are linked to establish interoperable system integration. Business networks need to design business process scenarios that are jointly used and to establish the priorities of different development phases. Through business processes, information is transferred and shared.

Network collaboration (Where) is the activity of choosing the partners and locations through which integration needs to be established. This is also a management issue concerning how to coordinate work at an intra-organizational level and to orchestrate a network at an inter-organizational level. The design of coordination mechanisms is one of the key components in integration success.

People capabilities (Who) refer to the activity of finding the core capabilities that make up different levels of working groups across organizational levels. Information logistics integration requires a demanding combination of special leadership skills, expertise and motivation activities.

The theoretical base for value activities comprises transaction cost economy (TCE) (as value of integration), information management (IM) (as information logistics integration) and Resource based view (RBV) (as managing integration resources and skills). These activities are further distributed on the DBE integration framework in Table 3 and are defined as horizontal value activities.

Information integration value	Value activities					
Value management	Value of integration		Information logistic integration		Managing integration	
DBE integration framework	Customer Value	Network Value Competitiveness	Data Model	Process Model	Network Collaboration	People Capabilities
Definition of value activities	The column describes how information enables to add value for products and services.	The column describes the value we aim to capture in our company.	The column describes what information is needed and how it is designed.	The column describes how information is transferred and shared in business processes.	The column describes where the business integration is designed to be established.	The column describes competence and people who we need to involve.
Motivation	Why		What	How	Where	Who

Table 3 DBE integration framework for value activities

In the DBE integration framework, each shell of the six by six matrix serves as an independent factor and contributes valuable knowledge as such. By combining this knowledge in various ways, we will unearth interesting findings and dependencies. This DBE integration framework is the fundamental structure for this research; it establishes a mutual framework within which to integrate theoretical observation, structure the focus of academic papers, define the research questions,

design the interview and the questionnaires for the survey and structure the working process with experts and focus groups. The results are monitored and explained through this framework in order to better explain both the findings and the blind spots, which have not been fully explored in this research.

1.4.2 Integration models

Investments in B2B integration can be estimated through the use of different B2B integration models. The basic concept of investment cost is based on three variables: a) integration volume, b) the total amount of process integration and c) the volume of transactions.

In terms of technology, standardization and service development, the development of B2B-integration business models could be categorised as follows:

Manual transaction integration

The vast majority of world businesses documents (B2B, B2G and B2C) are sent in non-machine-readable form (e.g., paper, fax, or PDF). At the end of each process, information has to be manually transferred from the document to the systems used. The integration volume can be defined as $i = \sum t \times 2$, where t represents each process transaction.

EDI B2B integration model (point-to-point)

The simplest EDI topology is a permanent link between two endpoints to integrate business processes. The value of a permanent point-to-point EDI network lies in the use of EDIFACT standard business process communications between the endpoints of the two systems, whereas that of an on-demand point-to-point connection is proportional to the square of the number of connected users of the system. The business model is based on the connection between the companies and on the number of processes integrated into the systems. The integration volume can be formed as $i = n^2$, where n represents each process integration.

Hub B2B integration model (one-to-many)

A single company can establish business process connections with intermediates. Intermediates have established a network of connections, and this allows the company to perform many transactions with multiple customers via the same connections. The value of a one-to-many connection is proportional to the sum of the number of connected users of the system minus one. An intermediate's business model is based on the revenues generated through the connections, the number of processes integrated and the transactions between the systems. The integration volume can be defined as $i = \sum_{n=7}^{12} - 1$, where n represents each process integration.

Cloud B2B integration model (many-to-many)

Many-to-many communication is based on open Internet computing paradigms, meaning that companies can establish business process connections and transfer information dynamically. Companies using the open Internet protocol must agree to use the common information model in order to establish an interface for end-to-end information exchange within their systems. Software as a service (SaaS)—operated over the Internet and hosted on the cloud—has become a common delivery model for many business applications. The integration volume can be defined as $i = 1 (\sum_{n=13}^{7000})$, where n represents each process integration.

Figure 8 explains the integration models available and the dynamics of cost savings in integration

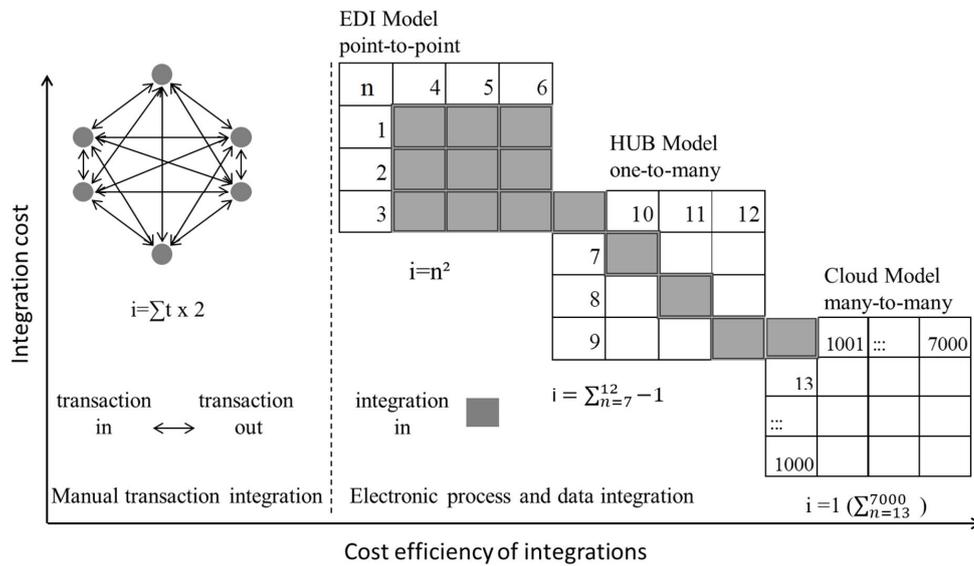


Figure 8 Integration rates for different integration models

1.5 The structure of the thesis

This thesis consists of two main parts: the overview (Part I) and the publications (Part II: See Table 4). Part I serves as an introduction to the research, describing the motivation and the potential of information logistics integration in a multi-stakeholder environment, as well as the value activities. It summarizes the theoretical background and the research approach and presents the results and conclusions. The research design was completed according to systematic combining, by delivering results as business reports to a focus group and as academic papers. In each phase, the research was redirected based on the findings and a discussion of the results. Part II comprises the five publications that aim to answer the research questions. Some key findings were left out of this thesis due to the fact that the validation process is still underway. The general conclusions of the research are based on the findings presented in these publications.

Part I: An overview of the dissertation

Introduction

Theoretical background

Research design

Review of the results

Conclusions

Part II: Publications

Publication 1. A framework for exploring digital business ecosystems

Publication 2. Assessing information logistics development in supply networks

Publication 3. A management and orchestration model for integrating digital business ecosystems

Publication 4. Supporting the integration of digital business ecosystems with real option valuation

Publication 5 Value creation through information logistics integration in the supply chain

Table 4 Outline of the thesis

|

2 THEORETICAL BACKGROUND

2.1 Theoretical framework

Information logistics integration in a Digital Business Ecosystem (DBE) is quite a novel approach and is based on economic literature as a whole. Theoretical observations can be undertaken from many perspectives. From strategic management point of view, this source could be established on the basis of the literature on competitive advantages, such as transaction cost economics (TCE), the resource-based view (RBV) and, recently, ecosystem literature. We will further focus this ecosystem literature to represent digital business ecosystem (DBE) literature, due to the speed of the digitalization of economics.

The research could also have been accomplished through topics such as data management, electronic information exchange, information processing, or knowledge from a technology perspective. However, this research defines technology as an enabler and establishes continuity to explore and build understanding regarding how information adds value to products and services delivered to customers. This information value contributes to company value activities and to profit formulation, which is based on industrial economics, as presented in Figure 9.

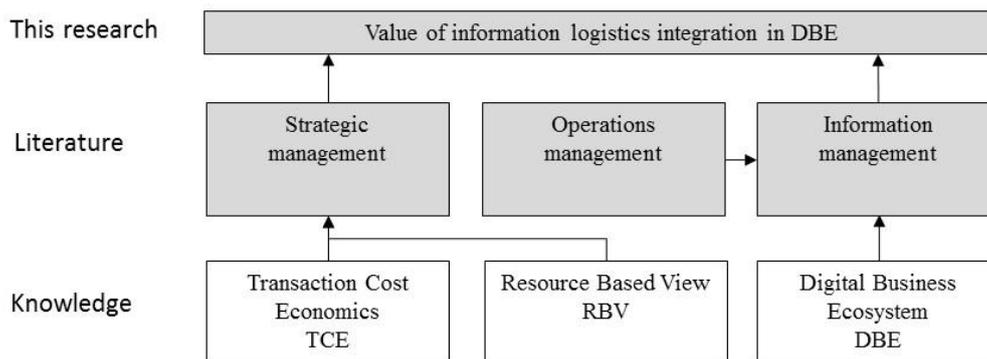


Figure 9 Positioning the research within fields of industrial economics

By studying the knowledge of transaction cost economics, we try to contribute knowledge regarding the value of integration to tangible assets, and by studying the knowledge of the resource-based view, we try to understand the kinds of core capabilities necessary to coordinate an intangible asset. A digital business ecosystem establishes the stakeholder view of network co-operation.

2.1.1 Transaction Cost Economics

Global trade is based on trade practices and business transactions, with the facilitation of technology. Companies tend to move from manual transactions towards digitalized information flows in both intra- and inter-operations. Technology gives companies the option to decrease internal management costs and increase efficiency through digitalization or to sustain competitiveness by digitalizing external networks. These intra- and inter-company relations are about decision making (e.g., “make or buy”), which is largely covered in Transaction Cost Economics (TCE).

Inter-firm relations have been analysed in depth ever since Coase’s (1937) pioneering work on transaction costs. Coase pointed out that the firm, as a production function, needs to know the cost of internal business activities and external market activities in order to conduct transactions effectively. Coase emphasized the roles of uncertainty, asset specificity and frequency in determining the effectiveness of coordinating mechanisms: hierarchy versus markets. The theory concerns the “make-or-buy” decision: whether a firm carries out business activities in-house or outsources them to the market (Williamson, 1983). When valuing and balancing this decision, firms weigh the governance costs involved in production (the “make” decision) against the market transaction costs associated with market profits (the “buy” decision). Technology focuses where a transaction occurs and when goods, services or information are transferred across activities and systems. With well-designed interfaces, the transfer occurs smoothly (Williamson, 1996).

Williamson explained that the main differences between an internal organization of transaction costs and a market-based organization comprise three basic points: 1) the market offers and operates information more effectively than an internal organization, 2) the market can offer economies of scale and 3) an internal organization has access to distinctive information (Williamson, 1996). Based on Williamson, business information can also be managed and transferred via one of two alternatives. One is traditional, manual document management/paper-based transfer, and the other is electronic, automated information management/electronic transfer. Global trade practices involve a classical selection of business processes. Electronic business process management involves end-to-end interoperability within systems, which is explained in the electronic data integration literature. In brief, the TCE perspective is that the firm economizes on transaction costs through the selection of internal governance costs for handling market transaction costs (Tsang, 2002).

Classical TCE points out three contradicting outcomes, corresponding to the ultimate purpose of exploring economic value. Electronic business process integration is often based on standards for exploring the economic scale, commonly used with strategic partners (Nurmilaakso, 2008). In the applied illustration in Figure 2, there are two fundamental nodes for information logistics integration: no standards and standard-based.

No standards – This node is not based on system interoperability (i.e., no standards/no information exchange within systems), which uses, for example, e-business solutions for general buying and market operations. This manual operation (a) is based on transactions using manual integration, and the cost of integration formula is $i = \sum t \times 2$.

Standard-based – This node involves sourcing and purchasing based on interoperable solutions (i.e., standards exist/information exchange within systems). This node can be further divided into three nodes, based on the integration model: the EDI model (b) is based on a system level, point-to-point integration, and the cost of integration formula is $i = n^2$. The HUB model (c) is based on standards, using messages (EDI or XML) and one-to-many integration, and the cost of integration

formula is $i = \sum_{n=1}^{\infty} -1$. Cloud model (d) is based on using standards, using messages (EDI or XML) and many-to-many integration, and the cost of integration formula is $i = 1 \sum_{n=1}^{\infty} -1$. The development phases are illustrated in the introduction (Figure 10).

In classical TCE, the fundamental contracting framework can be seen as an option to combine contracting power with price, and this contracting can be further improved through arrangements to use standardized business process transactions. Standards enable the establishment of fully electronic, cost-effective business process communication within IT solutions and, thus, form an interoperable system from IT solutions. The formulas for integration models clearly explain the cost efficiencies of information logistics integration.

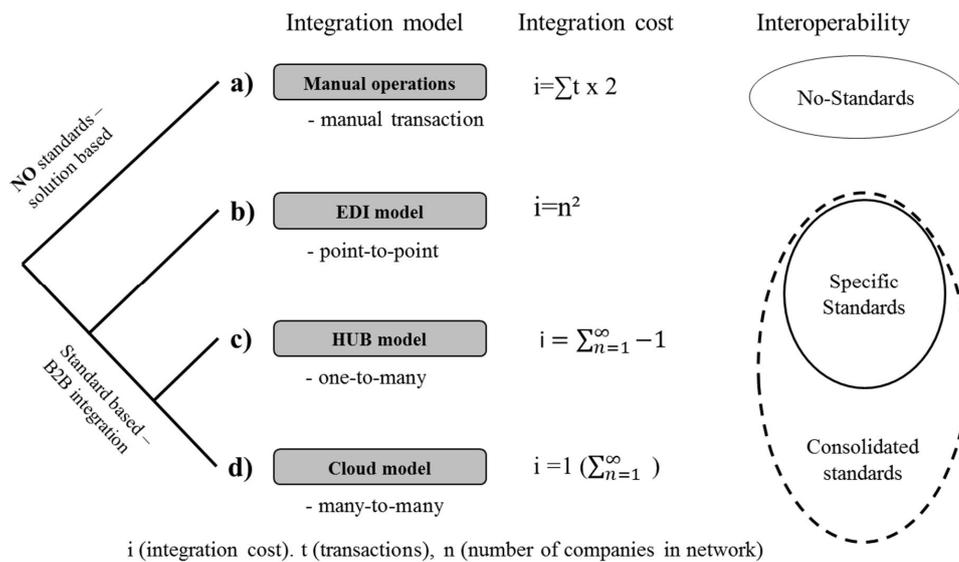


Figure 10 Applied TCE contracting framework for information logistics integration

The original TCE used the terms “internal activities” and “external market activities” (Coase, 1937). Williamson (1983) defines this as a decision by a company to make or buy, based on internal management costs (bureaucracy costs) compared to external market transaction costs (market profit). In a digital business ecosystem, we use the original thinking for intra- and inter-company activities; in other words, we use the general terms for management and production costs, divided into buyers and suppliers, to explore electronic business process communication based on transactions.

TCE considers the decision of a company to make or buy based on internal costs (IC) compared to external market costs and profit (EC). In Figure 11, the original TCE mechanism is explained and illustrated. The production unit cost (P) goes down due to economies of scale, and internal management unit costs (M) will decrease by the volume. Total internal production and management costs (T=P+M) equals a specific point (t0) within the external market costs (Williamson, 1996).

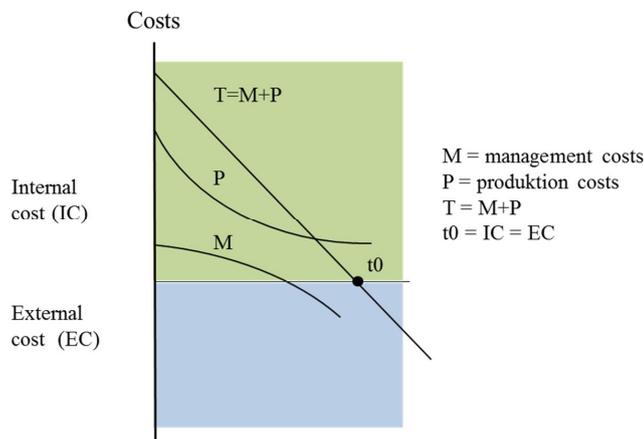


Figure 11 Classical transaction cost mechanism of governance

Considering internal business information management costs and the information exchange between organizations, electronic information integration has become the key asset governing information. Based on TCE, we are able to establish the following framework to explain the theory of DBE information logistics integration. Based on Williamson's heuristic model, we are able to explain the advantages of information logistics integration costs. Companies have the option to manage information manually or to establish electronic business process integration to optimize costs. A few decades ago, all business process information was transferred manually and managed internally.

Now, due to information logistics, business process transactions cross company borders and cause management costs for each partner involved. The total costs are divided between buyer and supplier organizations, according to the line T, and are divided at a specific point (t_0). In a business ecosystem, the total information logistics integration cost is the total unit costs of suppliers and buyers, multiplied by the total volume of transactions in the business ecosystem.

Traditionally, business transactions are operated based on manual, paper-based information transfer and management. When partners switch over to electronic transactions, often in the first phase, the ecosystem starts to improve its information integration through processes that support mainly buyer organizations (EDI 1), as described in Figure 12. The total cost can be cut according to the line EDI 1. The biggest cost savings will be gained by the buyer organizations (due to lower internal management costs), whereas the suppliers' external costs might be higher, due to the investment costs required by EDI 1 (Koch, 2013). The specific point (e_1) represents the buyer organizations' negotiation power in the ecosystem.

In the second phase, the ecosystem improves information integration through EDI 2 processes that support supplier organizations. The manual costs can be cut according to the line EDI 2. At this time, the savings are gained by the supplier organizations. The specific point (e_2) represents the supplier organizations' negotiation power in the ecosystem.

Figure 12 illustrates how temporary competitiveness can be established by cutting manual costs through EDI savings. From the previous operation level (t0), companies are able to expand their volume within the ecosystem and reach new levels (t1) of market share. The EDI 2 operations could even allow suppliers to capture bigger market shares; however, this is dependent on buyer organizations' information logistics integration costs and may lead to negotiations over the sharing of the cost savings. The market will operate over time to compensate the temporary competitiveness.

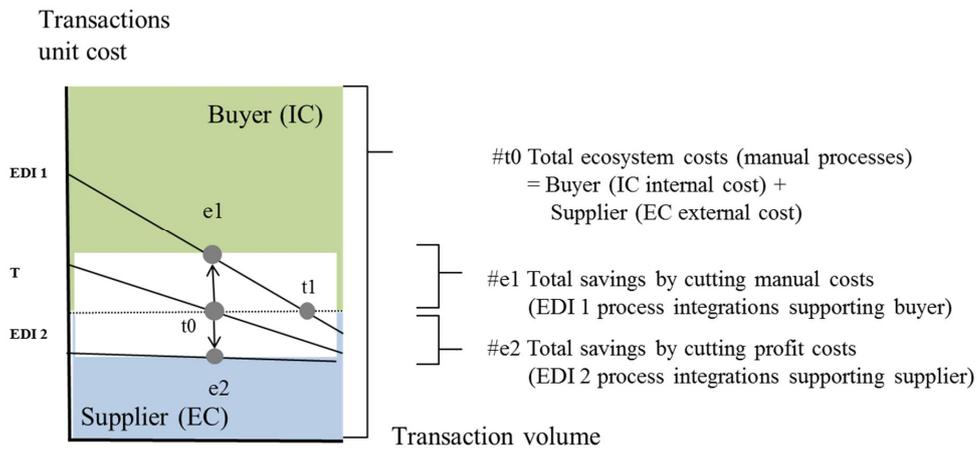


Figure 12 Maximizing the total savings by cutting the manual costs in the ecosystem

TCE theory explains the internal and external optimization of competitive advantage, but there is little literature on how the theory supports information logistics integration in a business ecosystem. An important point to note here is that the TCE framework over-emphasizes cost minimization and neglects the value creation aspect of a transaction (Tsang, 2002).

2.1.2 Resource-Based View

Management and coordination mechanisms for information integration are based on the ability to organize the best available resources, based on knowledge and capabilities, to manage internal and external network development, including value-added networks.

The resource-based view (RBV) was introduced by Wernerfelt (1984) to explain how to fill the gaps between firm resources, competitive strategy and customer value. Originally, RBV literature was concerned with questions of value appropriation and the sustainability of competitive advantage (e.g., Barney, 1991). Firms can gain and sustain competitive advantages by developing and deploying valuable resources and capabilities, which are deeply embedded in organizational routines. According to Barney (1991), a firm's resources can be classified into three categories. First are tangible assets like physical capital resources, which include technology, plants and equipment, location, access to raw materials, and related physical resources. Second are intangible assets like human capital resources, which include the training, expertise, judgment, intelligence, relationships, insights and knowledge of the members of the workforce, and organizational/social resources, which include reporting structures, formal and informal planning processes, administrative and management systems and informal relationships among groups within the firm and between a firm and its environment (Tomer, 1987; Allee, 2002).

Core capabilities of RBV explain that a firm should bundle its core resources and capabilities, own them exclusively and, in this manner, generate a unique core competence for the firm. If these practices cannot be traded or imitated, they will form economic value as competitive advantages (Dierkx & Cool, 1989). Any differences in firms' capabilities will affect their competitive advantages and indicate their strategic value to firms (Prahalad & Hamel, 1990; Barnett et al., 1994). Within an ecosystem, the core capabilities should be used across organizational limits and between partners and should coordinate information sharing to support business process development (Day, 1994).

RBV has been studied in several business sectors. In supply chain literature, supplier capabilities come from the core offering capability, the communication capability, and the operations capability. These capabilities encourage the customer to stay loyal to a firm through firm customer dependence (Scheer et al., 2010). Supply chain collaboration through business processes is essential to establish inter-organizational partnerships. In such cases, two parties can, together, produce outcomes that would not have been attainable in the absence of collaboration (Jap, 1999). In logistics management studies, the effects of logistics capabilities performance have been examined (Lai, 2004; Shang & Marlow, 2005; Sinkovics & Roath, 2004). All studies have found logistics capabilities to be significantly positively related to firm performance. When there exists a common understanding of a strategic partnership's vision, goals, tasks and processes, as well as of the nature of the other party's competencies, firms can save valuable time and effort by focusing on potential strategic outcomes.

Dynamic capabilities are an extension to the RBV literature approach (Teece, Pisano, & Shuen, 1997). They explore how valuable resource positions are built and acquired over time. Dynamic capabilities are rooted in a firm's managerial and organizational processes, such as those aimed at coordination, integration, reconfiguration or transformation (Teece et al., 1997; Eisenhardt & Martin, 2000), or in learning and knowledge sharing within a network (Lei, Hitt, & Bettis, 1996; Ritala & Hallikas, 2012). This collaboration can be further developed through electronic business process integration (Yang, 2009). Sarivastava et al. (1990) pointed out three core process capabilities to create customer value and competitiveness within a supply network: customer relationship management, product development management and supply chain management. These activities need to be executed as organizational capabilities.

RBV literature focuses predominantly on the internal resources and capabilities supporting strategy development; however, the lack of literature on RBV from an ecosystem or customer value perspective has been criticized.

2.1.3 Digital Business Ecosystem

Porter (1985) defined the business ecosystem as being made up of coevolving, interdependent and interconnected actors: customers, agents and channels, sellers of complementary products and services, suppliers and the firm itself (Porter, 1985). Power and Jerjian (2001) were against the linear way of thinking. In their book, *Ecosystem: Living the 12 Principles of Networked Business*, they state that you cannot manage a business on its own; instead, you have to manage an entire ecosystem and claim that the ecosystem constitutes an integrated electronic business. Their definition for a business ecosystem is “a system of websites occupying the world wide web, together with those aspects of the real world with which they interact” (Power and Jerjian 2001). Despite their strong emphasis on technological connectedness, they admit that becoming a networked business does not just mean getting on the Internet, but, rather, fundamentally changing everything that the company does (Power & Jerjian 2001: 289).

The business ecosystem concept was originally coined by Moore (1993). Moore defines a business ecosystem as “an economic community supported by a foundation of interacting organizations and individuals – the organisms of the business world” (Moore, 1993). The basis of a business ecosystem is formed by leadership companies—“the keystone species”—that have a strong influence on the ecosystem. Keystone companies serve as enablers that have a great impact on the whole system (Moore, 1998). This definition highlights the interactions within a business ecosystem. According to Moore, a business ecosystem is an “extended system of mutually supportive organizations; communities of customers, suppliers, lead producers, and other stakeholders, financing, trade associations, standard bodies, labour unions, governmental and quasigovernmental institutions, and other interested parties”—a definition that emphasizes decentralized decision-making and self-organization (Moore, 1993). There are three critical success factors in a business ecosystem. First, productivity is fundamental and serves as the basis for success in any kind of business. Second, any business ecosystem should be robust. This means drawing competitive advantages from many sources and having the ability to transform when the environment changes. Third, a business ecosystem should have the ability to create niches and

opportunities for new firms. This requires a change in attitudes from protectionist to cooperative (Iansiti, 2004; Gupta, 1996).

A business ecosystem, as an organizational form, is enabled by four related ideas. The first one is collaboration, or creating complementary capabilities; the second one is finding “space” for business opportunities; the third one is developing business within a space as a specific business ecosystem; and the fourth one is creating a concept for aggressive, continuous innovators. The concept of a specific business ecosystem naturally follows from the concept of a space. Within a particular space, there will be a number of critical contributions that need to be linked in order for solutions to be produced. Managers must identify these critical contributions, make preliminary distinctions about modularization and, in turn, define the initial niche contributions and contributors (Moore, 2006).

The key motivation for information logistics integration is, according to Santos and Eisenhardt (Sheddon, 2004), the efficiency required to minimize governance costs, including the costs of conducting exchanges with other ecosystem participants and within the individual organization. The capability of an organization to interact, both with the participants within its own ecosystem and with other ecosystems, is also essential. Furthermore, according to Santos and Eisenhardt (Sheddon, 2004), the five main characteristics of an ecosystem are: (a) the ability to individually assign the purpose of the ecosystem to its components (participants), (b) the interactions (among and between participants), (c) the development process within the ecosystem (influencing the on-going evolution), (d) the maturity and stability of the ecosystem and its components, and (e) the effects the ecosystem causes in terms of results, measurements, changes in size and composition.

Power and Jerjian claim that the ecosystem constitutes an integrated electronic system of businesses: “a system of websites occupying the world wide web, together with those aspects of the real world with which they interact, it is a physical community considered together with the non-living factors of its environment as a unit” (Moore, 1993). Integrated electronic business

creates truly networked business, which has fundamentally changed everything that companies do (Moore, 2004).

The complex reality of the networked environment in B2B integration cannot be analysed at the firm level, since no organization is able to coordinate the development of such a network alone. The integration of B2B processes requires active collaboration on different levels of stakeholders across organizations in the supply network, including an additional, value-creating software ecosystem (Teece, 2012). Even the big networks seek to develop and use common standards for integration. The B2B integration context actually resembles the ecological phenomenon of co-evolution, in which “all species evolve” (Moore, 1998) “in endless reciprocal cycle” (Iansiti 2004). In this research, we conceptualize such a context through the concept of the digital business ecosystem (DBE).

The digital business ecosystem (DBE) concept was established for the first time in the field of business research in the Lisbon Agenda in March 2000 (Nachira, 2002). The digital business ecosystem is a European-Union-funded environment, which provides a structure. The software coded by European SMEs function as organisms in the ecosystem. The main goal is to enhance the potential of SMEs to compete with larger software houses, a goal that was further developed by Nachira (2002; OASIS, 2012; RosettaNet, 2012). The concept of a digital business ecosystem was further developed by Nachira, Dini and Nicolai (2007). A digital business ecosystem improves upon traditional, thoroughly defined collaborative environments, such as centralized (client-server), distributed (e.g., peer-to-peer) and hybrid (e.g., web services) models and develops them further into a separate holistic model (Corallo, Caputo & Cisternino, 2007).

2.2 Value activities for information integration

In the previous section, we discovered how theories contribute to value activities. In this section, we will further explain how value activities are linked to ecosystem integration. The key strategic design element concerns how information will contribute better value to product and service

offerings to customers and how companies organize customer value delivery in an effective manner to create competitiveness. Information logistics integration is a key element in the digitalization of business information towards a real-time economy. To manage this, companies have to establish special management and coordination mechanisms across organizational borders, as illustrated in Figure 13.

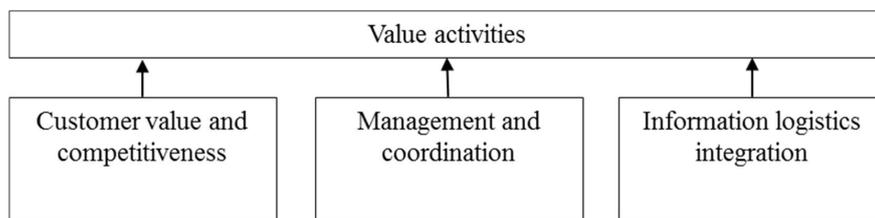


Figure 13 Value activities and common business concepts

Information logistics integration has to be aligned with the business strategy and the business model in order to address the issue of a holistic, enterprise-wide and cross-company view (Dinter, 2013). Synergies are created if the information created by one organization can be used as input for another organization, or if the network units can bundle their core competencies and, thereby, reduce costs or create added value (Laudon, 2006).

Information logistics value activities can be defined as the planning, implementation and control of the entirety of cross-unit data flows, as well as the storage and provision of such data (Dinter & Winter, 2009). Information logistics contributes to this research by modelling how information is shared through business processes and presented to stakeholders at the right time and in the right format (Hofor, 2010). Information logistics intends to explore the synergies of information sharing in a large variety of decisions across organizational boundaries (Dinter, 2013). Information logistics research is fragmented and needs to process new knowledge to this research disciplinary (Hofor, 2010). Research should establish efficient cross-organizational information flow, including the whole value chain of information, based on business process improvements (Swein et al., 2007).

The decision to invest in DBE integration has been understood to be a “now-or-never” decision for two reasons: (i) the opportunity exists only during a relatively narrow time window, since competitive advantages exist only for a relatively short time before competitors either catch up or move ahead; (ii) there is no future evaluation for what-if scenarios after the opportunity is lost. Figure 14 illustrates the DBE ecosystem development phases.

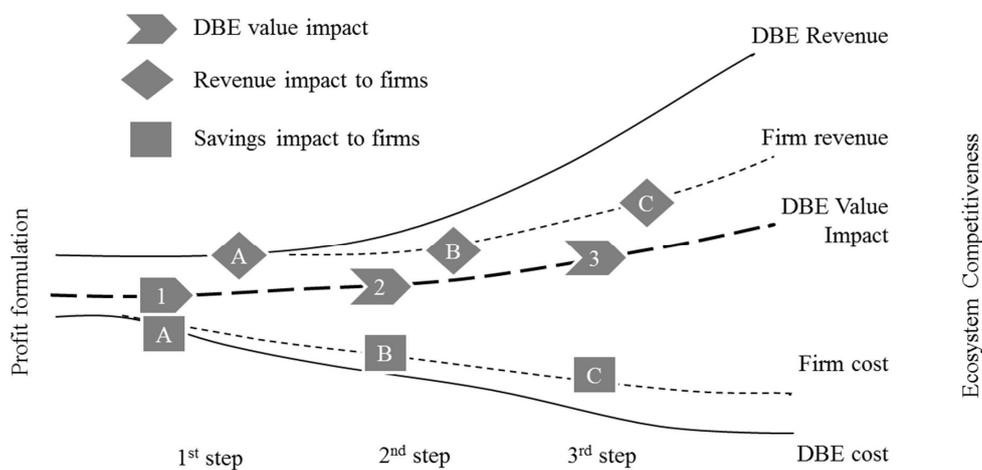


Figure 14 Example of development phases to improve competitiveness

Business value is created by firm-level revenue growth through the benefits of real-time information and new service revenues. Cost reduction can be achieved through electronic information exchange at a company level. The cap on revenue growth and cost reduction contributes to the profit increase as competitiveness grows in the ecosystem. Essential to ecosystem development is the understanding of how investments and revenues are divided among stakeholders within a given time period. The formulation of management and coordination to achieve competitive advantage is the key element in defining development phases.

2.2.1 Customer value and competitiveness

Customer value creation is essential for the existence of companies. In short, a company needs to deliver value to customers and understand its business design options, customer needs and technological possibilities (Teece, 2010). There has to be a deep understanding of how the customer is using the product or service and how information will contribute new value to the product and service, thus better solving the customer's problem. Information regarding products and services is created, stored and delivered through the business processes of downstream supplier networks, including logistics. The two basic requirements for information are quality and accessibility: delivering the right information to the right people at the right time for decision-making purposes (Dinter, 2013). Information is still produced and driven in isolated local services (Dinter, 2012) and is characterized by short-term considerations.

B2B integration has been defined by The International Centre for Competitive Excellence as “the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders” (Liu et al., 2005). In integrated processes, information gathering, sharing and exchanging among participants is essential (Gunasekaran & Ngai, 2003; La Londe & Masters, 1994).

Cost savings based on information technology enable the processing of more information with greater accuracy and frequency, as well as from more sources over the world (Neubert et al., 2004). Truly automatized information flows eliminate the need to enter data manually and, consequently, decrease human errors (La Londe & Masters, 1994). Even though B2B integration is widely identified and acknowledged as capable of building efficiency within the supply chain (e.g., Drucker, 1990; Haftor, 2011; Munoz, 2008), the interoperability of systems remains at such a low level that it causes high investment costs, and the real benefits have not been realised (Evangelista & Kilpala, 2007; Murphy & Daley, 1999). Visibility in supply chains and an accurate and real-time information flow among partners are essential for the smooth proceeding of functions and

logistics activities. Especially in logistics, which represent a connective factor along the whole supply chain, the information flow must be exact and in real time (Goswami, 2013).

The advantages of integration include increased efficiency and significant cost advantages through waste minimization. In addition, integration facilitates the development of new products and services through new ways of conducting business based on Internet workflows among organizations and individuals. Key operational business processes, such as manufacturing, purchasing, logistics and financial management, are open to observation (Nurmilaakso, 2008).

When the data are processed and communicated automatically, the speed of business interactions is increased and errors and operating costs are reduced. Thus, ICT can be used as an enabler to (re)design, manage, execute, improve and control business processes, both within and between organizations (Emery et al., 1996).

The current trend in information logistics is that of an increasingly expanding information flow (i.e., data), causing the persons in charge to collect, transfer, save and analyse information regarding the entirety of decision support initiatives in a comprehensive and superior manner. Information logistics integration speaks to the long investment cycles and infrastructure character of these projects (Dinter, 2009, 2013).

A competitiveness formulation, based on integration, can be seen as one divided into two phases: first, the integration of the supply chain, such that production and delivery become a seamless process; and second, the creation of new business models based on open systems of communication among customers, suppliers and partners (de la Fuente et al., 2010). The main motivation for global, multisite companies is having real-time information for strategic decision making at the executive level. External integration within a supply chain is driven by business managers and often started within strategic supply chain partners. The main motivation is to have real-time and error-free information to improve business performance (Vivek et al., 2011; Lee, 2004).

In the digital economy, the market values companies those are able to build competitiveness through collaboration within an ecosystem. Business networks, even among competing companies, co-operate to build system-level interoperability for information sharing and automation. The anticipated benefits of digital business ecosystems include the cost-effectiveness of services and value-creating activities, which are advantageous to many of the actors involved, including firms, their employees and consumers (Maier, Passiante & Zhang, 2011).

The enterprise architecture literature expresses the importance of including this collaboration as a fundamental criterion for sustainable business. The various benefits of ecosystem-level information logistics integration should not be underestimated. The development of information logistics is considered one of the most essential factors in increasing competitiveness (e.g., Dinter et al., 2010).

2.2.2 Management and coordination

The coordination of various actors in business ecosystems is a central task needed to ensure the achievement of ecosystem objectives (Iansiti, 2004). Oftentimes, the coordination of business ecosystems is dependent on the activities of one or several “hub actors” that aim to affect the evolution of the ecosystem in various ways (Moore, 1993; Dhanarag & Parkhe, 2006). Organizational structures should ensure effective coordination and generate synergetic effects to ensure that enterprise-wide goals are attained, consequently, in an organizational context (Dinter, 2013). In particular, the bundling of products, the combination of competencies and the integration of (e.g., customer) information necessitates data transfers between organizational units.

There are several conceptualizations of how networks and ecosystems are coordinated. In this study, following a recent study by Ritala et al. (2012), we aim to investigate network coordination mechanisms that encompass the full range of various activities, processes and resources within an ecosystem. Furthermore, network coordination is seen here to consist of two different, yet complementary mechanisms: *management* and *orchestration*. Management mechanisms can be

viewed as “coordination by commanding,” while orchestration mechanisms are considered “coordination by enabling” (Ritala et al., 2012). Therefore, management mechanisms in digital business ecosystems relate to concrete management activities in the network, such as the delegation of roles and responsibilities, scheduling and contracting throughout an ecosystem’s members. On the other hand, ecosystems are often hard to manage concretely, due to the independency of different actors and the heterogeneity in their motivations and goals (Dhanarag & Parkhe (2006). Therefore, orchestration-type coordination mechanisms are also needed. These relate to “softer” mechanisms, such as the communication of a joint vision, motivating activities and the facilitation of actors’ participation in various joint activities.

The aforementioned mechanisms of management and orchestration will be used as the basis for the analysis of coordination mechanisms in the empirical part of the study. Therefore, for the analytical purposes of this study, we divide management mechanisms into two categories, based on the existing literature on business ecosystems and their coordination (Dhanarag & Parkhe 2006; Ritala, 2009, 2012). The first category relates to *delegating* of roles and tasks to ecosystem members and setting up schedules. The second category relates to *controlling* the efficiency of various processes in the network, including those that affect supply and demand. Similarly, orchestration mechanisms are also divided into two categories. The first category includes *motivating* members to join the network, ensuring knowledge sharing and its mobility, and *communicating* vision. The second category relates to *enabling* activities that ensure the stability and longevity of the ecosystem processes and actors. All of these four categories are discussed throughout the remainder of the thesis.

Human relations approaches with the knowledge that workers are the greatest resource for controlling and improving quality and productivity, but that they lack the kind of information necessary to readily distinguish productive activity (Drucker, P. 1990). The main features regarding the management of knowledge include major systemic changes in speed, ever-shorter life cycles for products and services and new forms of co-operation between global competitors (Hitt, Ireland, Camp & Sexton, 2002). Globalization of production is distributed according to a

cost, competence and quality logic and coordinated through the use of ICT. Knowledge itself has become a key factor of production—specifically, knowledge related to identifying and exploiting new ways to establish temporary competitive advantages (von Krogh, Ichijo & Nonaka, 2000).

Managing knowledge has changed the traditional product-centric view into a customer-centric value creation view, in which innovations have an ever-important role. Value capture is seen from the supply side and value creation from the demand side. Knowledge has emerged as the most strategically important resource of a company. Knowledge-skilled workers are smoothly crossing firm boundaries, and the “not invented here” syndrome has been changed into inter-organizational co-operation within a value network.

The revolution of ICT, especially through the Internet, permits information exchange regardless of time or space constraints. The combination of increased individualism and the possibility and expectation of immediate feedback creates enormous potential for enhancing innovation and value creation, by directly connecting companies to customers’ needs (Johannessen & Olsen, 2010). Management and coordination value activities are discussed throughout the thesis, and this relates to research sub-question two: How can networks be designed (Where) and how can they involve core capabilities (Who) to manage and coordinate information logistics integration?

2.2.3 Information logistics integration

Information logistics integration is based on two main activities: i) designing the data model for information sharing at intra- and inter-organizational levels and ii) designing the process model that defines how to design business processes for where information (data) is delivered within a business network.

The International Centre for Competitive Excellence defines B2B integration as “the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders” (Liu, 2005). Information exchange and coordination within a supply chain are complex (Lambert et al., 1996) due to the

wide variety of process standards used in supply chains, the practical operational contexts within which they operate, and the complex, multi-function, multi-organization system required (Sun et al., 2009). The goal is to achieve an effective and efficient flow of products, services, financing and information for decision making and to provide value to the customer and competitiveness to the value network. Researchers have recently given a high priority to the joint improvement of inter-organizational processes of supply chains and comparative assessment measures to enable supply chains to be compared, irrespective of the contexts within which they operate (van der Vaart & van Donk , 2005).

Information logistics could also be understood from the system perspective, meaning that the whole of the supply chain forms an interoperable subsystem in which information is exchanged electronically end to end, offering the right information at the right time and in the right place, which can be analysed in line with its intended use (Dinter et al., 2010; DeLone & McLean, 1992; DeLon, 2003; DeLone, 2004). In this, ICT is typically considered an enabler in terms of (re)designing, managing, executing, improving and controlling business processes, both within and between organizations (Melao, 2009). However, according to Dinter (2012), companies are no longer primarily concerned with establishing analytical information systems; rather, they face the challenge of continuously operating and further developing these systems according to changing business requirements and the emerging potential of IT innovations. This section contributes to research sub-question one: How can information data flow be arranged (What) in business processes (How)?

The information data model is a building block for the information systems integration as a main objective to fundamentally establish the *interoperability of systems*. The interoperability of B2B integration describes the means by which automatic, inter-organizational, computer-to-computer communication is facilitated. Technical interoperability consists of a selection of communication protocols for actual data sharing, a syntax for structuring data during the exchange and a paradigm for data sharing (Ulankiewicz, 2010).

Information (data) flow is defined as the minimum set of information that needs to be transferred within a specific process and among specific supply partners. Information can be characterized by its quality and accessibility, as perceived by different stakeholders (Berentte, 2009). Business executives need real-time information for strategic planning and controlling. Business managers use a business model to design the information needed for purchasing and product management. This simulates the continuous improvement of product and service offerings and sets key performance indicators, such as delivery speed, service quality and lower stock levels (as defined in lean literature) (DeLone, 2004). ICT experts define integration as supporting real-time and error-free information flow, based on a business and information model used by standardized methods (Nurmilaakso, 2008). The information model provides an overall graphical illustration for how a wide range of activities, including material, service and logistic ordering, is designed in intra- and inter-company services, forming an interoperable system (Nurmilaakso, 2008).

This should allow separate organizations to share data and coordinate their actions expediently and efficiently (Becker, 2012). At the forefront of B2B integration are global multi-site companies, which integrate their internal business information. The main motivation is to have real-time information that facilitates strategic decision-making at the executive level. External integration within a supply chain is driven by business managers and often starts among partners in strategic supply chains. The main motivation is to have real-time and error-free information to improve business performance (Vivek et al., 2011; Lee, 2004).

The term data exchange (EDI) is often used to refer to all paperless document transfer systems. By this definition, EDI includes all the standards, messages, formats, transmissions and software systems used without the need for human interference. These should allow separate organizations to share data and coordinate their actions with expediency and efficiency (Becker, 2012; Flügge et al., 2010). The major problem arises from the different standards used by different businesses. Interoperability can be achieved by converting the messages within inter-organizational business process communications (Malhotra et al., 2007). External integration is often used with outsourced IT service providers, who are called message operators or intermediates. The need for external

integration and huge volumes of business transactions has recently raised this business to a new level.

Business rules for information logistics define the overall model for how business processes are defined, how their integration channels and interfaces are designed and how information is exchanged and delivered according to contractual terms.

Information logistics emphasises supply chain trade procedures by offering real-time information to support new customer value for products and services and better product life cycle management throughout the supply chain.

The information process model (How) concerns business process integration, which has been supported by many standardization units. For this study, we defined a common information model, using key experts from global standardization organizations, and mapped the message formats used by different standards. Figure 15 explains how processes and their relations are designed based on trade facilitation and buyer-supplier roles. Each standard uses a specific code or name for messaging (data flow) within processes. UDDI illustrates the IP addressing of a specific integration point (integration interface), by which businesses services worldwide can list themselves on the Internet.

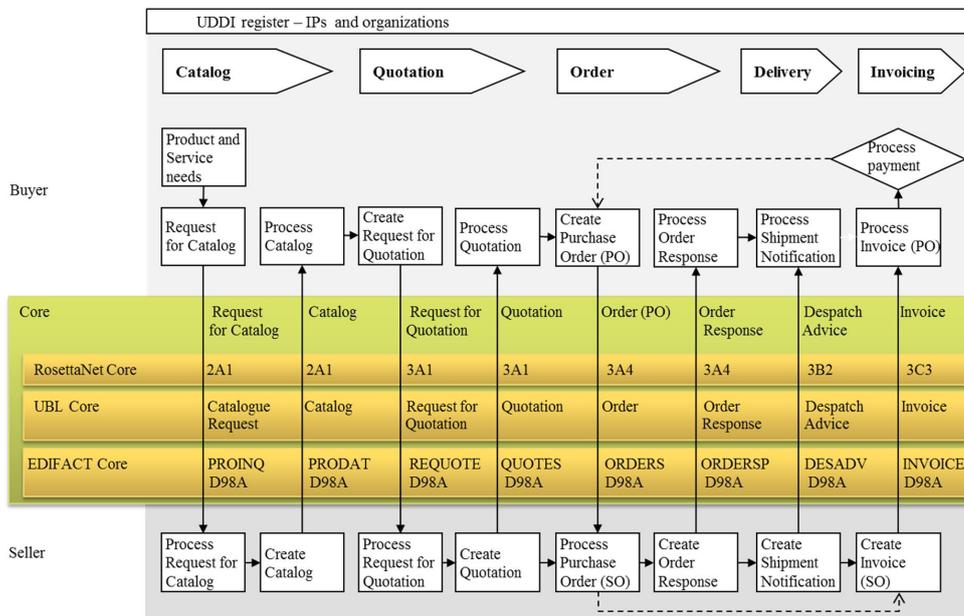


Figure 15 Example of a common information model for information logistics integration

In this study, we pay special attention to forming a framework to establish a common information model for process integration.

Information within the supply chain has become a vital element for B2B integration, performance and successful management. To enable dynamic actions and decision-making, information exchange and information quality are very important issues for coordination operations within the supply chain (Li & Lin, 2006; Fiala, 2004). Most approaches to network information focus on certain user groups or processes, without discussing the integrated network-wide information logistics (Dinter et al., 2010; La Londe & Masters, 1994). Even though B2B integration is widely acknowledged as building the efficiency of the supply chain (Croom, 2005; Closs et al., 1997), the interoperability of systems remains at a low level, and real benefits have not been realized

(Evangelista et al., 2012; Koch, 2013). Based on the literature review, more effective information exchange would have a significant effect on the broader, systematically functioning supply chain as a whole.

Companies today collaborate downstream with their customers and upstream with their strategic suppliers. The key to information value is the real-time information exchange within systems in a supply network (Berente, 2009; Davenport et al., 2004). The information is used by different stakeholders who use common business concepts to design, analyse and measure performance. Based on information logistics design, a few fundamental elements need to be added to cover the business model design phase.

Scenarios, or business process models, are based on the design of business models used with customers and supply networks. Business process integration involves defining the specific business processes used, the linkages within the processes, the minimum information (data) that has to be exchanged and the rules for how the processes and information are exchanged. Process integration is conventionally a design based on traditional global trade procedures, in which the process defines a specific trade phase and the activities involved between stakeholders. Contractually, it explains how information is exchanged and how the ownership of and responsibility for goods, services or finances are transferred to the next process phase. Enterprise Resource Planning (ERP) is commonly used for this purpose (Davenport, 2004). The ultimate purpose of ERP systems was, first, to integrate the fragmented information flow of internal integration and, then, to enable external integration within a supply network. However, due to the cost of ERP systems and the lack of system-level interoperability, the implementation of ERP systems has not solved the integration problem for SMEs (Bayraktar, 2009).

Business process standards are designed to facilitate the running of a company both internally, within the organization's operations, and externally, within the supply chain and through integration with value-adding ICT service partners. Figure 1 illustrates a generic B2B integration configured for a supply network. The design defines the overall selection of processes and how

they are related to each other, forming a core process model for B2B integration. Standards are designed with the logic of one-to-many. The core is the subset of common elements used in different standards, and it forms an interoperability within the standard of many-to-many.

The fundamental aim of information systems integration in the B2B context is interoperability, meaning the facilitation of, automatic, inter-organizational computer-to-computer communication. Technical interoperability relies on a selection of communication protocols for actual data sharing, syntax for structuring the data during the exchange process and a data-sharing paradigm (Ulanekiewicz et al., 2010).

3 RESEARCH DESIGN AND METHODOLOGY

This research is a primer in its topic, and we preferred to establish a broader research design through the selection of different methods and data collections, rather than detailing particular aspects. Since this research covers two rather new scientific disciplines—information logistics integration and digital business ecosystems—from the strategic point of view, it was obvious that special attention had to be paid to research design. We chose the case study methodology to include internal and external validity through a detailed research design (Yin; 2008). To improve the validity, we established the triangulation of evidence, data and investigator (Dubois & Araujo, 2002; Modell, 2005).

The risk of this study was also related to the extension of the two afore-mentioned research fields: information logistics integration and digital business ecosystems. We wanted to take this research challenge for many reasons: the digitalization of information is expanding rapidly; “Big Data” already exists, but the use made of it is still limited; information integration design has been implemented by several standardization organizations, but deployment remains limited; benefits have been realized in literature, but the methods to estimate economic value in business network literature are limited; and management and coordination mechanisms at both inter- and intra-organizational levels require new knowledge to reach digitalized business process penetration faster. To meet all these challenges, we established two specially funded projects, in collaboration with a large business consortium and experienced researchers, in order to work and conduct research at an operational level as well in the academic field. Much extension was undertaken to formulate the research design.

It is common practice in related research that strategic management is studied based on a stakeholder-specific view in business ecosystems, even by value add service providers (de la Fuente et al., 2010). This research has a focus on information logistics integration, and this thesis seeks to combine different perspectives on value activities and common business concepts used by different stakeholders to establish new knowledge. We wanted to extend this approach, due to

the fact that there is very little previous work available in information logistics (Dinter, 2010) and digital business ecosystem integration (Nachira & Nicolai, 2007).

This chapter describes how the research was conducted. The first section presents the hypothetic reasoning and theoretical perspectives; Sections 2 and 3 cover the research strategy; Section 4 describes the research process, research groups and data collection; and Section 5 discusses the validity and reliability of the study.

3.1 Research approach and the theoretical perspectives

Traditional philosophies suggest two opposite research management approaches: deductive and inductive (Eisenhardt, 1989; Yin, 1989). The deductive view of research relies on the relativism of a qualitative case study, which is typically used for exploring an area that has not been previously studied. The inductive view of research relies on the realism of a quantitative case study, which is an exploratory approach used to build theories (Yin, 1989). Recently, discourse about the position of *abductive* reasoning and mixed-method approaches in management research has gained attention among management scholars because of the potential of these approaches to provide more credible results through interpretation and because of the opportunity for more multi-dimension theoretical reasoning (Modell, 2010). In principal, we have used both deductive reasoning and inductive reasoning by forming a mixed-case-study research approach to formulate our research strategy.

The literature review made evident that this research has an interdisciplinary nature. The issues are multi-dimensional, and the related questions are generally asked both ontologically and epistemologically, each of which are focal concepts in the philosophy of science (Chen & Paulraj, 2003). Ontology deals with the order and structure of *reality*, whereas epistemology embodies assumptions about “how we know what we know” (Crotty, 2003), as a justification of what knowledge is (Blaikie, 1993). Järvensivu and Tömroos (2010) define social science as reflecting both subjective and objective realism. Moran (2000) defines the traditional approach as representing both positivism and phenomenology by explaining deductive and inductive

reasoning, such that the positivism approach relies on hypothesis testing from large congruent data sets and the phenomenological approach involves interpreting and understanding the phenomenon.

The research strategy was built by combining different classifications, as illustrated in Figure 16. First, we studied the hypothetic reasoning, based on the research objectives, the structure of ontological *reality* and the epistemological assumptions about “how we know what we know” (Crotty, 2003). Then, we explored whether the research relies on relativism, as a qualitative case study, or realism, as a quantitative case study (Yin, 1989). As a result of this assessment, we decided to use an abductive, mixed-case-study method (both qualitative and quantitative), in particular, from a network perspective (Järvensivu & Tömroos, 2010).

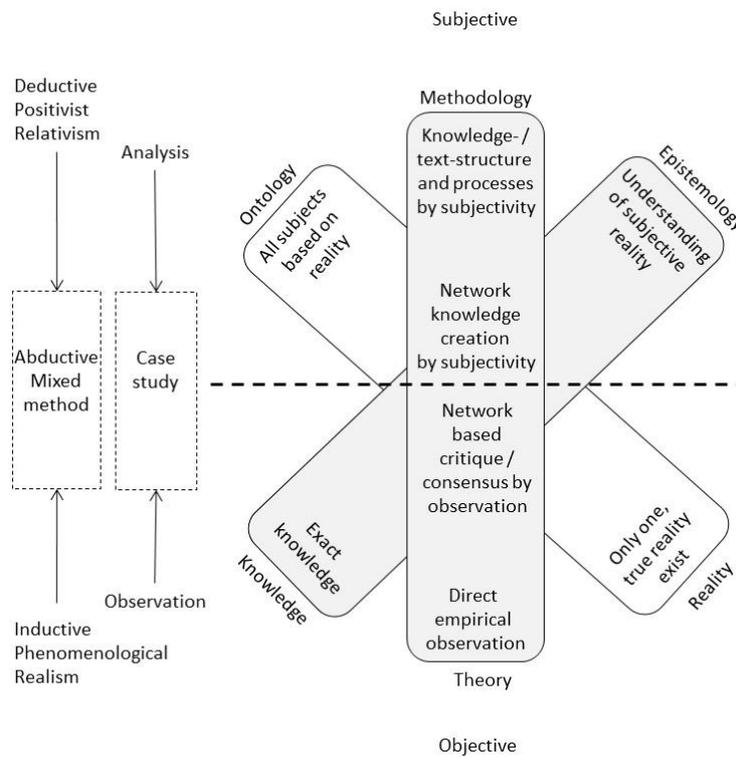


Figure 16 Hypothetic reasoning approach for case study

This combined research approach can be presented using detailed elements, thus forming a structure to design the research strategy and the process for the case study. This research structure allows the in-depth study of the processes approach for each paper and for this thesis, as illustrated in Table 5 (Dubois & Gadde, 2002; Modell, 2010; Järvensivu & Tömroos, 2010)

<i>Dimensions for research strategy</i>	Deductive	Abductive		Inductive
Research problem	Structured	Bounded		Unstructured
Paradigm	Explanatory	Approximate		Interpretive
Knowledge	Relies on existence	Refines existence		Creates new
Theoretical	Strict background	Pre-mature, pre-conceptions		Rich empirical observation
Approaches	Positivist	Mixed-method		Phenomenological
<i>Dimensions for case study</i>	Naïve realism	Critical realism	Moderate constructionism	Naïve relativism
Ontology	Only one true reality exists; universal truth claims apply	There is a reality; specific, local, contingent truth claims apply	There may be a reality; specific, local, contingent truth claims apply	There is no reality beyond subjects
Epistemology	It is possible to know exactly what this reality is through objective, empirical observations	Objective, empirical observations; truths through empirical observation, bounded by community-based critique/consensus	It is possible to understand local truths through community-based knowledge creation and empirical observations, bounded by subjectivity	It is possible to form an understanding of the subjective reality through analysis of the subject's account of knowledge
Methodology	Direct empirical observation	Empirical observations, bounded by subjectivity and community-based critique/consensus	Community-based knowledge creation through empirical observations, bounded by subjectivity	Analysis of knowledge structures and processes by observing texts
Research process	Deductive; theory testing	Objective; theory generating and testing	Subjective; theory generating and testing	Inductive; theory generating
Research data	Numeric variables	Rated numeric variables	Opinions and statements of text	Narrative text
Methods	Quantitative		Qualitative	
Paradigm assumptions	Validity		Reliability	

Table 5 The framework for the research strategy process of the case study

In this research we have used this traditional approach of mixed method for case-study. It helps to consider the relevance of the research approach and the formulation of the questions, especially in an area for which we are not able to explain the studied phenomenon based on current understanding or theories. Complex subjects, such as information logistics integration and digitalized economies, require observing an issue through multi-dimensional research approach.

3.2 Case study research

Case studies are suitable for exploring business networks and, specifically, business-to-business relationships and networks because they capture the dynamics of the studied phenomenon and provide a multi-dimensional view of the situation in a specific context (Järvensivu & Törnroos, 2010). Case studies can involve multiple views, consisting of various ontological, epistemological, and methodological premises. Over the years, there has been debate regarding realism and relativism in case studies, but now, most researchers argue in favour of ontological, epistemological and methodological pluralism (Kavanagh, 1994; Kwan & Tsang, 2001). Case study research can adopt ontologically, epistemologically and methodologically different positions, which can be placed along a continuum ranging from naïve realism to naïve relativism or from subjective relativism to objective realism.

Interpretive research has been criticised for lacking valid processes, which is considered a major weakness of the approach (e.g., Modell, 2010). According to Dubois and Cadde (2002), the problem lies in handling various research process elements and their interoperability to establish an in-depth, end-to-end understanding of knowledge production. Systematic combining is an approach to case study research advocated by Dupois and Cadde (2002).

The empirical world is considered “real life”, or reality, and we established the subset of the ‘business ecosystem’ in which the practical problem lies. *Theory* refers to the current level of scientific knowledge, which is focused in this to ‘integration knowledge’. The objective is to develop and enrich this knowledge through the *framework*, for which we design a specific ‘DBE integration framework’. *Matching* (information logistics integration) is an activity that sensors the

data to be analysed and eventually creates knowledge. This concept allows the research to choose iterative loops based on the selected methods. The *case* in the framework acts as a ‘tool’ and a ‘product’, which we have further developed in each paper as a ‘concept’ or ‘model’. The goal is to enable the researcher to understand the ‘ecosystem’ events in-depth.

Based on systematic combining that we applied, the detail framework for this research is based on four cornerstones. The business ecosystem is our case network, the concepts and modes are the research objectives, the integration knowledge represents all available knowledge and best practices and the DBE integration framework is the lens through which the research study is conducted (Figure 17).

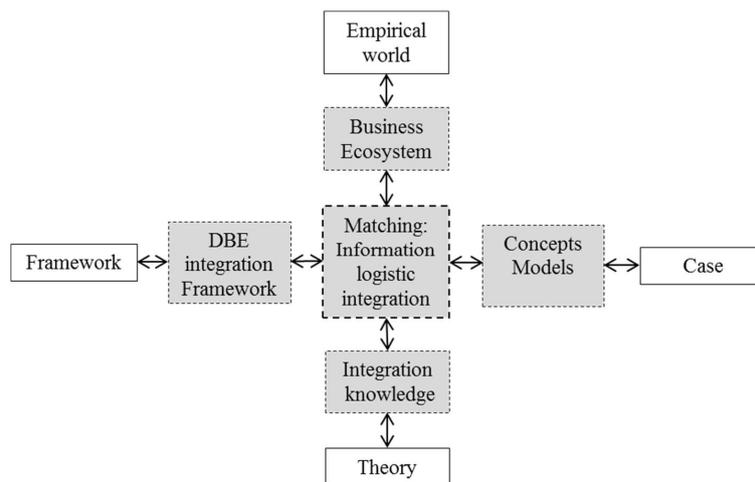


Figure 17 Systematic combining of research elements

Case study research emerges from the above-mentioned cross-contextual and inter- and intra-disciplinary research approaches. The heterogeneity of the researched phenomena—social, mental, physical, technological and other—requires different research methods for knowledge production, such as classical surveys for data collection, followed by statistical analysis (Hoftor, 2010). The

DBE integration framework and matching information logistics integration are further explained to interlink the stakeholder view with research questions and value activities. The value activity elements constitute the predominately empirical variables in the research design. Measuring the 'quality' and, therefore, the success of the actual information logistics integration strategy, the key motivation of value activity elements, does not make sense in a generic research model, since the goals of such a model are subjective (customer and organization-specific) and, thus, can only be assessed in the context of the customer or the organization. DeLone and McLeon (2003) defined the success of an information system using constructs like system quality, information quality and net benefits. These constructs were also used in an empirical investigation of the factors affecting this study. We adapted the constructs and the six critical factors—1) customer value, 2) network value and competitiveness, 3) people capabilities, 4) network collaboration, 5) processes and 6) data—as described as described in Figure 18. These value activity factors need to be linked to corresponding common business concepts used by stakeholders (e.g., strategy, operation and collaboration). The final matching needs to establish relevant case study questions, which traditionally “how?” and “what?” However, in this case study, we expand the questions to cover the overall research questions, as defined below:

Research Question: *What is the value motivation (Why) to establish B2B integration?*

Sub-Question One: *How should the information flow be arranged (What) in business processes (How)?*

Sub-Question Two: *How should the network (Where) and capabilities (Who) be designed to manage and coordinate information logistics?*

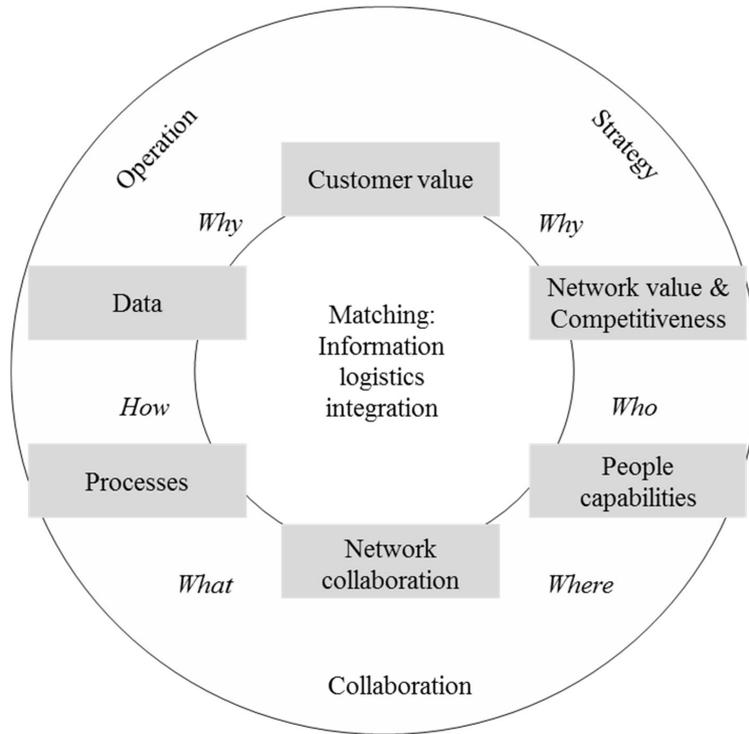


Figure 18 Research design for data variables, based on stakeholders and value activities

Finally, and as a consequence of the research structure, this research, as a whole, should produce knowledge that is descriptive and, when possible, explanatory by establishing concepts and models critical to the facilitation of knowledge production in information logistics integration.

3.3 Research process and data collection

Data Collection

For this study, we have used multidimensional methods and combined qualitative and quantitative approaches. In this section, we will present the two projects, the objectives, the design for the data collection, the establishment of the research groups and the events.

Data from two projects

The Virtual Service project was established by a large Finnish business consortium. The main objective was to define an economic value of integration and a common information model for business networks to design interoperable services. The consortium of companies operated in 36 countries, and the companies served as active partners in a global business network. These conditions formed a unique position to design research and development project settings and outcomes to fit international requirements. The Digital Service Supply Chain Financing project was a subset of the Virtual Service project. The main objective was to develop new financial services based on business transactions.

Project name	Duration	Objective	Related publication(s)
<i>Virtual Service</i> *: B2B integration in a digital business ecosystem	2011 – 2013	Design of information model based on global business process standards and concepts to speed up penetrations of business processes	Publication 1 Publication 2 Publication 3 Publication 4
<i>Digital Service Supply Chain Finance</i> *: Increasing supply chain financing based on business transactions	2012 –	Recognition of the value of the information model in forming new services based on information quality	Publication 5

Table 6 Projects and objectives for academic papers

*Author was involved as both a researcher and a project manager (Lappeenranta University of Technology 2011-2014)

Data collection process and methods used

The overall research design, process and methods used within the Expert Group and the Focus Group are explained in Figure 19.

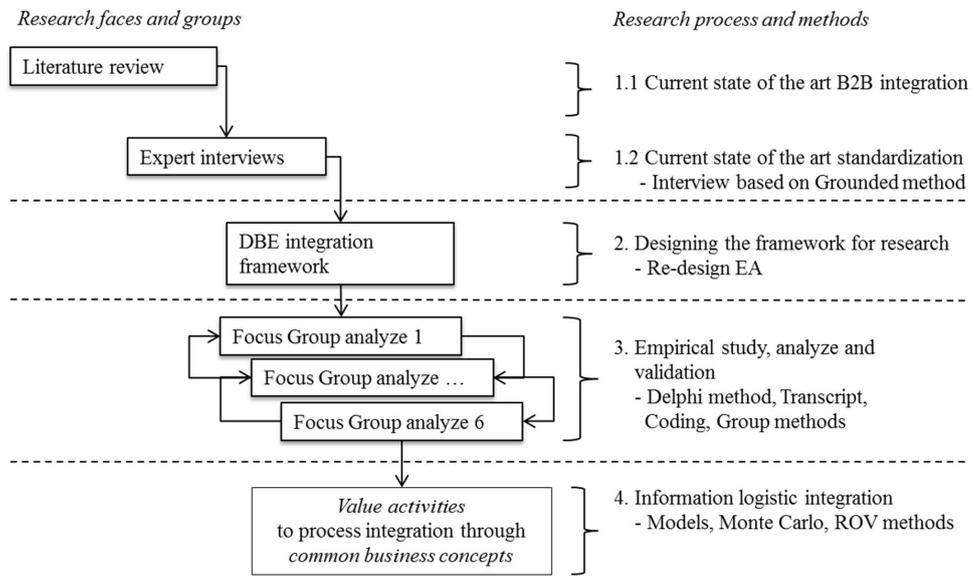


Figure 19 Research process and methods of data collection and analysis

Expert Group for knowledge-building data collection

This research combines industry, bank and IT service partners operating in 36 countries and in almost all continents. Due to the business network of international operations, it was necessary to invite representatives of an Expert Group, covering world-class experience and knowledge regarding standardization and implementation in different business domains. Global business standardization plays a key role in designing integration by defining the business process models and scenarios used and the data structures for each process. For this purpose, we formed an Expert Group of high-level standardization experts to support our research. Through the knowledge of

this expert group, the research provides answers to the research sub-questions one and two: How should information flow be arranged (What) in business processes (How)?

Virtual Service Project Expert Group (2011-2013):

Standardization unit	Country	Expert role
OASIS / UBL	USA	Founder
OASIS / UBL	Australia	Founder
RosettaNet	USA	Past Main Architecture
GS1/RosettaNet	USA	Main Architecture
GS1	USA	CEO
GS1	Europe	Director
RosettaNet	Singapore	Chair
RosettaNet Centre of Excellence	Singapore	Professor

Table 7 Expert Group of standardization units of B2B integration

Interviews and coding

Mixed-method research approaches often support in-depth interviews, which are done in sequence. For our study, we used this method specifically for the Expert Group and Focus Group interviews, which were transcribed and coded according to the DBE integration management model. The purpose of the interviews was to establish an in-depth understanding of success factors for information logistics integration and to generate a common process model for further studies. Parallel to the literature study, several iterative rounds of interviews were arranged.

During the first discussions with Expert Group members, we discovered that a gap indeed exists between the implementation knowledge regarding standards and that regarding practice in ecosystem deployment. Following open discussions during the first workshop with senior managers, we discovered that the phenomenon of standardization requires in-depth discussion.

During 2011, we held open discussions with all standardization experts; in 2012, we interviewed five experts based on open key topics/questions:

- a) What is the value of standardization?
- b) How well have your standards been implemented in business networks?
- c) Which are the main business domains, and why are these the main ones?
- d) What best practices would you recommend to business networks for implementation?

Based on this experience, we used the same method and interviewed 13 Finnish ICT companies (some of which form the Focus Group). In total, we had 18 digitally recorded interviews, which we transcribed into a written text format. We coded this documentation using the Atlas tool and Excel to explore different research aspects. Based on this work, we established several questionnaires and topics to further discuss with the Focus Group based on the Delphi method.

Focus Group for data validation using Sierra Delphi methods

The project business consortium formed the Focus Group of high-level managers and directors, representing different organizations. These stakeholders had different roles, needs and wants. Big-buyer organizations were focused on cost savings and the need to start using electronic and automated information exchange. ICT service providers, representing value-added services, were interested in developing new services and expanding revenues. Banks were invited to the consortium with the role of developing new transaction-based banking services, particularly focused on increasing financing and working capital to the supply chain. Suppliers of these big organizations represented the SME sector. This Focus Group design contributed a comprehensive representation of experts and, thus, increased the reliability and validity of the research.

Focus Group (2011-2013):

No.	Role of the company	Job title
1	Buyer	Country Manager Purchasing
2	Buyer	Head of Maintenance
3	Supplier	Service Design Manager
4	Supplier	Director of Information Management
5	Supplier	Procurement Manager
6	Supplier	Executive Director
7	Supplier	Purchasing Manager
8	Supplier	Executive Director
9	Supplier	Executive Director
10	Supplier	Head of Maintenance Support
11	Supplier	Purchasing Manager
12	Logistics service provider	Managing Director
13	IT service provider	Service Design Manager
14	IT service provider	Executive Director
15	Intermediate	Expert on Integration
16	Financing	Head of Payments Infrastructure
17	Financing	Director
18	Financing	Director

Table 8 Focus Group

The industrial Focus Group was a key partner in our research. We agreed to arrange six workshops during 2011 and 2012, involving 18 focus group partners, together with the researchers. Each workshop was well-structured and lasted four hours. It was necessary to find the best suitable methods to orchestrate discussions and to develop a common agreement for development steps. For this work, we decided to introduce the Delphi method and recent tools.

Survey: Web-based questionnaire

The survey approach refers to a group of methods that emphasize quantitative analysis, in which data for a large number of organizations are collected through questionnaires and then analysed using statistical techniques. By studying a representative sample of organizations, the survey approach seeks to discover relationships that are common across organizations and, hence, to

provide generalizable statements about the object of study. However, often, the survey approach provides only a "snapshot" of the situation at a certain point in time, yielding little information on the underlying meaning of the data. Moreover, some variables of interest to a researcher may not be measurable through this method (e.g., cross-sectional studies offer weak evidence of cause and effect) (Gable, 1994). In a mixed-method study, surveys and other case study methods compensate each other's strengths and weaknesses, as summarized by Gable and Guy (1994) in Table 9.

Relative Strengths of Case Study and Survey Methods		
	Case Study	Survey
Controllability	Low	Medium
Deductibility	Low	Medium
Repeatability	Low	Medium
Generalizability	Low	High
Discoverability (explorability)	High	Medium
Representability (potential model complexity)	High	Medium

Table 9 The relative strengths of case study and survey methods

We collected the data for our case study by establishing several surveys using web-based survey tools. The questionnaire was tested using the Delphi method in several iterative loops. This occurred in the focus group meeting and implemented a groupware tool. The final rating was done using a web-based survey tool. The answers were given by all 18 organizations in the focus group, along with their 22 suppliers, totalling 40 companies. One part of the questionnaire involved statistical information (e.g., transaction volume), and the other contained statements rated by the respondents on the Likert 7 scale.

Data collection events

These multiple data types, collected alongside the two long-lasting projects, represent different perspectives of value activities in the overall phenomenon under interest. The multiple data sources led to data triangulation, which is an appropriate method both to construct a coherent view of the

subject of study and to improve the validity of the study. The triangulation was carried out at the beginning of the study in 2011, and the data collection steps, methods, purposes and sources are defined in Table 10.

<i>Step</i>	<i>Method</i>	<i>Purpose</i>	<i>Number of sources</i>
1	Survey	Collect data on transaction volumes, frequencies and KPI for strategy and business management	40 companies; tier 0/19 and tier -1/21)
2	Expert group interviews	Identify and validate the structure of business process activities and success factors for the deployment of standards (7h digital recording)	5 key experts from standardization organizations (USA, Europe, Australia and Singapore)
3	Expert group workshops	Design the simplified data and process structure to consolidate (RosettaNet, UBL and EDIFACT) standards.	3 key experts from standardization organizations (USA, Europe and Australia)
4	Focus group workshops	Open discussion on specific topics related to articles, idea generation and priorities based on the Delphi method and the web-based tool.	6 workshops with 18 project partners; each workshop 4h (2h discussions + 2h group method session)
5	Focus group IT experts interviews	Success factors for deployment of integration (5h digital recording)	13 Finnish IT managers in service development and intermediates
6	Focus group interviews	Assess the lead-time distributions and automation rate	3 workshops, 14 experts from buyer, seller and logistics sides
7	Focus group IT experts interviews	Assess the investment model for the "EDI and HUB-operator model" of B2B integration	3 key experts from global Finnish intermediary organizations
8	Focus group interviews	Assess the investment model for the "operator model" of B2B integration	5 key experts from global intermediary organizations
9	Research group-internal development	Assess a real option model for B2B integration in a business ecosystem	4 workshops with researchers

Table 10 Data collection

Academic papers

The academic papers one through four were written during the Virtual Service project, and the last one was written during the Digital Service Supply Chain Financing project:

1. A framework for exploring digital business ecosystems,
2. Assessing information logistics development in supply networks,
3. A management and orchestration model for integrating digital business ecosystems,
4. Supporting the integration of digital business ecosystems with real option valuation,
5. The value of information logistics integration in the supply chain.

To explore contribution of the articles and conference papers to the research, each article is mapped to the DBE integration framework (Table 11). This illustration explains that the DBE framework article covers the entire framework design. The value activities have been covered in all other areas, but not particularly in data modelling. The most focus has been paid to the integration value of competitiveness, the design of business processes and network collaboration and capabilities.

Future research will cover blind spots, especially regarding customer value and technology development, including the data model.

DBE integration framework	Value activities					
	Customer value	Network value Competitiveness	Data model	Process model	Network Collaboration	People Capabilities
Common business concepts - Stakeholder						
Strategy - Executive	1,4,5	1,4,5	1	1,2,4,5	1,2,3	1,2,3
Business model - Managers	1,4,5	1,4,5	1	1,2,4,5	1,2,3	1,2,3
Information model - EA-experts	1,4,5	1,4,5	1	1,2,4,5	1,2,3	1,2,3
Standardization - Std.-experts	1,4,5	1, 4,5	1	1,2,4,5	1,2,3	1,2,3
Integration - Intermediates	1,4	1,4	1	1,2,4	1,2	1,2,3
Service portfolio - Users	1	1	1	1	1,3	1

Table 11 The explanatory power of publications to cover the DBE framework

Analysing methods

The Delphi method was developed by the RAND Corporation in the 1950s by Olaf Helmer and Norman Dalkey. This technique allows the application of expert input in a systematic manner, using a series of questionnaires with controlled opinion feedback, anonymity in the expert panel's responses and iteration of the questionnaires. A key benefit of the method is the ability of individuals to participate in group communication (Norman, 1963). The objective of the RAND Corporation was to develop a technique to obtain the most reliable consensus from a group of experts (Dalkey, 1962). While researchers have developed variations of the method since its introduction, Linstone and Turoff (Linstone, 1975) captured its common characteristics in the following description: "Delphi may be characterized as a method for structuring a group communication process; so, the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem" (Linstone, 1975). To accomplish this 'structured communication', certain aspects should be provided: some feedback of individual contributions of information and knowledge; some assessment of the group judgment or viewpoint; some opportunity for individuals to revise their views; and some degree of anonymity for individual responses (Linstone, 1975). Specific situations have included a round in which the participants meet to discuss the process and resolve any uncertainties or ambiguities in the wording of the questionnaire (Hung, 2010)

Over the past four decades, Delphi has been widely used and has been implemented as reliable technique in the domain covered by the Journal (Linstone, 2011). Recently, several software services have become available based on Delphi method; these are also offered as SaaS (Internet services). In our research, we used group method tools for our Focus Group workshops to facilitate questionnaires and to rank the priorities. These tools offered freedom for individual participants to list ideas and for the group to facilitate idea grouping and development and idea prioritization, with the comfort of anonymity. Consequently, the Delphi technique is considered by the author to be an explorative research tool (Steiner, 2008). Criticism is based on statistical and sampling

methods to support a quantitative approach. To ensure that the appropriate method is used to test the research idea regarding “information logistics integration,” for the quantitative analysis, we have used a Monte Carlo method and a Real Option Value method.

Monte Carlo methods are based on computational algorithms that rely on repeated random sampling to obtain numerical results; typically, one runs simulations many times over in order to obtain the distribution of an unknown probabilistic entity. Monte Carlo methods are mainly used in three distinct problem classes: optimization, numerical integration and the generation of draws from a probability distribution. The Monte Carlo method was invented in the late 1940s by Stanislaw Ulam, and John von Neumann programmed the Monte Carlo calculations method, which uses repeated sampling to determine the properties of some phenomenon (or behaviour) (Metropolis, 1949).

The Monte Carlo simulation is a stochastic simulation method that can be used to assess the interaction of several uncertain variables. The Monte Carlo simulation (probability simulation) is a technique used to understand the impact of forecasting models. The variables are not certain, but are, for example, based on the valuation of expertise, from which we are able to draw an estimate. However, this estimate contains some inherent uncertainty because it is an estimate of an unknown value. The key feature of a Monte Carlo simulation is that, based on how you create the ranges of estimates, the model estimates the likelihood of the resulting outcomes. In a Monte Carlo simulation, a random value is selected for each of the tasks, based on the range of estimates. The model is calculated based on this random value. The result of the model is recorded, and the process is repeated. A typical Monte Carlo simulation calculates the model hundreds or thousands of times, each time using different, randomly-selected values. The results of the simulation describe the probability of various results in the model. Like any forecasting model, the simulation will only be as good as the estimates you make. It is important for research to remark that the simulation only represents probabilities—not certainties. However, the Monte Carlo simulation is a well-known and valuable method for forecasting an unknown.

The Real Option Value method is traditionally used for investment planning. Investment decisions are usually considered to be now-or-never, which the firm can either enter into immediately or abandon forever. The decision to invest in information logistic integration has been understood to be a similar now-or-never decision for two reasons: (i) the opportunity exists only during a relatively narrow time window, since competitive advantages exist only for a relatively short time before competitors either catch up or move ahead and (ii) there is no future evaluation of what-if scenarios after the opportunity is lost.

We used the Real Option Value to build an option to work with what-if scenarios, since not investing in information logistics integration will cut off many future options for the ecosystem. The rule, derived from option pricing theory, is that we should only decide not to use resources on DBE integration now if the net present value of this action is high enough to compensate for giving up the value of waiting. Because the value of the option to wait vanishes right after we irreversibly decide to not use information logistics integration, this loss in value is actually the opportunity cost of our decision. The value of a real option has computed by Carlsson et al. (2005) and Collan (2004).

When we have the individual ROVt [scenario (i)], we can work out ecosystem development boosts by coordinating supplier-buyer scenarios. It will probably be the case that different combinations of scenarios have different boosting effects, and, as an extension, we can likely work out optimal combinations.

Facing a deferrable decision regarding investing in information logistics integration, the main question that a company needs to answer is the following: How long should we postpone the decision—up to T time periods—before making it (if it is made at all)? From the idea of real option valuation, we can develop the following decision rule for an optimal decision strategy (Benaroch & Kauffman, 2000).

The binomial model as part of ROV is a model we used for practical purposes. The binomial version of the real options model is easier to use and easier to explain in terms of the available data (which may be limited). For our case, the basic binomial setting is presented as a setting of two lattices: the underlying asset lattice and the option valuation lattice. In Figure 2, the weights u and d describe the movement of the asset value V over time, and q stands for a probability of the movement up and a $1-q$ movement down, respectively. The value of the underlying processes develops in time, according to probabilities attached to the movements q and $1-q$ and weights u and d , as described in Figure 21.

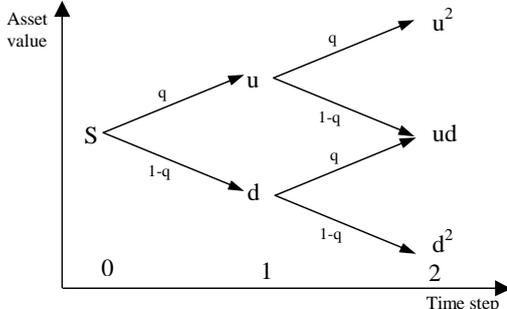


Figure 21 Underlying asset lattice of two periods

In the fuzzy real option model as part of ROV, a fuzzy number A is a fuzzy set of the real line with a normal (fuzzy) convex and continuous membership function of bounded support. Fuzzy numbers can also be considered possibility distributions (Dubois & Prade, 1988). If A is a fuzzy number and x is a real number, then $A(x)$ can be interpreted as the degree of possibility of the statement “ x is in A ”. The reasons for using fuzzy numbers are, of course, not self-evident. The imprecision we encounter when judging or estimating future outcomes of investment decisions is not, in many cases, stochastic in nature, and the use of probability theory gives us a misleading level of precision and a notion that consequences are somehow repetitive. This is not the case; the uncertainty is genuine, since we simply do not know the exact levels of future outcomes. Without introducing fuzzy numbers, it would not be possible to formulate this genuine uncertainty. Fuzzy numbers incorporate subjective judgments and statistical uncertainties, which may give managers a better understanding of the problems involved in assessing future cash flows.

In summary, the benefit of using fuzzy numbers and the fuzzy real options model—in both the Black-Scholes (Black & Scholes, 1973) and the binomial (Cox et al., 1979) versions of the real options model—is that we can represent genuine uncertainty in the estimates of future costs and savings and take these factors into consideration when we make the decision to either forget about the DBE integration or to postpone the decision by t years (or some other reasonable unit of time). The simpler, classical NPV representation does not adequately show the uncertainty.

The Pay-Off Value as part of ROV represents a recent application of the FROV: the (fuzzy) pay-off value method (POV) (cf. Collan et al., 2009; Collan & Heikkilä, 2011), which uses the modelling approach originally developed by Mathews et al. (2007). This method calculates ROV from three cash flow scenarios (CFS) given for the investment by experts. With the POV, it is possible to combine expertise in, for example, basic, optimistic and pessimistic CFS into a fuzzy cash flow and to calculate the ROV from the distribution of CFS.

The Data for this research are collected during two projects: Virtual Service (2011-2013) and Digital Service (2012-2014). For case studies, data collection may—and should—involve a broad variety of techniques, surveys, archival analyses, documentary searches and direct field observations. In fact, the more of these techniques that are used in the same study, the stronger the case study evidence will be (Yin 1994).

Publication No.	Objective	Case	Data collection	Theory connection	Applied frameworks ¹
1	Virtual Service.	DBE integration	Data from Expert Group interviews	KE	DBE integration framework
2		Success factors for integration	Expert Group interview and validation by Focus Group, Survey to 40 companies	RBV KE	Success factor
3		Success factors for integration management	Expert Group and ICT focus group interview and validation by Focus Group	RBV KE	Managing and orchestration model for integration
4		DBE real option value for integration	Intermediates interview for investment model, survey of transaction volumes, workshop for buyers, suppliers and LSP	TCE ROV	Model to use ROV theory for DBE integration based on manual and EDI integration investment model
5	Digital Services	Supply chain integration value by scenarios	Intermediates interview for investment model, survey of transaction volumes, workshop for buyers, suppliers and LSP	TCE Monte Carlo	Monte Carlo method for cost savings in LSP integration
6				TCE Monte Carlo	Monte Carlo method for cost savings in SC scenarios

¹) Theory-based tools which are applied to explain the studied phenomena

Table 12 Material collection and theory connection of the publications

3.4 The validity and reliability of the study

Validity, reliability and generalizability are considered (in modern, positivist philosophies of science) the most important hallmarks of credible scientific research (Kvale, 1995). The mixed-method approach used in qualitative and quantitative studies has various typologies of validity (e.g., Maxwell, 1992; Lather, 1993). Yin (2008) explained that, in case research, methodology validity comprises internal validity, external validity, construct validity and the research design. Construct validity can be increased through the triangulation of evidence, data and investigator (Dubois & Araujo, 2002; Modell, 2005). Gresswell and Miller (2000) suggested procedures for establishing validity through two perspectives: the lens through which the researcher chooses to validate his/her studies, and the researcher's paradigmatic assumptions. The framework they developed is further improved to locate nine different types of validity procedures within two dimensions. This study approaches validity and reliability of observation through this framework (see Table 13).

Paradigm assumption/Lens	Positivist or Systematic Paradigm	Constructivist Paradigm	Critical Paradigm
Lens of the Researcher	Triangulation	Disconfirming evidence	Researcher reflexivity
Lens of Study Participants	Member checking	Prolonged engagement in the field	Collaboration
Lens of People External to the Study	The audit trail	Thick, rich description	Peer debriefing

Table 13 Validity procedures based on the qualitative lens and paradigm assumptions (Crosswell & Miller, 2000)

Four different procedures were chosen in order to ensure the validity of the study: Triangulation (through the lens of the research), member checking and prolonged engagement in the field (through the lens of participants in study), and peer debriefing (through the lens of people external to the study).

The *triangulation* method combines different methods to provide complementary insights into the research problem (Modell, 2009). The target is to search competing explanations to the research problem from multiple perspectives when interpreting the empirical evidence (Modell, 2005, 2009).

According to Lincoln and Guba (1985), *member checking* is the most crucial technique in terms of establishing research credibility. It involves the careful arrangement of data recordings, transcription, coding, facilitations of work group sessions for discussions and validations of data. Conducting these arrangements with accuracy will enhance the credibility of the study (Cresswell & Miller, 2000).

Prolonged engagement in the field through the lens of participants expresses another validity procedure for researchers who stay in context for a prolonged period of time and, over time, solidify evidence by checking out the data and hunches and by comparing interview data with observational data. This process has to be designed in such a way as to enhance the pluralistic perspectives from participants. In this study the Expert Group interviews and transcriptions and the Focus Group participation, commentary and validation of data with analysis increased the validity and credibility of the study.

Collaboration, involving close working throughout the process, will increase credibility. Collaboration means that the participants are involved in the study as co-researchers, due to their operational experience in field. The intent of the process is to respect and support participants in a study by assuming multiple forms for the collection and analysis of data.

Peer debriefing is a peer review of the data and research process by someone who is familiar with the research phenomenon being explored. This procedure has been used over time through the process of scientific publication of articles.

4 A REVIEW OF THE RESULTS

This chapter summarizes the results of the publications of the study. The summary of each individual publication is first outlined, and, thereafter, the results of the whole study are presented based on the research framework value activities.

4.1 Positioning the publications in the research context

Each publication presents the research framework constructions based on a value activities view and on the connection to the research questions, providing a chain for reasoning. In this chapter, the position of each publication is explained in relation to the research questions, as illustrated on Table 14. The main research question has two main motivation aspects: customer value and company value of information logistics integration. This question relates to the strategic process design and knowledge. Sub-question one provides answers to the business process scenario design and the formulation of the core information that needs to be transferred in each process phase. This question relates to information management literature. Sub-question two covers the two aspects of managing and coordination mechanisms: that is, *where* and *with whom* we should establish the integration and *what kinds* of core capabilities we should combine at inter- and intra-organizational levels. This question relates to organization management.

Research questions	<i>Customer value</i>	<i>Network value Competitiveness</i>	<i>Data model</i>	<i>Process model</i>	<i>Network Collaboration</i>	<i>People Capabilities</i>
Main research question	What is the value motivation (<i>Why</i>) to establish information logistics integration?					
Sub question 1	How to arrange information flow (<i>What</i>) on business processes (<i>How</i>)?					
Sub question 2	How to design the network (<i>Where</i>) and capabilities (<i>Who</i>) to manage and coordinate information logistic?					
	<i>Why</i>	<i>Why</i>	<i>What</i>	<i>How</i>	<i>Where</i>	<i>Who</i>

Table 14 Research questions based on research framework

Publication 1 provides a new digital business ecosystem integration framework, which is used as the framework for this research and which was used and tested to explore the current ecosystem level of readiness and the caps on integration. The result explains how enterprise architecture is designed in a new way for use as a tool and a concept in digital business ecosystem development. The results apply to all of the research questions. Publication 2 provides knowledge of process priorities and the hindering factors for integration. The results apply to the main question one and to sub-question two. Publication 3 is focused on operations issues based on the management of internal organization and the orchestration of external networks. The results cover both the strategic area and the management and collaboration area, covering the main question and sub-question two. Publication 4 provides valuable information regarding how investments and cost savings should be designed when there exists a time-to-market investment aspect. The result explains that the real option value method can be used to estimate the right investment time frame. This applies to the main question of the research. Publication 5 is based on a detailed sourcing and purchasing process design for the ecosystem. Based on that design, a detailed valuation of cost savings through digitalization and automation was contributed. This publication finalizes the valuation of the main question. Both Publications 4 and 5 contribute new knowledge to strategic management. The overall research publications and their contributions to the research questions are presented in Table 15.

		Research question	Sub question 1	Sub question 2
Paper 1	A Framework for Exploring Digital Business Ecosystems	RQ	Sub-Q 1	Sub-Q 2
Paper 2	Assessing information logistics development in supply networks	RQ	Sub-Q 1	
Paper 3	A management and orchestration model for integrating Digital Business Ecosystems	RQ		Sub-Q 2
Paper 4	Supporting the Integration of Digital Business Ecosystems with Real Option Valuation	RQ	Sub-Q 1	
Paper 5	Value creation by the information logistics integration in supply chain	RQ	Sub-Q 1	

Table 15 Publications based on research questions

4.2 Publication 1: “A Framework for Exploring Digital Business Ecosystems”

Digital business ecosystems are becoming an increasingly popular concept for modelling and building distributed systems in heterogeneous, decentralized and open environments. However, traditional economic and computing theories do not focus on digital business ecosystems as a separate form of organization, and they do not provide conceptual frameworks that can be used to explore digital business ecosystems. In this paper, we present a framework for exploring digital business ecosystems developed from Zachman’s enterprise architecture. This framework serves as a structure for exploring the value network and the enterprise as part of a digital business ecosystem. This DBE integration framework should also serve as a guideline to find knowledge for the research questions:

Research Question: *What is the value motivation (Why) to establish information logistics integration?*

Sub-question 1: *How should the information flow be arranged (What) in business processes (How)?*

Sub-question 2: *How should the network (Where) and capabilities (Who) be designed to manage and coordinate information logistic?*

Enterprise architecture literature was studied for this publication to build new knowledge. Researchers have various definitions and explanations for enterprise architecture. Tang et al. (2004) provides a model for understanding enterprise architecture through the analysis of the goals, inputs and outcomes of six architecture frameworks (CADM, RM-ODP, the 4+1 View Model, TOGAF, DoDAF and the Zachman Framework). Further design is required in diverse areas of requirements modelling, network infrastructure, server configuration and middleware technologies. In the literature, there exist very few methods to design and analyse a digital business ecosystem.

Information logistics literature is related to enterprise architecture literature, and this publication builds the bridge to general strategic planning, based on common business concepts. In this publication, we use Zachman's enterprise architecture to design the DBE framework for B2B integration. The justification to develop a B2B integration framework for a digital business ecosystem arises from the following facts: Business is driven by many stakeholders using different common concepts (business elements), while enterprise architecture is mostly a model used by IT experts. However, B2B integration should be used by all stakeholders, and this specific knowledge should be included in common business elements. This study outlines the bridge between common business concepts and enterprise architecture by introducing the DBE integration framework. By using the DBE integration framework, we can design our research and estimate the maturity of a business ecosystem.

The literature review was done by the research group, and we could not find a suitable framework for exploring B2B integration in the digital business ecosystem. Therefore, the research group began the formulation of a framework using Zachman's enterprise architecture framework as a starting point. The formulated framework is based on six horizontal layers (rows) and six vertical layers (columns). Based on the literature, we developed the DBE integration model, in which horizontal layers describe the common business concepts used by stakeholders, and the vertical layers describe the value activities.

The Delphi method was used for the interviews with the Expert Group to build a questionnaire. Based on the literature and the interviews, we established the questionnaire. Each shell contains the argument that describes the integrated situation. The rating was given by the Focus Group. The questions were asked using a 7-point Likert scale. The questionnaire was tested using the Delphi method in several iterative loops in the Focus Group meetings. The final survey was done within an industry consortium of 18 buyers and their 22 suppliers. The key motivation to explore the situation in the existing digital business ecosystem was to understand the readiness and the knowledge caps of the digital business ecosystem. The respondents were executive-level managers, business-unit-level managers, and ICT service providers in the roles of buyers or sellers.

The scope of this study was to build and test the DBE integration framework. The framework serves as a logical structure for detecting, inspecting and exploring the enterprise as part of a digital business ecosystem. The results offer a network view of understanding the knowledge gaps in the ecosystem. These knowledge gaps form a potential for new innovations. The power of this DBE integration model is the ability to illustrate the maturity of B2B integration throughout the organizations and stakeholders within the DBE. The DBE integration model can serve as a tool for a better understanding of information logistics integration caps.

Further research is needed to fill these knowledge gaps in order to build end-to-end integrations in a digital business ecosystem. The sample size and the limited focus, which incorporated only one industry domain, limit the generalization of the research results. Further surveys will be undertaken, using quantitative methods and expanding the population and business domains. This extension will open new and interesting perspectives for a better understanding of this phenomenon. We also find that this framework has value in serving as a research structure.

4.3 Publication 2: “Assessing information logistics development in supply networks”

Developing deep integration of digital information logistics has become a great challenge. There is a growing need for information about this phenomenon, but only a few studies in scientific literature address it. To fill this gap, this study aims to identify and assess the key factors affecting DBE information logistics integration in terms of different business processes. This publication contributes knowledge to the research questions:

Research Question: *What is the value motivation (Why) to establish information logistics integration?*

Sub-question 1: *How should the information flow be arranged (What) in business processes (How)?*

Information logistics literature is the basis of this publication, in which we build new knowledge. Information exchange in the supply network enables dynamic actions and decision-making; moreover, information exchange and information quality are important issues for coordinating operations within supply networks (Li & Lin, 2006; Fiala, 2004). Most approaches to network information focus on certain user groups or processes, without discussing integrated, network-wide information logistics (Dinter et al., 2010; Inmon et al., 2008; Kimball, 2013). According to Dinter et al. (2010), information logistics can be defined as “the planning, implementation, and control of the entirety of cross unit data flows as well as the storage and provisioning of such data”. Information logistics should provide value to the whole network, not only through benefits, but also through cost reduction and the elimination of risks (Dinter et al., 2010). Harland et al. (2007) stated that electronic business and Internet increase the speed and complexity of supply networks. Information logistics in a supply network can be understood from the system point of view, meaning that the whole network forms an interoperable subsystem, in which information is exchanged electronically end-to-end and offers the right information at the right time and in the right place, analysed correctly for people's use (Dinter et al., 2010; DeLone & McLean, 1992; DeLone, 2003; DeLone, 2004). In doing this, ICT is typically considered an enabler to (re)design, manage, execute, improve and control business processes, both within and between organizations (Melao, 2009).

The resource-based view theory will have some new insights on the basis of this publication. Information logistics planning supports businesses achieving strategic goals in the long term by harmonizing technical solutions used in short-term business needs. Sheth (1996) lists four paradigms (global competitiveness, the TQM philosophy, industry restructuring and technology enablers) that have an enormous effect on organizational buying behaviour. These paradigms have led to global sourcing and to a shift from transactional relationships towards closer relationships in supply chains. Typical benefits of Internet-centric business models are listed by Bakos (1998) in the following: “reducing search costs by facilitating the comparison of price, products and services; reducing lead times; improving production and supply capability; managing demand; and improving the personalization and customization of product offerings”. The adoption of

applications for information logistics requires a proper understanding of the adoption readiness of companies in the supply chain. Richey et al. (2012) noted that the factors of technological readiness (e.g., personnel contact control, order accuracy and condition, information quality, order discrepancy handling and order release quantities) had a significant effect on logistics service quality. It is also necessary to turn this technological readiness into smart choices regarding process and application.

For this study, the supply network is significant, and the organizations in question operate in 36 different countries around the globe. The informants from the organizations were selected based on their responsibilities in the organizations and their knowledge of the field.

The research process was conducted in four main steps: (1) a literature review and the formulation of research support groups (by establishing an Expert Group and a Focus Group), (2) the execution of Expert Group interviews with experienced standardization experts by using the *grounded theory* to discover the current state of the art, (3) the use of a Focus Group and the *Delphi method with the support of group method tools* to find the factors hindering information logistics development, and (4) the finding and validating of key factors affecting supply network development.

Information logistics development and B2B integration are increasing in importance in many fields of business. While businesses have a clear need to move forward in developing their information exchanges, the current literature is unable to provide answers to emerging questions. This study was able to define the common business process standards used in information logistics. Based on this, the study contributes in several ways: Firstly, we analyse the current state of using electronic business processes, as well as the importance and priority of these processes for information logistics integration. Secondly, we identify and assess the hindering factors in information logistics development. The lack of a common information model and the cost of integration are the key hindering factors. Interoperable information logistics need to be designed using different standards and integrating supporting services in order to meet the needs of different stakeholders.

Finally, we presented the key success factors that should be considered in information logistics integration development. The following points were discovered as the main findings for different sectors:

- 1) *Executives* at the strategic level understand the value of real-time information, but they have not chosen their companies for integration.
- 2) *Business managers* understand the importance of real-time information for operations. B2B integration performance is not measured or communicated.
- 3) *IT experts* have been able to design an integration plan. However, the detailed practical implementation on the service portfolio level is under development.
- 4) *Process standards* are not yet in wide use, and there is a large gap in the understanding of common standards, which are not understood to speed up integration.
- 5) *Information integration* has been outsourced to intermediate services.
- 6) The lowest scores in the *service portfolio* explain that real integration has not been planned. We lack a list of interoperable services, and there are also many testing services that must be built for data and process testing.

The development of information logistics requires good collaboration and knowledge sharing between different stakeholders in supply networks. Executives and business managers have an important role in the establishment of network integration.

This study has limitations due to its qualitative and explorative nature, which should be taken into account when interpreting the results. However, we hope that the study will encourage discussion on the importance of the subject and serve as a catalyst for further studies.

4.4 Publication 3: “A management and orchestration model for integrating digital business ecosystems”

The aim of this publication is to build a coordination model for digital business ecosystem (DBE) integration and, in particular, to explore how various types of coordination mechanisms are related

to creating value for different stakeholders in this context. The results illustrate how specific coordination mechanisms, related to network management and orchestration, could be designed for DBE integration and how these could affect the success factors from the stakeholder and value-creation perspectives. Managers will be able to use the model in designing different network-coordination mechanisms to improve the implementation of B2B integration. This publication contributes knowledge to the research question:

Sub-question 2: How should the network (Where) and capabilities (Who) be designed to manage and coordinate information logistics?

The Resource-Based View is the key theory within which this publication builds knowledge. There are several conceptualizations of how networks and ecosystems are coordinated. For our purposes, network coordination comprises two different, yet complementary mechanisms: management and orchestration. Management mechanisms could be described as “coordination by commanding” and orchestration mechanisms as “coordination by enabling” (Ritala, 2012). Therefore, management mechanisms in digital business ecosystems relate to concrete management activities in the network that are related to the delegation of roles and responsibilities, scheduling, and contracting, for example, among the members. On the other hand, ecosystems may be hard to manage in reality, due to the independence of different actors and the heterogeneity in their motivations and goals (Dhanarag & Parkhe, 2006). Therefore, there is also a need for orchestration-type coordination mechanisms related to “softer” activities, such as communicating a joint vision, motivating the actors and facilitating actors’ participation in various joint activities.

Our specific focus in this paper is on digital business ecosystems, and our aim is to build a management model and to test it. We therefore need to design a framework to structure the environment in order to explore DBE integration management and orchestration.

The literature offers very few methods for designing and analysing digital business ecosystems. We used the DBE integration framework for common business elements and value activities. The focus is on the evaluation of integration maturity and supply-chain effectiveness.

The research design combines several data sources and methods. First, a coordination model is built based on existing literature, and generic success factors are identified on the basis of expert interviews. Second, the model is tested using information concerning global B2B integration, gathered from key informant focus groups. The research is based on a mixture of qualitative research methods, including interviews and Focus Group sessions. The Expert Group interviews, which represented the primary method of data collection, identified the relevant success factors affecting the management mechanisms. It was assumed that qualitative research would facilitate the in-depth and detailed study of the phenomenon, in its natural setting, in a real-life context and from the perspective of the interviewees. *Grounded Theory methods* were used for the open interviews of the Expert Group, with leaders of five experts from international standardization organizations (OASIS/UBL Australia, RosettaNet Singapore, UNCEFACT, GS1 Europe and RosettaNet US) and 13 Finnish experts in the field of B2B integration. Interviews included digital recordings and were transcribed for coding.

The coding was done based on three dimensions (stakeholder, value and management), each divided according to the DBE integration framework definitions. *Success factors* are defined in this research as statements or instructions indicating a) why value creation is important for the customer and the supply network, b) what common elements of the business architecture and stakeholders should be involved and c) how to manage the digital business ecosystem by means of efficient mechanisms. The *validation* was rated on a seven-point Likert scale by the Focus Group, with the members representing two focal hub firms, their key maintenance partners and service suppliers, seven industry partners, six industry service partners, four financial service partners and two ICT service partners. Responses were received from ten organizations.

Based on valuation and analysis, we were able to establish a maturity framework for management and orchestration. The competitive advantage can be realized by analysing the success factor potential. This potential can be defined as the cap between the current rating of a success factor and its maximum value (Likert scale 7). Maturity levels with regard to different activities are

presented and defined in four categories: 1) operations, indicating the importance of executive action to nominate and organize the key expert on integration; 2) knowledge improvement, indicating the importance of management's controlling activities to collect and share available knowledge about integration; 3) supply networking, referring to the motivating activities to work across organizations undertaken by the nominated expert, and 4) value and services, concerning the potential of service and tools development in supporting integration activities to achieve the expected value.

Our main contribution is in suggesting specific types of coordination mechanisms that facilitate the integration of digital business ecosystems. We identify mechanisms related to both management styles in organizational coordination (delegation and control, in particular) and orchestration styles in network coordination (motivation and enabling, in particular). We suggest that explicitly recognizing the nature of these different mechanisms makes the process of coordinating supply-chain and ecosystem integration much more effective. We focus on the linkages of the coordination mechanisms with both stakeholders and value activities.

Our study contributes to the existing research in providing conceptual tools for enhancing understanding of how coordination mechanisms affect stakeholders and value activities. The results also have practical value, which we discuss below.

From the managerial perspective, this study reflects the need to develop B2B integration within the global supply chain network that creates a business ecosystem. The model and method have practical applications in terms of designing, monitoring and controlling the development of heterogeneous digital business ecosystems. It seems that the biggest bottlenecks in the integration process are not technological, but, rather, business-related. The most elusive capabilities seem to be related to the valuation and service aspects of integration.

The main limitation of this study is that the focus group validation concentrated on one business domain, meaning that small- and medium-sized businesses are under-represented. Furthermore,

the informants were high-level experts and managers responsible for B2B integration in global business networks. Therefore, there may be limitations in terms of scope in the views expressed by this respondent group. A quantitative survey would facilitate an examination of the drivers of and the relationships between elements of the management and orchestration of digital business integration. Finally, the identified value activities indicate the need for further studies on the development of success factors from a user-centric perspective.

4.5 Publication 4: “Supporting the integration of digital business ecosystems with a real option valuation”

Investments in digital business ecosystems (DBE) are intended to add value through business automation and are key decisions in building up digital business-to-business (B2B) integration. Business solutions that build on automation are important sources of value in networks that promote and support business relations and transactions. Value is created through improved productivity and effectiveness when new, more efficient methods are discovered and integrated into transactions. At the same time, it is not unusual for such methods to contribute to a restructuring of business processes that will save costs, thereby creating a “win-win” effect. Real option valuation can be used to find optimal investment programs that will enable and support DBE integration. A real option model for ecosystem-level consortium investment was created and further tested on data describing cost-saving potential, for a total of 40 companies. Target time saving and estimated integration costs constituted the starting point for the calculation of fuzzy numbers for the three-year calculation period. The functioning and validity of the model is estimated, and the limitations regarding its use are discussed. This publication contributes knowledge to the research questions:

Research Question: *What is the value motivation (Why) to establish information logistics integration?*

Sub-question 1: *How should the information flow be arranged (What) in business processes (How)?*

Transaction Cost Economics theory is the basis of this publication. *Cost savings* can be accomplished by cutting the manual costs, and the DBE integration estimate is accomplished by comparing the time spent on integration on three levels: a) manual transactions, b) electronic information exchange and c) the degree of automation. *Investments* in B2B integration can be estimated through the use of different B2B integration models. The basic concept of investment cost is based on three variables: a) the integration volume, b) the total amount of process integration and c) the volume of transactions. The development of *B2B-integration models* can be categorised as follows: EDI B2B integration model (point-to-point), Hub B2B integration model (one-to-many) and Cloud B2B integration model (many-to-many).

The real option theory for DBE investment calculations in traditional investment planning and investment decisions is usually considered to be “now-or-never”, in that the firm can either enter into the investment right now or abandon it forever. The decision to invest in DBE integration has been understood to be a similar now-or-never decision for two reasons: (i) the opportunity exists only during a relatively narrow time window, since competitive advantages exist only for a relatively short time before competitors either catch up or move ahead and (ii) there is no future evaluation of what-if scenarios after the opportunity is lost.

The rule, derived from option pricing theory, is that we should only decide not to invest resources in DBE integration now if the net present value of this action is high enough to compensate for the value giving up the option to wait. Because the value of the option to wait vanishes right after we irreversibly decide to not use DBE integration, this loss in value is actually the opportunity cost of our decision. The value of a real option is computed by Carlsson et al. (2005) and Collan (2004).

The binomial model is the real options model and is easier to explain in terms of the available data. For our case, the basic binomial setting is presented as a setting of two lattices: the underlying asset lattice and the option valuation lattice.

Fuzzy number and real option modelling is a fuzzy set of the real line with a normal (fuzzy) convex and continuous membership function of bounded support. Fuzzy numbers can also be considered possibility distributions (Dubois & Prade, 1988).

Pay-Off Value (POV), a recent application of the FROV, is the (fuzzy) pay-off value method (cf. Collan et al., 2009; Collan & Heikkilä, 2011) that uses the modelling approach originally developed by Mathews et al. (2007). This method calculates the ROV from three cash flow scenarios (CFS) provided for the investment by experts. With the POV, it is possible to combine expertise in, for example, basic, optimistic and pessimistic CFS into a fuzzy cash flow and to calculate the ROV from the distribution of CFS.

Research was done in four phases to collect the data.

<i>Step</i>	<i>Method</i>	<i>Purpose</i>	<i>Number of sources</i>
1	Survey	Collect data about transaction volumes and frequencies	40
2	Expert group interviews	Identify and validate the structure of business process activities for the information model	5 key experts from standardization organizations
3	Group interviews	Assess the lead-time distributions and automation rate	2 workshops, 14 experts from both buyer and seller sides
4	Focus group interviews	Assess the investment model for the "operator model" of B2B integration	5 key experts from global intermediary organizations
5	Research group-internal development	Assess a real option model for B2B integration in a business ecosystem	4 workshops with researchers

Table 16 Data collection methods

We interviewed the major intermediate of B2B integration used by the Finnish biorefinery industry. The intermediate's business model is well-developed due to the fact that electronic

invoicing was started in 2005 and the current penetration level (2012) is over 70%. The business model is to establish interfaces with companies' ERP solutions, then transfer and validate data. Information mapping and inter-firm messaging form the core of the current business model.

As the last and fifth phase, we developed and applied real option valuation methods to analyse the collected data.

Since organizational networks have become more complicated, and especially in digital business ecosystems, disintegration is a pressing issue. This has a high impact on B2B integration management activities and requires collaboration among partners, which typically entails more information exchange. Our contribution to these issues is, in particular, to form a method to analyse investment options on the DBE level. Real option valuation is used to assess network values with real options. This paper shows how ROV (cf. Carlsson et al., 2005; Collan, 2004) can be used to analyse DBE investment options. By using the collected data, we are able to show the overall investment potential for B2B integration. The results support our assumption that real option valuation can be applied to deal with ecosystem complexity in a coherent and financially sound way. Through its ability to split investment decisions into a series of sequential sub-decisions, it offers an integrated method for prioritization among various investment paths.

According to the literature, the Hub-Buyer organizations have a key role in coordinating DBE B2B integration. They are ideally positioned to manage internal integration and to orchestrate external B2B integration. The common methods used to analyse investments on the DBE and organizational levels will help stakeholders find mutual investment models and technologies to be used for B2B integration. The results will definitely establish motivation for gross organizational co-operation to search for new solutions for automated B2B integration.

This research was executed by high-level experts and managers responsible for global business network B2B integration. However, the research was dominated by one industry domain, and, therefore, a more comprehensive study should be undertaken to cover a larger population of

business sectors. Obviously, the research will continue with this DBE and will contribute new data and research, most probably followed by excluding quantitative methods.

4.6 Publication 5: “Value creation by information logistics integration in the supply chain”

This study provides valuable knowledge regarding supply chain process integration by utilizing a suitable information model for collaboration. An information model based on the business process contains scenarios and detailed transactions for mapping and for automated information flow. In this thesis, we structure the information model needed for supply chain integration, design the structure of organizations and stakeholders to collect data for the study, and analyse the cost savings of information flows in the supply chain using the Monte Carlo simulation method. As a result, this study provides new knowledge regarding how to improve value, especially by presenting methods for analysis and by showing the results regarding the creation of cost savings in global supply chain operations. This publication contributes knowledge to the research questions:

Research Question: *What is the value motivation (Why) to establish information logistics integration?*

Sub-question 1: *How should the information flow be arranged (What) in business processes (How)?*

Transaction Cost Economics theory is the basis of this publication. Williamson explains that the main differences between market-based and internal organizations of transaction costs (i.e., information management costs) can be applied and described with the following three basic points: 1) the market offers and operates information more effectively than an internal organization, 2) the market can offer economies of scale and 3) an internal organization has access to distinctive information (Williamson, 1996). According to Williamson, business information can also be managed and transferred based on two alternatives: one is a traditional and manual document management/paper-based transfer, while the other is an electronic and automated information

management/electronic transfer. TCE theory explains the internal and external optimization of competitive advantage, but there is little literature on how the theory supports information integration in a supply chain.

The contracting framework for information logistics is based on a classical selection of business processes. Based on TCE, we defined two fundamental nodes for supply chain trade: a) purchasing that is not based on any standards, but is instead based on using an e-Business solution for general buying and market operations and b) sourcing based on standards that can be further divided into integration phases. Standards enable the establishment of cost-effective and fully electronic business process communication within IT solutions and, thus, an interoperable system.

The TCE heuristic model explains the advantage of information management costs. The total information management cost in the supply network is divided among the partners. When the supply network develops a contract to use a specific business process electronically, it creates savings by cutting the cost of the manual work involved. TCE can be leveraged to support an understanding of business process integration mechanisms and of how competitive advantages can be achieved by reducing hierarchical internal costs and external market transaction costs by combining the development efforts.

Information logistics literature is about information visibility in supply chains and an accurate and real-time information flow among partners. In integrated processes, information gathering, sharing and exchanging among the participants is essential (Gunasekaran & Ngai, 2003). Companies today are collaborating downstream with their customers and upstream with their strategic suppliers. The key to information value is real-time information exchange within the systems in a supply network (Berente, 2009; Davenport et al., 2004). The information is used by different stakeholders, who use common business concepts to design, analyse and measure performance. Based on information logistics design, a few fundamental elements need to be added to cover the business model design phase:

Scenarios, or business process models, are based on the design of business models used with customers and with the supply network. Business process integration involves defining the specific business processes used, the linkages within the processes, the minimum information (data) that has to be exchanged and the rules for the exchange of the processes and information.

Information (data) flow is defined as the minimum set of information that needs to be transferred within a specific process with specific supply partners. Information can be characterized by the quality and accessibility perceived by different stakeholders (Berentte, 2009).

Business rules for information logistics define the overall contractual model for how business processes are defined, the integration channel and interfaces are designed, and information is exchanged and delivered according to the contractual terms.

Information logistics emphasize the supply chain trade procedures by offering real-time information to support new customer value for products and services and better product life cycle management throughout the supply chain.

The research design covers the expert data collection methods related to the supply chain processes and a simulation-based application for investigating process value, using the process lead times as a measure.

The research process covers different data collection methods. We developed a survey instrument for collecting data regarding the transaction frequencies and volumes of logistics activities. For the purpose of the process selection and the mapping of the business process activities, several Expert Group interviews were organized. We also used manuals and expert knowledge from the leading standardization organizations (i.e., GS1/RosettaNet, Oasis/UBL and UN/CEFACT) in this process mapping and information model development stage. Measures of process lead-time variations and automation were also collected during the Expert Group interviews. The lead-time evaluations were made with two different groups of experts, one presenting OEMs (original

equipment manufacturers) and the other representing their suppliers (including their logistic partners). Two different focus groups provided a good source of information for simulation purposes.

A Monte Carlo simulation was selected due to the approach's applicability in analysing complex situations. The objective of the simulation study was to identify the performance potential of the supply chain processes when automation and standardized process designs were implemented for the processes. An advantage of the simulation method is obviously its ability to analyse the performance of an existing system in a cost-efficient way. We used Monte-Carlo-based simulation software to calculate the lead-time flows with variation. In the analysis, the activity lead times are modelled as triangular distributions, which are commonly used when the expert is able to evaluate the minimum, maximum and most likely value for a variable.

The simulation results showed the large potential of automation to produce financial benefits resulting from the time savings in the processes. The average hourly rate was determined according to Finnish statistics on the biorefinery industry and was estimated at 37.50 EUR/h, which is rather high in international comparison. The total potential of the supply chain integration in the study of 40 companies was 598 million euros per year. Total savings were also presented based on chosen scenarios. The largest potentials were identified in the logistics-to-invoice (mean value of 218 million euros) and order-to-invoice (mean value of 197 million euros) scenarios. These two process scenarios seemed to be the most lucrative investment areas for supply chain companies.

A large selection of business process standards and specifications are used in business environments, but due to their diversity, there has been little use for them in academic literature. This study was able to form and consolidate a common model for business processes used in a supply chain for manual and electronic processes and across the major standards. Based on this process model, the supply chain valuation created a more comprehensive and meaningful study of cost savings.

The Monte Carlo method is validated in the literature, and the tools developed based on these computational algorithms are suitable for the case study design. The overall design of this study can be repeated for various business sectors and across multiple data collections to improve the knowledge regarding this valuable research area.

The results provide a broad understanding of B2B integration and its design. B2B integration has a great impact on independent firms, strategic business partners and value-adding services. To conclude the findings of this study for business networks, we recommend searching for a common, interoperable information model for B2B integrations that will support the design of interoperable solutions and the overall interoperable system.

Large multinational companies are searching, along with their strategic partners, for new economic value based on cost savings and new revenues. This study will support future, expanded study in different business sectors and markets. A fundamental part of this business network integration development will be new service innovations and investments. Since the cost savings are obvious, it would be highly interesting to explore the needed investment costs for integration and payback time. Even a comparison of different methods, such as the real option value method, would be recommended for future studies.

5 CONCLUSIONS AND DISCUSSION

The final chapter presents the conclusions of the study. There are many methods available for assessing information logistics, digital business ecosystems and value creation. The aim of this study is to introduce the key value activities used in a multi-stakeholder environment. This combined understanding should produce new knowledge in theoretical, methodological and operational terms. The limitations are discussed, and suggestions for future research are given.

5.1 Answering the research questions

The main research aim of this study was to analyse the value of information logistics integration in digital business ecosystems. This topic includes three main questions, which can be assessed with a central statement: Companies need to create sustainable customer value through information, which needs to be delivered effectively through interoperable systems; moreover, joint management and orchestration of core capabilities need to be arranged within the business ecosystem.

The previous chapter discussed the connections of publications with the phenomenon; this chapter will further address how the specific research questions relate to the publications. Table 17 shows how the publications align with the research questions in terms of primary and secondary focus.

Research questions	Publications				
	1	2	3	4	5
1. What is the value of information logistics integration to Customer and Company to build network competitiveness? (Why)	x	x	x	X	X
2. How to arrange information data flow (What) on business processes (How)?	x	x	x	X	x
3. How to design the network (Where) and involve core capabilities (Who) to manage and coordinate information logistic integration?	X	x	X		

Table 17 The research questions and the publications

Questions:

- *What is the value of information logistics integration—of the products and services used by the customer and of the company—in building network competitiveness? (Why)*
- *What is the value to the customer and the company of information logistics integration? (Why)*
- *What is the value of information logistics integration in digital business ecosystems? (Why)*

Value:

This question is studied based on strategy management and reflects executive and managerial operations. During this research, we have studied the literature and produced new knowledge through the analysis of collected data. It is obvious that companies are moving towards a real-time economy by establishing end-to-end, digitalized business process transactions to ensure information interoperability. We also realized that the phenomenon, at its current size and complexity, exceeds the ability of individual operating actors within an ecosystem to achieve the objective without joint collaboration within the business ecosystem. The first research question seeks to build a holistic picture of the main motivations and causalities for actors to build a joint vision and goals. Referring to the literature and the research, it was stated that even the biggest organizations do not have the power, knowledge or capability to design or deploy information

logistic integration by themselves. That is why this research question is a relevant to several publications. The fourth and fifth publications focus primary on this question. The fourth publication builds a collaborative business process model for cost savings validation, whereas the fifth publication adds an investment model for real option validation. The first publication points out the question related to research framework and its components. The second publication discusses the facilitating and hindering factors, and the third publication points out the role of management and orchestration mechanisms in coordinating the motivation.

Sub-question 2: How should the information data flow be arranged (What) in business processes (How)?

This question is studied based on information management, and it reflects managerial and IT operations. The research work done for this question represented a fundamental question from the managerial perspective. That is, the two research projects with Focus Group organizations stated that the ultimate question to be solved was that of which standard on which to base B2B integration development. This statement seals in the Focus Group's understanding of standards to speed up integration in a global business environment. Although this question was discussed in all workshops and was validated and analysed in several studies, the best holistic picture is written in Publication 4, as a result of Expert Group interviews and manuscripts. Publication 5 uses the same process model but adds the investment model.

...

Sub-question 3: How should the network (Where) be designed and how should it involve core capabilities (Who) to manage and coordinate information logistics integration?

This question is studied based on operations management, and it reflects all stakeholder activities at the intra- and inter-organizational levels. The specialization of operations and the disintegration of business network collaboration are the major concerns of this study. Operation needs strongly impact management activities and the collaboration among partners, which rely on the reliable

exchange of information. This research question relates to the establishment of a network, the activities necessary to design a successful collaboration and the activities necessary to find key experts, all of which are core capabilities to form network-level collaboration. The third publication, in particular, builds the knowledge regarding success factors for management and orchestration mechanisms across organizational boundaries and uses best practice studies to find the core capabilities necessary to form network-level operations. The first article establishes the research framework by linking this question to the overall study. The second article contributes new insights regarding the hindering factors to be considered.

5.2 Contribution to the literature

Transaction cost economics build a solid ground for understanding information logistics integration and the overall study. Fundamentally, the question of this study concerns global trade practices that have long traditions and cultural nuances. The literature expresses the IT importance of solving certain barriers and changing trade procedures through digitalized information exchange. Williamson (1996) defines the simplified contracting framework based on two major options: open market operations, without contracts or safeguards, or operations based on contracts with increased safeguards. The main motivation for trade to be based on contracts is in order to build sustainable partnerships to grow competitiveness. In this study, we were able to define how integration models can be aligned to contractual frameworks. By doing this, we were able to illustrate how technology options could be analysed. This understanding establishes interesting insights into the potential of technology options. This might even lead to the use of new methods, like agent-based simulation, to produce new knowledge.

The transaction cost economics heuristic model explains the internal bureaucracy cost as compared to the market transaction cost and builds the model for understanding the “make-or-buy” reasoning. The observation was done at the firm level to achieve competitive advantages against the market. In this study, we broadened the firm-level boundaries to a network level. By doing this, we were able to define how this TCE heuristic model explains the value of information

logistics integration in a business ecosystem. The key to this new understanding is that, by expanding the integration level, the value is divided among the partners in different phases. Saving costs by cutting down manual costs through the automation of information integration will increase ecosystem competitiveness, but required investments in particular development phases might be distributed unevenly. This research was able to point out the network-level value creation mechanisms, but these mechanisms should be studied further and improved upon through new methods and analyses. In these circumstances, network-level motivation and negotiations to find win-win models come to prominence.

Regarding *strategy management*, this research has produced new knowledge and insight to imbed information logistics integration as a part of the strategy process. A strong digitalization strategy is a key asset to sustainable competitiveness and, thus, should be embedded into strategy management activities at a company and network level.

The resource-based view is concerned with value appropriation and the sustainability of competitive advantage. This view was introduced to explain how to fill the gap between firm resources, competitive strategy and customer value (e.g., Wernerfelt, 1984; Barney, 1991). Originally, RBV literature was concerned with questions of value appropriation and the sustainability of competitive advantage (e.g., Barney, 1991). Human capital as an organization and social resources should be understood widely within the firm and between the firm and its environment (Allee, 2002). Previous literature expresses that the unique human resources of a firm should bundle the core resources and capabilities and own them exclusively. If these practices cannot be traded or imitated, they will form economic value as a competitive advantage (Dierckx & Cool, 1989). Current literature emphasises core capabilities, which should be used between partners across organizational limits, and the coordination of information sharing to support business process development at a network level (Prahalad & Hamel, 1990; Day, 1994).

In our research, we studied and analysed an Expert Group and a Focus Group. Based on that knowledge, we emphasize that the core capabilities should be used at a network level to build

competitiveness. These core capabilities should be formed as key resources to produce joint efforts and common goals for information logistics integration development. Furthermore, we define a DBE integration management and orchestration model. While testing the model, we identify mechanisms related to the management style of network coordination and, in particular, delegation and control. We also identify mechanisms related to the orchestration styles of coordination, motivation and enabling, in particular. We suggest that, through the process of explicitly recognizing the nature of these different mechanisms, the process of coordinating supply chain and ecosystem integration becomes much more effective. These issues have been pointed out in recent research on supply chain integration (Ritala, 2012). Current literature includes perspectives related to just such a coordination of supply chain integration.

Our research aim was to build competitive advantage through information logistics integration to support a real-time economy. The presented maturity-based framework for B2B integration provides practical examples and tools for the identification and assessment of the success factors (the need aspect) behind the integration, as well as the capabilities (the infrastructure aspect) required for building an integrated supply chain structure.

Operations management is concerned with designing and controlling the process of production and with redesigning business operations in the production of goods or services. Optimizing business operations in a global business network requires operations management to involve inter- and intra-organizational coordination mechanisms. We conceptualize how networks and ecosystems are coordinated. In this study, management mechanisms can be viewed as “coordination by commanding” and orchestration mechanisms as “coordination by enabling” (Ritala, 2012). Therefore, management mechanisms in digital business ecosystems relate to concrete management activities in the network, related, for example, to the delegation of roles and responsibilities, scheduling and contracting throughout the ecosystem members. On the other hand, ecosystems are often hard to manage concretely, due to the independency of different actors and the heterogeneity in their motivations and goals (Dhanarag & Parkhe, 2006). Therefore, orchestration-type coordination mechanisms are also needed. These relate to “softer” mechanisms,

related to, for example, the communication of a joint vision, motivating activities, and the facilitation of actors' participation in various joint activities.

The digital business ecosystem concept was established for the first time in the field of business research in the Lisbon Agenda in March 2000 (Corallo et al., 2007) and was further developed by Nachira (2002; Nachira & Nicolai, 2007). A digital business ecosystem improves upon traditional collaborative environments, such as centralized models (such as client-server models), distributed models (such as peer-to-peer models), and hybrid models (such as web services) and develops them further into its own, holistic model (Corallo et al., 2007). Digital business ecosystems include the benefits and cost-effectiveness of services and value-creating activities, which are advantageous to many actors in the ecosystem, including firms, their employees and their consumers (Maier et al., 2011). Santos and Eisenhardt (2005) stress the efficiency required to minimise governance costs, including the costs of conducting exchanges with other ecosystem participants and with participants within the organization. The integration of B2B processes requires active collaboration from different levels of stakeholders across organizations in the supply network, including an additional value-creating software ecosystem (Jansen & Cusumano, 2012). In our research, we utilize several concepts and models for the digital business ecosystem (DBE), such as the framework for DBE integration, the management and orchestration maturity model for DBE, the integration model and the consolidated information logistics integration data and process model. These results relate to and conceptualize the digital business ecosystem value activities, but they are more specifically discussed in other sections as conclusions.

Information management refers to the collection and management of information from one or more sources, as well as the distribution of that information to one or more audiences. In a business network, it can be defined as the integration of key business processes, from the end-user through the original suppliers, which provide the products, services and information that add value for customers and other stakeholders (e.g., The International Centre for Competitive Excellence, Liu, 2005). Information exchange and coordination within a supply chain are complex (Lambert et al., 1996), due to the wide variety of process standards used in supply chains, the practical operational

contexts within which they operate, and the complex and multi-function multi-organization required (Sun et al., 2009). The goal is to achieve an effective and efficient flow of products, services, financing and information for decision making and to provide value to the customer and competitiveness to the value network.

Our studies were able to explain information logistics integration based on the data model, the process model, and the business process scenarios defined by the Expert Group of members of key standardization units. The data model is presented only at the message level, due to the fact that the validation is still under process and, thus, will not be included in this thesis in its data element level. However, the model has been used in several publications, and the results were appreciated by academics in peer review processes. The contribution to academia is the improved general understanding of business process integration, which can be used for future studies.

5.3 Methodological contribution

This study illustrates how information logistics integration improves value and how we can improve ecosystem interoperability through management and orchestration. The Focus Group participants had a clear understanding that interoperability can be achieved only by close cooperation with partners and even competitors. We also demonstrated how information logistics integration is built based on business process transactions and related data, end-to-end electronically, and how these will build the backbone of the system-level interoperability. This enables companies to step towards a real-time economy and to create competitive advantages.

Strategic research design held a key role in the establishment of a meaningful research project. This research was able to achieve some fundamental results in the complex reality of a digitalized economy. Base on ontology, we called into question whether the vision of the digitalized economy will be based on a reality in which all service providers have the freedom to design their IT systems without considering the realities of interoperability. Interoperability was discussed in an open manner during the workshops by trying to understand the complexity of technology networks,

“Big Data” problems, Internet of Things (“IoT”) connectivity aspects and system or transaction interoperability. The study explains that this phenomenon will not have only one reality in the context of digitalization; neither will it be that all developed systems could operate in isolated silos.

The establishment of these two projects was based on the epistemological questions: Do we have objective, exact knowledge, or do we even have an understanding of the subjective reality? During the literature review, we discovered that the knowledge is fragmented in different academic fields and that the power of this knowledge was limited to explaining the phenomenon. We were able to find some subjective best practice cases, in which various methods were introduced. It became clear that our research strategy should be based on a case study methodology.

The case study approach was chosen for the detailed research design. The establishment of the Expert Group gave us access to the ultimate best knowledge in the practice field of standardization, and the Focus Group gave the research an environment of discussion and validation. Through this arrangement, we were able to focus on an explorative “network“ case study methodology. For the knowledge matching, we established a systematic framework, which included the first publication, in which we designed the digital business ecosystem integration framework. The systematic framework provided us the ability to direct and re-direct research data within different methods. Value activities formed the data collection method that guided us to contribute new and meaningful knowledge to the existing academic knowledge.

The research process was combined into a business project plan and a process. The case study approach with a proper research design gave us good experience in combining different methods and contributing results in an effective and iterative manner. The triangulation of the paradigm assumption, through the lenses of researchers, participants and academic evaluators, improved the validity and reliability of the research. During the research project, we developed several tools and concepts for development, as listed in Table 18.

Table 18 Methodological contribution

Tool/concept/framework	Research objective	Practitioner objective for validation
DBE integration framework	Structure to design the research architecture	Finding the business ecosystem's readiness for integration
DBE integration framework for coding	Structure for coding of the interviews	Structuring the management component and core capabilities relevant to the business ecosystem
DBE maturity framework	Explains management and orchestration maturity based on success factors	Finding the priorities of management mechanisms and current caps
Integration model	Explains the technology options-based integration effectiveness	Strategy development for integration
Integration process model and scenarios	Explains the global trade business processes and their inter-relations	Gives business a common understanding of business processes and an option for scenario development

5.4 Managerial implications

Strategy management for practitioners involves on-going, large activities at a company and a network level. This research was able to structure the digital business ecosystem integration into six horizontal elements of common business concepts used by stakeholders and six value activities in order to build the understanding of information logistics integration. Based on this model, we

were able to analyse and identify the current level of knowledge and service readiness for integration. The model explains the stakeholder and value view and points out development caps. A Focus Group was formed, including companies and key managers in the field of global sourcing and purchasing. Their interest lay in finding economical savings based on digitalization. We formed two studies to collect data for the manual work involved in the current phase and estimated how the savings would be contributed in different business process scenarios. A Monte Carlo Simulation was used for ecosystem-level cost savings calculations and the Real Option Value method was used to add the investment model to the development phases. The results gave Focus Group practitioners the motivation and the tools to understand development activities.

Customer value and network competitiveness are two main value activities. The first, customer value, responds to the question regarding how real-time information adds value to product and service offerings. The second concerns how profit is formulated in business networks by increasing revenues or cutting costs. However, at the ecosystem level, we need to observe these questions and activities in parallel, since the roles of the companies and customers might change during value delivery, and since the ultimate purpose was to establish win-win models. This research was able to present valuable methods and practical tools to evaluate reliable results in the field of information logistics integration. These well-tested methods (e.g., Monte Carlo and Real Option Value methods) were previously used in other business sectors.

Information management is a key motivation in global trade to develop and implement electronic invoicing integration. The benefits have been generally understood, and the shift from manual, paper-based processing to electronic and automated invoicing processing is increasing throughout the global market. This shift's potential and impact are explained in the first section as the introduction. XML-based electronic transactions for invoicing were started in 2005 by the Focus Group involved in this study, and the penetration of electronic invoicing is at a high level. This research was able to present a consolidated process model based on global standards. This particular work enabled the design of the research in business in an accurate manner, as well as the contribution of reliable results.

Information logistics integration is realized during this research as representing concrete technology options to establish business process integration. It offers practitioners business process scenarios to design development steps in sequence and to generate new business models for ecosystem development.

Operations management is well studied in the literature and offers various tools and methods to develop and control business operations. These activities are carried out and applied based on best practices in different business sectors. This research paid special interest to the management and coordination mechanisms in business networks by designing a maturity model based on success factors.

The digital business ecosystem integration management and orchestration model identifies the management gaps in integration activities. This model will help businesses understand the stage that they are in at the present and will provide insight into action points to help businesses further their progress in information logistics integration. Based on our study, the biggest bottlenecks in the integration do not seem to be technological; rather, they are business-related issues. The capabilities that are the most difficult to achieve seem to be related to the valuation and service aspects of the integration.

5.5 Limitations and suggestions for further research

The choice of an explorative case study as the research approach was appropriate, given the knowledge fragmentation, technology complexity, heterogeneous stakeholder environment and multi-task value activities, which all imply a field that is still developing in many ways. However, we have to face the inherent limitations of an explorative case study, which should be taken into account. In the following section, we will discuss in parallel the limitations of this research and pathways for future research.

The research strategy was chosen as the case study method, which has been criticized for providing little basis for scientific generalization (Yin, 1994). In the present study, the Expert Group included five high-level experts, and the Focus Group included 18 experienced managers, representing practical experience. Thus, in total, 23 key persons were involved in the research. There were several interviews within the Expert Group and six workshops with the Focus Group based on cases. The Eisenhardt (1989) recommendation is to include between four and ten cases in order to improve knowledge generation. Increasing the number of cases and choosing the proper methods (e.g., Delphi) is believed to improve generalizability (e.g., Lovelock & Gummesson, 2004). However, the small- and medium-sized companies' involvement should be recognised to better enrich the data through comprehensive study, arranged in different geographical and business domain locations. These studies should be done using quantitative methods to improve generalization.

The research process was executed by a structured data collection, based on value activities and cases that were studied in an iterative manner by choosing different methods for analysis. We could argue that the research was able to produce a reliable subjective reality and observations linked to current knowledge of theories. The theoretical limitations of the study are related to the scope of the research. The research was able to explain the economic value of business ecosystem; however, the real-time data regarding improving customer value was mainly explained through economic value. To cover all the benefits of real-time economics, we need future research.

Academic papers contributed new knowledge, tools and concepts to cover the research question design based on the framework. Through the results of each paper, we identified the cap of understanding or knowledge needed. Information technologies are developed by experts and often explained to other experts in the field. The results of this study included the generalization of data and a process structure that allowed other business experts to join in the development of information logistics integration. This work should be further studied and should simplify technology development in a user-centric manner.

REFERENCES

Allee, V. 2000, "Reconfiguring the value network", *Journal of Business Strategy*, vol. 21, no. 4, pp. 36-39.

Amit, R. & Schoemaker, P.J. 1993, "Strategic assets and organizational rent", *Strategic Management Journal*, vol. 14, no. 1, pp. 33-46.

Ansoff, H. I. 1965, "Corporate strategy: An analytical approach to business policy for growth and expansion", New York: McGraw-Hill.

Bakos, Y. 1998, "The emerging role of electronic marketplaces on the Internet", *Communications of the ACM*, vol. 41, no. 8, pp. 35-42.

Barney, J. 1991, "Firm resources and sustained competitive advantage", *Journal of Management*, vol. 17, no. 1, pp. 99-120.

Bayraktar, E., Demirbag, M., Koh, S.C.L., Tatoglu, E. & Zaim, H. 2009, "A causal analysis of the impact of information systems and supply chain management practices on operational performance: Evidence from manufacturing SMEs in Turkey", *International Journal of Production Economics*, vol. 122, no. 1, pp. 133-149.

Becker, M. 2012, "Electronic Data Interchange (EDI) (Interoperability Case Study)", Berkman Center Research Publication, no. 2012-5.

Benaroch, M. 2000, "Justifying electronic banking network expansion using real options analysis", *MIS Quarterly*, vol. 24, no. 2, pp. 197-225.

Berente, N., Vandenbosch, B. & Aubert, B. 2009, "Information flows and business process integration", *Business Process Management Journal*, vol. 15, no. 1, pp. 119-141.

Berente, N. 2009, "Information flows and business process integration", *Business Process Management Journal*, vol. 15, no. 1, pp. 119-141.

Bharadwaj, A., El Sawy, O.A., Pavlou, P.A. & Venkatraman, N. 2013, "Digital business strategy: Toward a next generation of insights", *MIS Quarterly*, vol. 37, no. 2, pp. 471-482.

Black, F. & Scholes, M. 1973, "The pricing of options and corporate liabilities", *The Journal of Political Economy*, 1973, pp. 637-654.

Brynjolfsson, E. & McAfee, A. 2014, *The second machine age: Work, progress, and prosperity in a time of brilliant technologies*, WW Norton & Company.

Carlsson, C. 2007, "A fuzzy approach to R&D project portfolio selection", *International Journal of Approximate Reasoning*, vol. 44, no. 2, pp. 93-105.

Chen, H., Daugherty, P.J. & Landry, T.D. 2009, "Supply chain process integration: A theoretical framework", *Journal of Business Logistics*, vol. 30, no. 2, pp. 27-46.

Chen, I.J. & Paulraj, A. 2004, "Understanding supply chain management: Critical research and a theoretical framework", *International Journal of Production Research*, vol. 42, no. 1, pp. 131-163.

Coase, R.H. 1937, "The nature of the firm", *Economica*, vol. 4, no. 16, pp. 386-405.

Collan, M. 2004, "Giga-investments: Modelling the valuation of very large industrial real investments". Ph.D. thesis, Turku Centre for Computer Science, Turku, Finland, 2004.

Collan, M., Fullér, R. & Mezei, J. 2009, "A fuzzy pay-off method for real option valuation", *Journal of Applied Mathematics and Decision Systems*, 2009.

Collan, M. & Heikkilä, M. 2011, "Enhancing patent valuation with the pay-off method", *Journal of Intellectual Property Rights*, vol. 16, no. 5, pp. 377-384.

Conner, K.R. & Prahalad, C.K. 1996, "A resource-based theory of the firm: Knowledge versus opportunism", *Organization Science*, vol. 7, no. 5, pp. 477-501.

Cooper, D.P. & Tracey, M. 2005, "Supply chain integration via information technology: Strategic implications and future trends", *International Journal of Integrated Supply Management*, vol. 1, no. 3, pp. 237-257.

Corallo, A., Caputo, E. & Cisternino, V. 2007, "Business modelling language: A framework supporting interoperability in cluster of SMEs", *Digital EcoSystems and Technologies Conference, 2007. DEST'07. Inaugural IEEE-IESIEEE, 2007*, pp. 107.

Cox, J.C., Ross, S.A. & Rubinstein, M. 1979, "Option pricing: A simplified approach", *Journal of Financial Economics*, vol. 7, no. 3, pp. 229-263.

Creswell, J.W. & Miller, D.L. 2000, "Determining validity in qualitative inquiry", *Theory into Practice*, vol. 39, no. 3, pp. 124-130.

Crotty, M. 1998, *The foundations of social research: Meaning and perspective in the research process*, Sage.

Dalkey, N. 1963, "An experimental application of the Delphi method to the use of experts", *Management Science (pre-1986)*, vol. 9, no. 3, pp. 458.

Daugherty, P.J. 2006, "Is collaboration paying off for firms?", *Business Horizons*, vol. 49, no. 1, pp. 61-70.

Davenport, T.H., Harris, J.G. & Cantrell, S. 2004, "Enterprise systems and ongoing process change", *Business Process Management Journal*, vol. 10, no. 1, pp. 16-26.

Day, G.S. 1994, "The capabilities of market-driven organizations", *The Journal of Marketing*, 1994, pp. 37-52.

de la Fuente, M.V., Ros, L. & Ortiz, A. 2010, "Enterprise modelling methodology for forward and reverse supply chain flows integration", *Computers in Industry*, vol. 61, no. 7, pp. 702-710.

DeLone, W.H. 2004, "Measuring e-commerce success: Applying the DeLone & McLean information systems success model", *International Journal of Electronic Commerce*, vol. 9, no. 1, pp. 31-47.

DeLone, W.H. 2003, "The DeLone and McLean model of information systems success: A ten-year update", *Journal of Management Information Systems*, vol. 19, no. 4, pp. 9-30.

Dhanarag, C. & Parkhe, A. 2006, "Orchestrating innovation networks", *Academy of Management Review*, vol. 31, no. 3, pp. 659-669.

Dierickx, I. & Cool, K. 1989, "Asset stock accumulation and sustainability of competitive advantage", *Management Science*, vol. 35, no. 12, pp. 1504-1511.

Dinter, B., Lahrmann, G. & Winter, R. 2010, "Information logistics as a conceptual foundation for enterprise-wide decision support", *Journal of Decision Systems*, vol. 19, no. 2, pp. 175-200.

Drucker, P.F. 1990, "The emerging theory of manufacturing", *Harvard Business Review*, vol. 68, no. 3, pp. 94-102.

Dubois, A. & Gadde, L. 2002, "Systematic combining: An abductive approach to case research", *Journal of Business Research*, vol. 55, no. 7, pp. 553-560.

Dubois, D. & Prade, H. 1988, Possibility theory, Springer.

Eisenhardt, K.M. 1989, "Building theories from case study research", *Academy of Management Review*, vol. 14, no. 4, pp. 532-550.

Eisenhardt, K.M. & Schoonhoven, C.B. 1996, "Resource-based view of strategic alliance formation: Strategic and social effects in entrepreneurial firms", *Organization Science*, vol. 7, no. 2, pp. 136-150.

Emery, C.R., Summers, T.P. & Surak, J.G. 1996, "The role of organizational climate in the implementation of total quality management", *Journal of Managerial Issues* 1996, pp. 484-496.

Evangelista, P. & Kilpala, H. 2007, "The perception on ICT use among small logistics service providers: a comparison between Northern and Southern Europe", 2007.

Fiala, P. 2005, "Information sharing in supply chains", *Omega*, vol. 33, no. 5, pp. 419-423.

Flügge, B., Schmidt, A., Raus, M. & Vogel, T. 2010, "Standardised data models", *Accelerating Global Supply Chains with IT-Innovation*. 2011, pp. 175-201.

Geary, S., Childerhouse, P. & Towill, D.R. 2002, "Uncertainty and the seamless supply chain", *Supply Chain Management Review*, vol. 6, no.4 (July/Aug. 2002), pp. 52-61.

Gossain, S. 1998, "Reinventing value: The new business ecosystem", *Strategy & Leadership*, vol. 26, no. 5.

Goswami, S., Engel, T. & Krcmar, H. 2013, "Information visibility in supply chain management information systems: A comparative analysis", *Journal of Enterprise Information Management*, vol. 26, no. 3, pp. 5-5.

Gunasekaran, A. & Ngai, E. 2003, "The successful management of a small logistics company", *International Journal of Physical Distribution & Logistics Management*, vol. 33, no. 9, pp. 825-842.

Gupta, U.G. 1996, "Theory and applications of the Delphi technique: A bibliography (1975-1994)", *Technological Forecasting and Social Change*, vol. 53, no. 2, pp. 185-211.

Haftor, D.M., Kajtazi, M. & Mirijamdotter, A. 2011, "Information logistics as a guide for research and practice of e-maintenance operations", *International Journal of Performability Engineering*, vol. 7, no. 6, pp. 593-603.

Harland, C., Caldwell, N., Powell, P. & Zheng, J. 2007, "Barriers to supply chain information integration: SMEs adrift of eLands", *Journal of Operations Management*, vol. 25, no. 6, pp. 1234-1254.

Linstone, H.A. 2011, "Delphi: A brief look backward and forward", *Technological Forecasting and Social Change*, vol. 78, no. 9, pp. 1712-1719.

Hoyer, V. 2008, "Collaborative e-business process modelling: Transforming private EPC to public BPMN business process models", *Collaborative e-Business Process Modelling: Transforming Private EPC to Public BPMN Business Process Models*, vol. 4928.

Hung, Y., Chou, S.T. & Tzeng, G. 2011, "Knowledge management adoption and assessment for SMEs by a novel MCDM approach", *Decision Support Systems*, vol. 51, no. 2, pp. 270-291.

Iansiti, M. 2004, "Keystone advantage: What the new dynamics of business ecosystems mean for strategy, innovation, and sustainability (hardcover)", *Harvard Business School Press Books*, 2004.

Inmon, W.H., Strauss, D. & Neushloss, G. 2008, "Chapter 15 - DW 2.0 and performance" in *DW 2.0*, Morgan Kaufmann, Burlington, pp. 239-260.

Ireland, R.D., Hitt, M.A. & Sirmon, D.G. 2003, "A model of strategic entrepreneurship: The construct and its dimensions", *Journal of Management*, vol. 29, no. 6, pp. 963-989.

Jansen, S. & Cusumano, M. 2012, "Defining software ecosystems: A survey of software platforms and business network governance", *Proceedings of IWSECO, 2012*, pp. 41.

Järvensivu, T. & Törnroos, J. 2010, "Case study research with moderate constructionism: Conceptualization and practical illustration", *Industrial Marketing Management*, vol. 39, no. 1, pp. 100-108.

Johannessen, J. & Olsen, B. 2010, "The future of value creation and innovations: Aspects of a theory of value creation and innovation in a global knowledge economy", *International Journal of Information Management*, vol. 30, no. 6, pp. 502-511.

Johnsen, S., Schümmer, T., Haake, J., Pawlak, A., Jørgensen, H., Sandkuhl, K., Stirna, J., Tellioglu, H. & Jaccuci, G. 2007, "Model-based adaptive product and process engineering", *New Technologies for the Intelligent Design and Operation of Manufacturing Networks*, Fraunhofer IRB Verlag, Stuttgart, vol. 42.

Kimball, R. & Ross, M. 2013, *The data warehouse toolkit: The definitive guide to dimensional modeling*, John Wiley & Sons.

Koch B. 2012, *E-Invoicing / E-Billing 2012 report, "Opportunities in a challenging market environment 2012"*, Billentis.

Kvale, S. 1995, "The social construction of validity", *Qualitative Inquiry*, vol. 1, no. 1, pp. 19-40.

Kwan, K. & Tsang, E.W. 2001, "Realism and constructivism in strategy research: A critical realist response to Mir and Watson", *Strategic Management Journal*, vol. 22, no. 12, pp. 1163-1168.

La Londe, B.J. & Masters, J.M. 1994, "Emerging logistics strategies: Blueprints for the next century", *International Journal of Physical Distribution & Logistics Management*, vol. 24, no. 7, pp. 35-47.

Lambert, D.M. 1996, "Developing and implementing supply chain partnerships", *International Journal of Logistics Management*, The, vol. 7, no. 2, pp. 1-18.

Lather, P. 1993, "Fertile obsession: Validity after poststructuralism", *The Sociological Quarterly*, vol. 34, no. 4, pp. 673-693.

Laudon, J.P. & Laudon, K.C. 2006, *Essentials of business information systems*, Prentice-Hall, Inc.

Lei, D., Hitt, M.A. & Bettis, R. 1996, "Dynamic core competences through meta-learning and strategic context", *Journal of Management*, vol. 22, no. 4, pp. 549-569.

Liu, J., Zhang, S. & Hu, J. 2005, "A case study of an inter-enterprise workflow-supported supply chain management system", *Information & Management*, vol. 42, no. 3, pp. 441-454.

Lovelock, C. & Gummesson, E. 2004, "Whither services marketing? In search of a new paradigm and fresh perspectives", *Journal of Service Research*, vol. 7, no. 1, pp. 20-41.

Maier, R., Passiante, G. & Zhang, S. 2011, "Creating value in networks", *International Journal of Innovation and Technology Management*, vol. 8, no. 03, pp. 357-371.

Malhotra, A., Gosain, S. & El Sawy, O.A. 2007, "Leveraging standard electronic business interfaces to enable adaptive supply chain partnerships", *Information Systems Research*, vol. 18, no. 3, pp. 260-279.

Maxwell, J.A. 1992, "Understanding and validity in qualitative research", *Harvard Educational Review*, vol. 62, no. 3, pp. 279-301.

Melao, N. 2009, "E-business processes and e-business process modelling: A state-of-the-art overview", *International Journal of Services Technology and Management*, vol. 11, no. 3.

Metropolis, N. & Ulam, S. 1949, "The Monte Carlo method", *Journal of the American Statistical Association*, vol. 44, no. 247, pp. 335-341.

Modell, S. 2010, "Bridging the paradigm divide in management accounting research: The role of mixed methods approaches", *Management Accounting Research*, vol. 21, no. 2, pp. 124-129.

Modell, S. 2005, "Triangulation between case study and survey methods in management accounting research: an assessment of validity implications", *Management Accounting Research*, vol. 16, no. 2, pp. 231-254.

Moore, G. 2004, "Darwin and the demon", *Harvard Business Review*, vol. 82, no. 7/8, pp. 86-92.

Moore, J.F. 2006, "Business ecosystems and the view from the firm", *Antitrust Bull*, vol. 51, pp. 31.

Moore, J.F. 1998, "The rise of a new corporate form", *Washington Quarterly*, vol. 21, no. 1, pp. 167-181.

Moore, J.F. 1993, "Predators and prey: A new ecology of competition", *Harvard Business Review*, vol. 71, no. 3, pp. 75-86.

Munoz, A. & Clements, M.D. 2008, "Disruptions in information flow. A revenue costing supply chain dilemma", *Journal of Theoretical and Applied Electronic Commerce Research*, vol. 3, no. 1, pp. 30-40.

Murphy, P.R. & Daley, J.M. 1999, "EDI benefits and barriers: Comparing international freight forwarders and their customers", *International Journal of Physical Distribution & Logistics Management*, vol. 29, no. 3, pp. 207-217.

Nachira, F. 2002, "Towards a network of digital business ecosystems fostering the local development," Directorate General Information Society and Media, European Commission, Tech. Rep., 2002. [Online]. Available: <http://www.digital-ecosystems.org/doc/discussionpaper.pdf>

Nachira, F., Dini, P. & Nicolai, A. 2007, "A network of digital business ecosystems for Europe: roots, processes and perspectives", European Commission, Bruxelles, Introductory Paper.

Neubert, G., Ouzrout, Y. & Bouras, A. 2004, "Collaboration and integration through information technologies in supply chains", *International Journal of Technology Management*, vol. 28, no. 2, pp. 259-273.

Nurmilaakso, J.M. 2008, "EDI, XML and e-business frameworks: A survey", *Computers in Industry*, vol. 59, no. 4, pp. 370-379.

Power, T. & Jerjian, G. 2001, *Ecosystem: Living the 12 principles of networked business*, FT. com.

Prahalad, C. & Hamel, G. 1990, "The core competence of the corporation", Boston (MA), 1990, pp. 235-256.

Ritala Paavo 2009, "What's in it for me? Creating and appropriating value in innovation-related cooperation", *Technovation*, vol. 29, no. 12, pp. 819-828.

Ritala, P. 2012, "Coordination in innovation-generating business networks – the case of Finnish mobile TV development", *Journal of Business & Industrial Marketing*, vol. 27, no. 4, pp. 324-334.

Ritala, P., & Hallikas, J. 2012, "Network position of a firm and the tendency to collaborate with competitors—a structural embeddedness perspective", *International Journal of Strategic Business Alliances*, vol. 2, no. 4, pp. 307-328.

Santos, F.M. & Eisenhardt, K.M. 2005, "Organizational boundaries and theories of organization", *Organization Science*, vol. 16, no. 5, pp. 491-508.

Sowa, J.F. 1992, "Extending and formalizing the framework for information systems architecture", *IBM Systems Journal*, vol. 31, no. 3, pp. 590.

Steiner, F.R. 2008, *The living landscape: an ecological approach to landscape planning*, Island Press.

Sun, S., Hsu, M. & Hwang, W. 2009, "The impact of alignment between supply chain strategy and environmental uncertainty on SCM performance", *Supply Chain Management: An International Journal*, vol. 14, no. 3, pp. 201-212.

Tang, A., Avgeriou, P., Jansen, A., Capilla, R. & Ali Babar, M. 2010, "A comparative study of architecture knowledge management tools", *Journal of Systems and Software*, vol. 83, no. 3, pp. 352-370.

Teece, D.J. 2012, "Dynamic capabilities: Routines versus entrepreneurial action", *Journal of Management Studies*, vol. 49, no. 8, pp. 1395-1401.

Teece, D.J., Pisano, G. & Shuen, A. 1997, "Dynamic capabilities and strategic management", 1997.

Teece, D.J. 2010, "Business models, business strategy and innovation", *Long Range Planning*, vol. 43, no. 2, pp. 172-194.

Tsang, A.H. 2002, "Strategic dimensions of maintenance management", *Journal of Quality in Maintenance Engineering*, vol. 8, no. 1, pp. 7-39.

Ulankiewicz, S., Henningsson, S., Bjørn-Andersen, N. & Flügge, B. 2010, "Interoperability tools", *Accelerating Global Supply Chains with IT-Innovation*, ITAIDE tools and methods. Springer, 2010.

van Donk, D.P. & van der Vaart, T. 2005, "A case of shared resources, uncertainty and supply chain integration in the process industry", *International Journal of Production Economics*, vol. 96, no. 1, pp. 97-108.

Vivek, N., Sen, S., Savitskie, K. & Ranganathan, S.K. 2011, "Supplier partnerships, information quality, supply chain flexibility, supply chain integration and organisational performance: The Indian story", *International Journal of Integrated Supply Management*, vol. 6, no. 2, pp. 181-199.

Von Krogh, G., Ichijo, K. & Nonaka, I. 2000, *Enabling knowledge creation: How to unlock the mystery of tacit knowledge and release the power of innovation*, Oxford University Press.

Wernerfelt, B. 1984, "A resource-based view of the firm", *Strategic Management Journal*, vol. 5, no. 2, pp. 171-180.

Williamson, O.E. 1996, *The mechanisms of governance*, Oxford University Press, New York.

Williamson, O.E. 1983, *Markets and hierarchies analysis and antitrust implications: A study in the economics of internal organization*, Free Press, New York.

Yang, H., Zuo, Y. & Li, Y. 2013, "IoT-based 4PL: Prospects and business models" *Applied Mechanics and Materials*, vol. 273, pp. 65-69.

Yin, R.K. 2003, "Applications of case study research (applied social research methods)", Series, 4th.
Thousand Oaks: Sage Publications,

Zachman, J.A. 1999, "A framework for information systems architecture", IBM Systems Journal, vol.
38, no. 2, pp. 454-470.

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