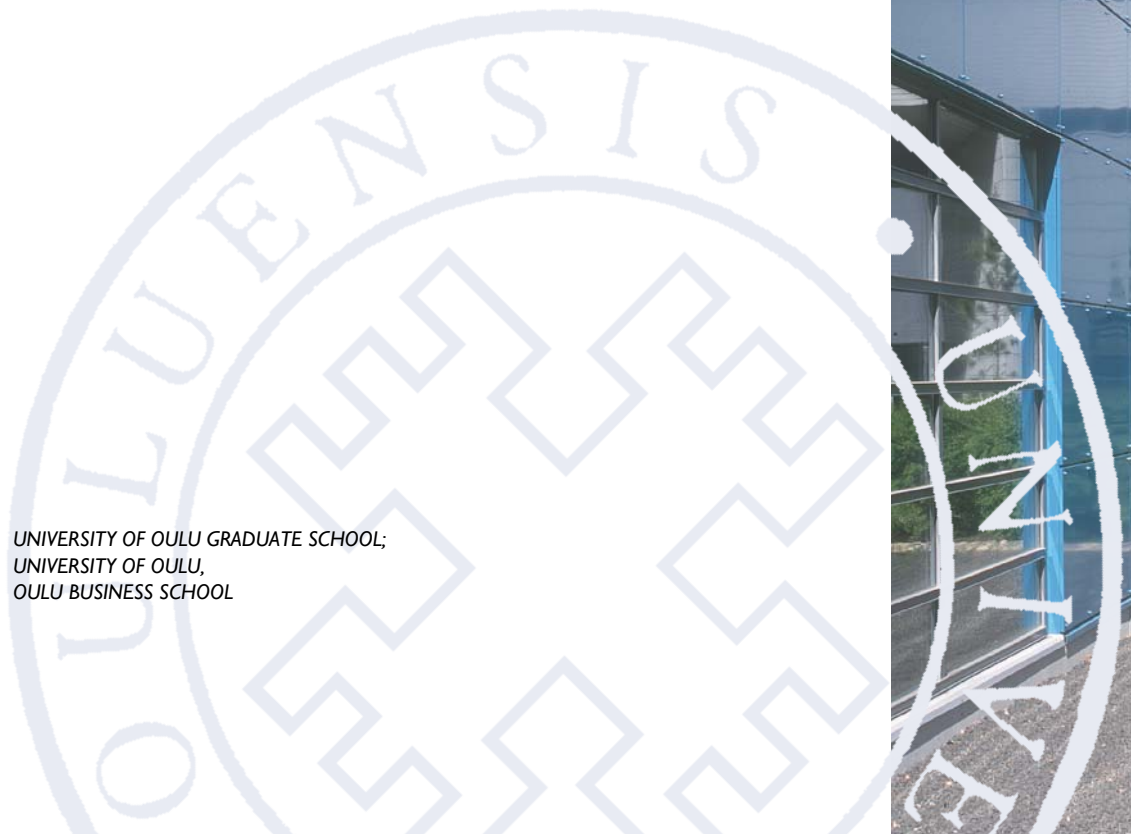


Timo Pohjosenperä

VALUE CO-CREATION IN
HEALTH CARE LOGISTICS
SERVICES

UNIVERSITY OF OULU GRADUATE SCHOOL;
UNIVERSITY OF OULU,
OULU BUSINESS SCHOOL

G
OECONOMICA



ACTA UNIVERSITATIS OULUENSIS
G Oeconomica 115

TIMO POHJOSENERÄ

**VALUE CO-CREATION IN HEALTH
CARE LOGISTICS SERVICES**

Academic dissertation to be presented with the assent of
The Doctoral Training Committee of Human Sciences,
University of Oulu for public defence in the Arina
auditorium (TA105), Linnanmaa, on 28 May 2020, at 12
noon

UNIVERSITY OF OULU, OULU 2020

Copyright © 2020
Acta Univ. Oul. G 115, 2020

Supervised by
Professor Jari Juga
Doctor Saara Pekkarinen

Reviewed by
Professor David Grant
Associate Professor Anu Bask

Opponent
Professor Jan de Vries

ISBN 978-952-62-2616-3 (Paperback)
ISBN 978-952-62-2617-0 (PDF)

ISSN 1455-2647 (Printed)
ISSN 1796-2269 (Online)

Cover Design
Raimo Ahonen

PUNAMUSTA
TAMPERE 2020

Pohjosenperä, Timo, Value co-creation in health care logistics services.

University of Oulu Graduate School; University of Oulu, Oulu Business School

Acta Univ. Oul. G 115, 2020

University of Oulu, P.O. Box 8000, FI-90014 University of Oulu, Finland

Abstract

This study describes how value is created within a health care logistics setting, especially considering the context of sparsely populated areas where distances play a critical role in service management. Health services are changing rapidly due to cost pressures and increasing demand. Therefore health care organisations have a growing need to improve patient processes and supporting logistics services such as material supply, pharmacy, instrument maintenance, food supply, assistive device and laundry services.

Health care logistics has been recognised in the academic literature since the 1990s. Most of the studies focus on patient flows and care processes, while research on material flows in health care have been quite limited. In this dissertation material logistics is studied together with the concepts of value co-creation, service modularity, resilience of work and accessibility. The dissertation includes four case studies that are conducted in a multidisciplinary manner. Qualitative methods are accompanied by GIS-analyses with quantitative measures. The research data was collected between the years 2012–2019 using interviews and focus group discussions with representatives from public health care organisations in Northern Finland together with comparative cases from Southern Finland and the private sector.

The nursing staff play a key role in both perceiving and creating value of health care logistics services during the usage of the supplied items, whereas the logistics organisation facilitates the value process. Both actors benefit from clarifying the task allocation and increasing resilience by adjusting working practices at the interface between the logistics personnel and the nursing staff. The various processes, services and organisations can be managed by recognising modularity as a cognitive frame. This also helps with organising the services into larger geographical entities with sufficient accessibility. As the distance between logistics facilities and points of use gets longer the importance of value co-creation between the actors increases in order to secure trustworthy deliveries for the end users.

Managers of health services and logistics services can use these findings to develop their services. Understanding logistics as a critical part of health care helps the hospitals and health care systems cope with growing costs and provides better services for patients.

Keywords: accessibility, health care logistics, modularity, resilience, value co-creation

Pohjosenperä, Timo, Arvon yhteisluonti terveydenhuollon logistiikassa.

Oulun yliopiston tutkijakoulu; Oulun yliopisto, Oulun yliopiston kauppakorkeakoulu

Acta Univ. Oul. G 115, 2020

Oulun yliopisto, PL 8000, 90014 Oulun yliopisto

Tiivistelmä

Tämän väitöskirjan tarkoituksena on kuvata terveydenhuollon logistiikan arvonluontia erityisesti harvaan asutulla alueella, jossa pitkät etäisyydet vaikuttavat palveluiden toteuttamiseen. Terveyspalvelut ovat muutoksessa hoitomuotojen kehittyessä ja kustannuspaineiden lisääntyessä, minkä vuoksi myös logististen tukipalveluiden, kuten hoitotarvikejakelun, lääkzejakelun, välinehuollon, apuvälinepalvelun, pyykkipalvelun ja ravintohuollon on kehitettävä materiaali-, tieto ja pääomavirtojen hallintaa siten, että palvelut tukevat hoitoketjuja ja terveydenhuollon ammattilaisten työtä.

Terveydenhuollon logistiikkaa on tutkittu 1990-luvulta alkaen. Suurin osa tutkimuksesta keskittyy potilasvirtojen logistiikkaan, kun taas materiaalivirtoja on tutkittu vähemmän. Tässä tutkimuksessa materiaalilogistiikkaa tarkastellaan logistiikan tutkimuksen lisäksi arvon yhteisluonnin, modulaarisuuden, resilienssin ja saavutettavuuden käsitteiden avulla. Neljä osajulkaisua on tehty monitieteisellä otteella, jossa laadullisen tapaustutkimuksen lisäksi hyödynnetään myös numeerista GIS-analyysiä. Aineisto on kerätty vuosien 2012 ja 2019 aikana ja se käsittelee pääasiassa pohjoissuomalaisia julkisen terveydenhuollon organisaatioita. Lisäksi vertailukohtia on tuotu tapauksilla Etelä-Suomesta ja myös yksityiseltä sektorilta.

Terveydenhuollon logistiikan arvonluonnin kannalta keskeisiä toimijoita ovat hoitohenkilökunnan jäsenet, jotka osaltaan luovat ja myös kokevat tukipalveluihin liittyvää arvoa. Hoitohenkilökunta ja tukipalveluhenkilöstö hyötyvät toistensa töiden sisällön ymmärtämisestä, arvon yhteisluonnista ja työn resilienssistä. Useita erilaisia prosesseja, palveluita ja organisaatioita käsittävää terveydenhuollon logistiikan johtamista voidaan selkeyttää modularisoimalla esimerkiksi kaupan alalta tuttujen toimintamallien avulla. Siten palveluita voidaan järjestää myös maantieteellisesti suurempina kokonaisuuksina. Etäisyyden kasvaessa arvonluonnin merkitys korostuu, jotta turvallinen toimitusketju voidaan taata loppukäyttäjälle.

Logistiikkapalvelu ja terveystalvuluorganisaatiot voivat hyödyntää tutkimuksen tuloksia kehittäessään toimintaansa. Ymmärrys logistiikasta keskeisenä osana terveystalvulujen kokonaisuutta auttaa terveystalvuluorganisaatioita ja terveydenhuoltojärjestelmiä kehittymään kustannustehokkaammaksi ja paremmaksi käyttäjilleen, eli potilaille.

Asiasanat: arvon yhteisluonti, modulaarisuus, resilienssi, saavutettavuus, terveydenhuollon logistiikka

Acknowledgements

Many people and organisations have helped me to accomplish this research during the last few years. To my main supervisor, Professor Jari Juga I owe my deepest gratitude. With your cautious guidance I have had the opportunity to access the academic world, manage projects, do research, publish articles and write my doctoral dissertation. For me your work is irreplaceable. My sincere thanks also go out to my second supervisor, Saara Pekkarinen, D.Sc., who has been very helpful, especially by providing insightful comments, good cheer and examples of how to utilise previous industry background to conduct academic research.

Then I would like to express my gratitude to the pre-examiners, Professor David Grant and Adjunct Professor Anu Bask. Thank you for your meticulous work that offered valuable comments to clarify and sharpen my message in the dissertation. Professor Saila Saraniemi and Professor Jouni Juntunen I would like to thank you for offering a resilient and efficient follow-up group that together with Helena Miettunen, gave me rational advice and encouragement particularly during the last year of the study.

Most of the empirical work of this research was conducted in research and development projects. I acknowledge the support from Business Finland, The Council of Oulu Region, European Union Regional Development Fund and other public and private organisations. Especially the hospital district of Northern Ostrobothnia and its procurement manager Juha Putkonen have been very helpful in interconnecting my research with health care processes. In that regard I also want to mention Aila Orabi, Mikko Häikiö, Vesa Kämäräinen, Anna-Maria Levy, Marjukka Manninen, Anu Vuorinen and Professor Petri Sahlström. For direct financial support for the dissertation process I want to thank the Jenny and Antti Wihuri Foundation and the Foundation for Economic Education.

I have had the most outstanding opportunity to conduct multidisciplinary research with my highly esteemed, professional, eager and rigorous co-authors Professor Jarmo Rusanen, Professor Seppo Väyrynen, Hannele Kantola, Päivi Kekkonen, Hanna Komulainen and especially Ossi Kotavaara, with whom I have engaged in the most exceptional collaboration conducting research and projects together.

The Oulu Business School, the Department of Marketing, Management and International Business and the University of Oulu Graduate School have together offered me a safe home base for studying, carrying out my research and have provided a wonderful place to work. I want to thank every individual of this

scientific community for your support and for being who you are. With first Professor Pauliina Ulkuniemi and later Professor Vesa Puhakka I have had the privilege to plan my employment relationship in a forward-looking manner. The administrative staff have been very helpful in many phases of my research. Vuokko Iinatti, Elina Pernu, Liisa Bozkurt, Katja Hannula, Marketta Holmberg, Jukka Maamäki, Marja Alatalo and Arto Eljander, I hope you recognize your crucial role in this research and I sincerely thank you for the arrangements you helped to make.

My fellow doctoral students such as Hannu Torvinen, Outi Keränen, Marika Tuomela-Pyykkönen, Syed Mubaraz, Tero Huhtala, Eija-Liisa Heikka, Tan Teck Ming, Johanna Still, Eeva-Liisa Oikarinen, Jan Hermes, Hanna Okkonen, Anniina Rantakari and Anna-Liisa Kaasila-Pakanen, not to forget my office mate Waqar Nadeem, have offered me a lot of help, whether it has been commenting on my presentations, taking doctoral courses together, arranging events or meeting at occasional lunch and coffee breaks. Then there are a number of important colleagues such as Professor Satu Nätti, Ulla Lehtinen, Sakari Nikkilä, Tuula Lehtinen, Mari Juntunen, Sauli Sohlo, Pirjo Jaukkuri and Antti Kauppila, who I wish to know all had a positive effect on my development at the university. I would especially like to thank Sauli Pajari, for teaching me a lot of important problem solving skills in a compelling manner.

Chronologically, the first work community for me at the university was based around the people from the ancient Desperado corridor. With these inspiring persons we shared our everyday discussions and the most humorous coffee breaks ever. My thanks go to President Raimo Kalliopuska, Jukka Ruopsa, Leena Ruopsa, Sakari Sipola, Marika Iivari, Antti Vähäkangas, and Marjut Uusitalo. Most of us also had lunches together forming the prestigious Lunch Parliament with brilliant members such as Jaakko Simonen and Pasi Karjalainen. Essential thanks go to you as well as to Chef Kimmo for providing delicious hamburgers every Thursday during the Parliament-era.

Outside university life, I am thankful for my friends I have kept in touch with throughout these busy years of studying, working and raising a family. Thank you Ilkka Vuojala, Miikka Keränen and Tuomas Halonen for sharing so many nice meetings, filled with laughter, offering long-term perspectives on all of the big and small issues in life and for having the most open discussions about progressing in our careers.

Lastly, I want to thank my loved ones, my daughters Senja and Helka and my wife Mirja. Even though I have not always opened my research process to you in detail, I have received a significant amount of mental support from you. The book

that I have been writing for the last few years is now ready, and it is dedicated to you with love.

At home, April 2020

Timo Pohjosenperä

List of Abbreviations and definitions

e.g.	exempli gratia
et al.	et alia
etc.	et cetera
GIS	Geographic information system
i.e.	id est
LSP	Logistics service provider
OM	Operations management
SCM	Supply chain management
SM	Service management

List of original publications

This dissertation is based on the following publications, which are referred throughout the text by their Roman numerals:

- I Pohjosenperä, T. & Komulainen H. Getting closer by increasing distance: The dynamics of value creation spheres in health care logistics. Accepted to *Journal of Business and Industrial Marketing*.
- II Pohjosenperä, T., Kekkonen, P., Pekkarinen, S. & Juga, J. (2019). Service modularity in managing healthcare logistics. *International Journal of Logistics Management*, 30(1), 174–194.
- III Kekkonen P., Pohjosenperä T., Kantola H. & Väyrynen S. (2018). Rational and participative task allocation between the nursing staff and the logistics support service provider in healthcare. *Human Factors and Ergonomics in Manufacturing and Service Industries*, 28(3), 117–129.
- IV Kotavaara, O., Pohjosenperä, T., Juga, J., & Rusanen, J. (2017). Accessibility in designing centralised warehousing: Case of health care logistics in Northern Finland. *Applied Geography*, 84, 83–92.

Table of contents

Abstract	
Tiivistelmä	
Acknowledgements	7
List of Abbreviations and definitions	11
List of original publications	13
Table of contents	15
1 Introduction	17
1.1 Background of the study	17
1.2 Research problem.....	19
1.3 Key concepts and positioning of the study.....	21
1.4 Research process and dissertation structure	23
2 Health care logistics	25
2.1 Overview	25
2.2 Development of health care logistics literature	28
2.3 Logistics development: reports in Finnish health care organisations	30
3 Conceptual background	33
3.1 Value and value co-creation	33
3.2 Service modularity	35
3.3 Resilience.....	37
3.4 Accessibility.....	38
3.5 Theory synthesis	40
4 Methodology	43
4.1 Research philosophy	43
4.2 Multidisciplinary approach	44
4.3 Abductive case research process.....	45
4.4 Description of the empirical context.....	46
4.5 Data collection	48
5 Review of the results of the papers	53
5.1 Getting closer by increasing distance: the dynamics of value creation spheres in health care logistics	53
5.2 Service modularity in health care logistics	54
5.3 Rational and participative task allocation between the nursing staff and the logistics support service provider in health care.....	55

5.4	Accessibility in designing centralised warehousing: Case of health care logistics in Northern Finland	57
6	Conclusions	59
6.1	Answers to research questions	59
6.2	Theoretical contributions.....	65
6.3	Managerial and social implications.....	67
6.4	Evaluation of the research	68
6.5	Limitations and ideas for further studies.....	70
	References	73
	Original papers	83

1 Introduction

This chapter first introduces the academic and managerial background of the conducted research. Then the purpose of the study and the research questions are presented. The positioning of the study and key concepts are presented in 1.3 followed by the research process and structure of the dissertation in 1.4.

1.1 Background of the study

Health care systems are under pressure to improve their performance in service terms and in relation to cost efficiency. The challenges originate firstly from the increasing use of health care services by the ageing population and secondly as the variety of methods for treating progressively challenging medical conditions is growing. Therefore, health care organisations are globally aiming to gain more value and reduce costs through structural changes (see e.g. Kaplan & Porter, 2011). Health care providers have therefore a growing need to find ways to improve patient processes, as well as support activities.

Health care systems need many kinds of support services that can be considered logistical. These *logistics support services* include: material supply, pharmacy, instrument maintenance, food supply, assistive device services and laundry services. The services support actual health services by providing the required supplies at the right time and in the correct condition to the actors in the care chains. The awareness of these logistics support services as an important part of health services is recognised nowadays both in management of health care organisations and in academic research (e.g. Beier, 1995; Jarrett, 1998; Landry & Philippe, 2004; Kumar et al., 2008). Core processes and supporting processes need to be managed as one entity. Thus, the co-operation of the actors in health care and support service processes enables the complex system of health care to function cost efficiently and for the benefit of patients (Hollnagel et al., 2013).

Focusing on redesigning the logistics support services has resulted in increasing service levels and lower cost-structures in health care (Poulin, 2003) and logistics has in fact been identified as one of the key levers to manage health care costs (de Vries, 2011; Dacosta-Claro, 2002). However, logistics has the potential to offer significant improvements in performance in health care (e.g. Jarrett, 1998). In some estimations, up to half of the hospital's logistics costs could be eliminated by more efficient logistics management (Poulin, 2003). Therefore, logistics is one of

the main tools for managing health care costs and for improving quality at the same time (Elmuti, et al., 2013).

Health care has not been at the forefront of development in logistics (see e.g. Jarrett, 1998). New models are being sought from other sectors such as manufacturing industry and retail. However, many researchers note that the unique features of health care that constrain the applicability of logistics initiatives (de Vries & Huijsman, 2011; Abdulsalam, et al., 2015). The reasons for this inapplicability involve the high complexity of health care supply chains, their merely supporting role (Beier, 1995) and the overall unique features that affect the applicability of logistics knowledge from the industrial sector to the health care sector (de Vries & Huijsman, 2011). These context-specific needs have opened an inspiring area for health care logistics research and are an important developmental area for health care organisations (Volland et al., 2017).

Many logistics and supply chain management definitions highlight the goal of logistics services in adding value for customers and other stakeholders (see e.g. Lambert, et al., 1998). Key challenges include identifying the appropriate services for the customers, delivering the services in a cost-efficient manner and continually renewing the services to meet the customer needs. Therefore, descriptions of value in different settings are needed. This calls for identifying, defining and categorising measurable service attributes in a rational and organised manner.

In the marketing and service management literature this kind of categorisation is widely used and also extended to a more holistic view in order to better describe the many-sided characteristics of value and how it is created. Therefore, many researchers are calling for a customer-oriented approach to increase the understanding of interactive value co-creation processes (see e.g. Lehtimäki et al., 2018). However, the value co-creation literature is based mainly on conceptual papers (Perks et al., 2012) and has been criticised for losing its focus on everyday practices as the view is too broad (Leroy et al., 2013). Hence, inner details of value co-creation and more in-depth empirical analysis of the phenomenon are needed (Grönroos & Voima, 2013; Leroy et al., 2013).

A customer focus and the importance of customer understanding as critical parts of value co-creation are seldom studied in logistics services (Yazdanparast et al., 2010). Furthermore, defining value and understanding value co-creation seems exceptionally multifaceted in public health care because of the multiple stakeholders involved, such as patients, governments, municipals, hospitals, employees, physicians, insurance companies, logistics service providers etc. (Porter, 2014; Ledlow et al., 2017). Therefore, describing the value and the

stakeholders within health care logistics services and explicating the value co-creation between the actors provides an interesting avenue towards a new understanding.

Besides the ageing population mentioned above, another special condition affecting health care services and their logistics support systems, particularly in Northern Finland where this research is positioned empirically, is related to the sparse population and long distances. This causes challenges for patients who live far away from service locations as well as health care organisations that need to find reliable and efficient ways of providing service units with the required materials and supplies. The concept of accessibility is therefore intrinsically linked to the value creation models of the health care systems in this study. Essentially, this calls for a multidisciplinary understanding of the phenomena associated with health care services and the related support systems in their specific contexts. This study attempts to shed light on the challenges of health care logistics and how this can be approached through research-based frameworks and tools.

1.2 Research problem

The purpose of this dissertation is to describe how value is created within a health care logistics setting, especially considering the context of sparsely populated areas where distances play a critical role in service management. To achieve this purpose, the study first aims at identifying and describing the main stakeholders in health care logistics and the conditions, interactions, activities, critical events and experiences between them. Secondly the role of distance and its implications on the accessibility of health care logistics services is examined. Thirdly the dynamics of value creation in the health care logistics environment is studied by analysing changes in value co-creation spheres between service providers and customers. Thus, three more specific research questions are formed:

1. *How do different stakeholders contribute to value generation in health care logistics services?*
2. *What implications does distance have on the co-creation of value of health care logistics services?*
3. *How is the dynamics of value co-creation manifested in health care logistics processes?*

The research problem is approached through four different multidisciplinary studies that are presented in Table 1. These papers contribute both individually and conjointly to answering the three research questions presented above.

Table 1. The research papers of the dissertation

No.	Title	Paper-specific RQ	Contribution to RQ	Contribution of the present author
I	Pohjosenperä, T., & Komulainen H. Getting closer by increasing distance: The dynamics of value creation spheres in health care logistics. Accepted to <i>Journal of Business and Industrial Marketing</i> .	If, and if so, how does the increasing physical distance influences value creation in the context health care logistics and why?	1, 2, 3	The present author had the main responsibility for planning and writing the paper, as well as for the collection and analysis of the empirical data.
II	Pohjosenperä, T., Kekkonen, P., Pekkarinen, S., & Juga, J. (2019). Service modularity in managing healthcare logistics. <i>International Journal of Logistics Management</i> , 30(1),174-194.	How modularity is used for enabling value creation in managing healthcare logistics services?	1, 2	The present author had the main responsibility for planning and writing the paper, as well as for the collection and analysis of the empirical data.
III	Kekkonen, P., Pohjosenperä, T., Kantola, H., & Väyrynen, S. (2018). Rational and participative task allocation between the nursing staff and the logistics support service in healthcare. <i>Human Factors and Ergonomics in Manufacturing and Service Industries</i> , 28(3), 117-129.	How rational task allocation between the nursing staff and the support service provider increase the positive output and minimise the negative output of the work system.	1, 3	The present author had the main responsibility for case 2 in the paper, forming the theoretical background of the resilience concept and writing the case research method. The results and conclusions were written in evenly in close collaboration with the first author of the paper.
IV	Kotavaara, O., Pohjosenperä, T., Juga, J., & Rusanen, J. (2017). Accessibility in designing centralised warehousing: Case of health care logistics in Northern Finland. <i>Applied Geography</i> , 84, 83-92.	How extensive must a delivery network be to produce adequate logistics services for health care in sparsely populated areas?	2	The present author had the main responsibility in forming the theoretical background, collecting the information on material flows of the health organisations and forming the conclusions with the co-authors

1.3 Key concepts and positioning of the study

This dissertation is positioned in multiple fields of research. Logistics management is the main discipline, which is augmented by views from service and health care management. Furthermore, location analysis is used in applying geographic information system (GIS) research to answer questions related to accessibility and distance between logistics service facilities and points of use. Figure 1 shows the research fields of this study and the positioning of the main theoretical concepts in their intersection.

The central concepts attributed to value co-creation in this study are service modularity, resilience of work and accessibility. The roman numerals pinpoint the Papers I-IV in which the particular concepts are examined. Most of the concepts can be found in the interface between health care, logistics and service management. Resilience of work (see e.g. Hollnagel, 2014) in the hospital environment clarifies the task allocation between multiple actors in health care logistics services. Research on service modularity (see e.g. Pekkarinen & Ulkuniemi, 2008) explores the relationships between organisations, processes and services that are needed in managing health care logistics. Lastly, the concept of accessibility (see e.g. Paéz et al., 2012) is related to locations and the distance between the health care service and the supporting logistics service facilities. These concepts affect the value co-creation between the stakeholders in health care logistics services. The stakeholders are described in the theory synthesis (Section 3.5).

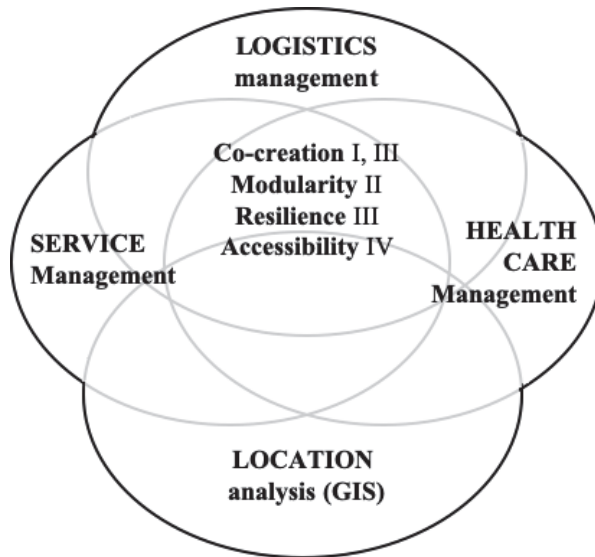


Fig. 1. Positioning of health care logistics research in this dissertation.

This dissertation adopts a service logic view that offers a management-level perspective on value co-creation (Grönroos, 2008; Grönroos & Voima, 2013) in health care logistics. Therefore, value in this dissertation is defined as value-in-use that is created during the usage of resources and processes by user (or emerging for the user) (Grönroos, 2008). Value co-creation focuses on the interactions between the service provider and the customer. The value generation process includes three value spheres: the customer's sphere, the provider's sphere and a joint sphere (Grönroos & Voima, 2013). Opportunities for value co-creation exist if a service provider manages to engage with the customer's value creation process in the joint sphere. The provider and customer can ideally form a merged, coordinated and dialogical process in which both parties operate within each other's processes. This joint sphere provides a platform for value co-creation (Wetter-Edman et al., 2014; Sorrentino et al., 2016).

De Blok et al. (2010) divide health care services into the fields of cure and care. Curative services relate to professional services focusing on medical treatment, repair and recovery, whereas care services focus on nursing, maintaining a particular health status and preventing deterioration. Services can also be framed by the place where they are provided. This separates institutional cure and care that

takes place e.g. in hospitals, health centres and nursing homes, while some of the services are provided at the patient's/client's home. This dissertation recognises these dimensions and primarily focuses on logistics value in curative services taking place in the hospital environment.

There are numerous different settings for value creation inside and outside the hospitals. For example, Helkkula et al. (2013) examine how value is co-created, calculated and experienced by different micro, meso and macro level actors within public health care service systems in order to optimise value creation within the entire system. Jacobson and Neumann (2009) present a framework that could be used in measuring the value of public health services. The framework considers four elements to measure value: external factors that must be taken into account, key internal actions that a local health department must perform, using appropriate quantitative measures and communicating value to elected officials and the public.

The health care service systems involve multiple stakeholders such as patients, governments, municipalities, hospitals, employees, physicians, insurance companies service providers etc. (Porter, 2014; Ledlow et al., 2017). Thus, there are multiple actors in different roles in the value creation processes. In this research the main stakeholders include patients, employees and administration. In addition the various service organisations, especially logistics service providers are included as a critical stakeholder group in this study.

1.4 Research process and dissertation structure

The research was conducted mostly during the years 2015-2019. However, the dissertation utilises earlier data that was collected since 2011 by first carrying out a pre-study with the local hospital district. This study opened up the problematics in managing and renewing the logistics support services in health care. The main phase of the research was a multidisciplinary research project with researchers from geoinformatics, work science and accounting. The author's work included the simultaneous management of the project and conducting the doctoral research. Most of the data of the research was collected during the project through interviews and focus group discussions. However, also statistical and geographical data were used in the geoinformatics analyses of the study. Analysing the data with the project members resulted in four research articles attached to this dissertation.

In this dissertation, the research stream of health care logistics is first introduced in chapter 2. Then in chapter 3 the concepts of value creation, modularity, resilience and accessibility are presented. Methodological

consideration and research data are presented in chapter 4. Chapter 5 gives an overview of the original publications and chapter 6 summarises the results and implications of the research.

2 Health care logistics

Chapter 2 first presents an overview of health care logistics research and lists the selected articles in which the research is published. In addition, the developments of health care logistics in the Finnish health care system are described by listing a selection of project reports.

2.1 Overview

A basic definition describes logistics as the task of coordinating material flow and information flow across the supply chain (Harrison & van Hoek, 2005). Logistics includes activities connected to the transformation and circulation of goods, such as the material supply of production, the core distribution and transport function, wholesale and retail as well as the related information flows (Handfield & Nichols, 1999). The mission of logistics management is to plan and coordinate all those activities necessary to achieve desired levels of the delivered service and quality at the lowest possible cost (Christopher, 1998).

Compared to industrial and retail organisations, the opportunities for logistics improvements have received relatively little attention in the health care sector. Health care has not been a forerunner in logistics development, but in the last decades the role of logistics has been recognised as an important instrument for improving performance also in this sector. Thus, health care logistics has become an important area of development for health care organisations and is a constantly growing field of academic research (Volland et al., 2017).

In the health care context logistics research is generally divided into two genres on the basis of the unit of analysis or “element of exchange” (de Vries & Huijsman, 2011). The main difference between these research areas can be illustrated in using the terms patient and non-patient logistics (Bamford et al., 2009). Most of the research focuses on patient flows and care processes throughout the care chain (de Vries & Huijsman, 2011; Ageron et al., 2018). This field focuses on how logistics and supply chain viewpoints improve the health care ecosystem by searching for innovative practices and principles for health care managers to better understand strategic alternatives and make evidence-based decisions (Abdulsalam, 2015). Kriegel et al. (2013) further divide the logistics of persons into employee logistics including visitor logistics and patient logistics that includes operating room, emergency, outpatient and inpatient logistics.

Research on supporting material flows in health care has been quite limited (Olsson et al., 2014; Vissers & Beech, 2005, p. 26). This has been attributed to the complex nature of health care supply chains the merely a supporting role of logistics in health services (Beier, 1995; Abdulsalam et al., 2015; Jarrett, 1998). However, the importance of material flows in health care systems is gradually becoming recognised and the potential improvements that can be accomplished are also gaining attention in the academic research of logistics and health care management (e.g. Jarrett, 1998; Landry & Philippe, 2004; Kumar et al., 2008). According to Kriegel et al. (2013), material logistics can be divided into medical and non-medical goods. The former consists medical devices, pharmaceutical goods, sterile goods, blood and laboratory logistics, while the latter refers to the logistics of waste, energy, water, bed, laundry and catering.

Ledlow et al. (2017) describe health care material logistics to include the procurement, storage, inventory control, quality control and operational management of supplies, pharmaceuticals, equipment and other items used in the delivery of patient care or the management of the patient care system. By providing the right items at the right time at the right place and at the right quality, logistics enables the delivery of health care services. In more general terms, the health care supply chain integrates with the health care provider to diagnose, treat, and care for a patient—if either are removed from the equation, health care as a whole is significantly less effective, less efficient, and less efficacious. However, the definition is not widely understood by the practitioners. According to Kwon et al. (2016), the health care supply chain has been mistakenly identified as merely consisting of purchasing and contract management, although a broader understanding would benefit from having the mentioned outcomes.

There are unique features that affect the applicability of logistics knowledge from the industrial sector to health care (de Vries & Huijsman, 2011). For example, non-standard processes, a lack of relevant information and a high level of division of labour characterise hospital logistics (Nachtmann & Pohl, 2009). Sufficient medical items need to be available for the medical staff to enable them to perform their daily work. Typically, in hospitals medical supplies are stored in large quantities at many locations in a hospital to prevent stockouts. This is, however, constrained by the lack of available storage space (Lapierre & Ruiz, 2007; Little & Coughlan, 2008.)

Abdulsalam et al. (2015) mention four unique features of health care supply chains that increase their variety and complexity. Firstly, the *mission of health care is to improve and save lives*, which differs from the goals of organisations that

function primarily to gain profit. Therefore, also the consequences of failure are different from other supply chains (Ledlow et al., 2017). Secondly, the *high variety of actors* in the supply chain including suppliers, distributors, purchasing organisations, provider organisations, clinicians and patients differ from other industries. Thirdly, the *high range and criticality of the delivered products* are emphasised as health care organisations have diverse clinics and wards with varying needs for specialised medical devices and pharmaceutical products (Landry & Beaulieu, 2013) combined with overall high variation in demand for supplies (Ledlow et al., 2017). Lastly, *some products are extremely expensive and highly complex* with requirements for special handling. Some product types also change rapidly with the technological and medical innovations. In addition to these four factors, Ledlow et al. (2017) mention *high regulation* that guides and restricts the work, procedures and products in health care.

According to Jarrett (1998), health care professionals especially see their branch as a unique sector, offering purely care and curative treatments without confluences to other industries or businesses. Controlling or projecting the production schedules is considered particularly hard as emergency care and surgical procedures cannot be accurately projected. However, the supplies used in the most inpatient wards can be estimated based on seasonal data and average census. Thus, in the areas of supply distribution, inventory control, and product production, health care shares many similar business processes to the manufacturing industry (see e.g. Jarrett, 1998) and retail business (see de Vries, 2011; Abjulsalam et al., 2015). Therefore, logistics innovations can offer significant potential for performance improvements also in health care.

In many health care organisations, the funding model has not supported the development of renewal processes using logistics knowledge. In public health care and also in many privately-owned health care organisations governments and third parties (such as insurance companies) work with pre-decided budgets. Running over the budget results in a bigger budget the following year and vice versa, offering no incentives to re-engineer delivery systems. The health care organisations have, therefore, lacked this natural mechanism to seek improvements in cost efficiency (Jarrett, 1998).

Despite the unique features and heavy cost structures in the past decades, health care organisations have started to pay attention to logistics arrangements. Lower cost structures and increasing service levels can be achieved by redesigning material logistics (see e.g. Poulin, 2003), for instance by centralising warehouses (Kumar et al., 2008). Sometimes these reforms also aim at more comprehensive

changes in health care supply chains in the manner of industry-led initiatives such as quick response (QR) or efficient consumer response (ECR) initiatives for instance (Landry & Filippé, 2004).

2.2 Development of health care logistics literature

A selection of health care logistics articles is listed in Table 3. These articles are used in the four papers of this dissertation and are listed in chronological order (published between 1995-2017). The listing shows the variety of 13 different journals mostly from the fields of logistics, supply chain management (SCM), operations management (OM) and service management (SM). The table also indicates the unit of analysis whether the paper has main focus on patient or material flows. Even though this dissertation focuses on material logistics, both patient and material flows are relevant units of analysis in understanding logistics in the health care context.

Table 2. Selection of health care logistics articles in chronological order.

Author(s)	Year	Article / chapter name	Journal / book name	Element of exchange
Beier FJ	1995	The management of the supply chain for hospital pharmacies: a focus on inventory management practices	Journal of Business Logistics	Material flow – (pharmacy inventory)
Jarrett GP	1998	Logistics in the health care industry	International Journal of Physical Distribution and Logistics Management	Patient and material flows
Rivard-Royer H, Landry S & Beaulieu M	2002	Hybrid stockless: a case study: lessons for health-care supply chain integration	International Journal of Operations and Production Management	Material flow
Poulin E	2003	Benchmarking the hospital logistics process: A potential cure for the ailing healthcare sector	CMA Management	Material flow
Landry S & Philippe R	2004	How logistics can service health care	Supply Chain Forum	Patient flow
Vissers J & Beech R	2005	Patient flow logistics in health care	Health Operations Management	Patient flow
Kumar A, Ozdamar L & Ning Zhang C	2008	Supply chain redesign in the health care industry of Singapore	Supply Chain Management: An International Journal	Material flow (medical)
Bamford D, Thornton H & Bamford J	2009	Health-care logistics redesign	OR Insight	Patient and material flows
Meijboom B, Schmidt-Bakx S & Westert G	2011	Supply chain management practices for improving patient-oriented care	Supply Chain Management: An International Journal	Patient flow
de Vries J & Huijsman R	2011	Supply chain management in health services: an overview	Supply Chain Management: An International Journal	Patient and material flows
Bijvank M & Vis IF	2012	Inventory control for point-of-use locations in hospitals	Journal of the Operational Research Society	Material flow
Kriegel J, Jehle F, Dieck M & Mallory P	2013	Advanced services in hospital logistics in the German health service sector	Logistics Research	Goods and persons
Dobrzykowski D, Deilami VS, Hong P & Kim SC	2014	A structured analysis of operations and supply chain management research in healthcare (1982–2011)	International Journal of Production Economics	Generally logistics, OM and SM
Abdulsalam Y, Gopalakrishnan M, Maltz A & Schneller E	2015	Health care matters: Supply chains in and of the health sector	Journal of Business Logistics	Material flow
Volland J, Fügener A, Schoenfelder J & Brunner JO	2017	Material logistics in hospitals: A literature review	Omega	Material flow

2.3 Logistics development: reports in Finnish health care organisations

Finnish hospitals have also become interested in health care logistics development. Research and consultant organisations have published multiple reports on the challenges and solutions to logistics issues in health care organisations. An overview of reports published between 1995-2019 in Finland is presented in Table 4. One genre of the reports describes the logistics flows in one particular hospital or hospital district (Laukala & Venäläinen, 2008). There are also many reports summarising research and development of partly academic projects related to materials management (Kämäräinen, 2005) or task allocation (Paananen, 2008) in hospitals. Logistics reports have also been produced in many Finnish hospitals as part of hospital building projects (Ruohonen et al., 2011). Some reports take a broader view of logistics support services and municipal health centres (Tuomi logistiikka, 2017). Digitalisation is seen as a driver for improvements in health care logistics (DiRVa, Lillrank et al., 2019). The national public health care reform has resulted in extensive reports in all regions that have prepared to join special health care and primary health care into the same regional organisations. As part of these reports the logistics as well as purchasing and other support services are outlined (Lapland, 2018; PoPSTer, 2018). The latest reports look at sustainability that also pertains to health care logistics operations (HUS Logistiikka, 2018).

Table 3. Selection of Finnish health care logistics development reports.

Genre	Year	Report name	Object	Organisation	Author(s)
Hospital logistics reports	2008	Töölön sairaalan tukipalveluiden palvelukoordinaattorihanke	HUS	EP Logistics	Laukala & Venäläinen
Partly academic reports	2005	Materiaalinhallinta Suomen erikoissairaanhoidossa	Multiple hospitals in Finland	HEMA-institute	Kämäräinen et al.
	2008	Sairaalan materiaalogistiikan mallintaminen ja sen tehokkuuden analysointi	HUS	Helsinki University of Technology	Orelma
	2008	Ihannesairaala -Visioita ja valintoja	HUS	HUS	Aaltonen et al.
	2008	Lääkelogistiikkaselvitys Meilahden sairaala-alueella	HUS	Helsinki University of Technology	Rimpiläinen
	2008	Tampere University Hospital's logistic processes and space resources till 2020	Tampere University Hospital	Tampere University of Technology	Paavilainen & Toivonen
	2010	Analysis of current state of the hospital's delivery center and the improvement of operations	Kuopio University Hospital	JAMK University of Applied Sciences	Laitinen
	2012	PPSHP logistiikan esiselvitys	PPSHP	University of Oulu	Pohjosenperä et al.
Hospital campus building projects	2011	Keski-Suomen keskussairaalan logistiikka – Uusi sairaala -hankkeen osaselvitys	Central Finland health care district	University of Jyväskylä	Ruohonen et al.
		Kainua – new hospital to Kainuu alliance	Kainuu Central Hospital		
Regional reform reports	2018	Future Hospital OYS 2030	PPSHP	Reform organisation	Perälä et al.
	2018	Lapin maakunta- ja sote-uudistuksen valmistelu 2016 – 2019	Lapland region		
Digitalisation	2018	Pohjois-Pohjanmaan sosiaali- ja terveydenhuolto osana tulevaisuuden maakuntaa	Northern Ostrobothnia	PopSTer	Lillrank et al.
		DiRVA - Terveydenhuollon digitaalisten ratkaisujen vaikuttavuuden osoittaminen	Many (funded by Tekes)	HEMA-institute	
Sustainability report	2019	HUS-logistics sustainability report	HUS	HUS logistics responsibility team	Juuma et al.

3 Conceptual background

Logistics and supply chain management research has its roots in using different concepts and from non-logistics areas to explain interorganisational phenomena (Stock, 1997; Halldórsson et al., 2007). According to Stock (1997) many of the theories used in logistics research have been adopted from disciplines such as strategic management, marketing, economics, social sciences, and engineering. This chapter presents the concepts of value and value co-creation, service modularity, resilience of work, and accessibility which are later analysed in the context of health care logistics involving multiple stakeholders.

3.1 Value and value co-creation

The concept of value has intrigued researchers in many disciplines over the years. In business studies, value was first conceived as the value of something that can be measured by the amount of money that a person or company is willing to pay for it. These definitions use words such as equivalent price, exchange amount, and return to describe value. Another area of value definitions concerns the non-corporeal nature of value. Value may be described in terms of the usefulness, worth, quality, desirability and importance to the user (see e.g. Rutner & Langley, 2000). On a more general level, value can be understood as the customer's peace of mind (Woodruff & Gardial, 1996) or a process that increases the customer's well-being, such that the user becomes better off in some respect (Grönroos, 2008; Grönroos & Voima, 2013).

According to Stock (1997), marketing scholars introduced the notion that marketing creates utilities of time, place and possession, adding value for customers. In logistics, time and place utilities can be further broken down into more specific goals often described as the principle of the 7Rs, denoting the ability to deliver the right product, in the right amount, at the right place, at the right time, for the right customer, in the right condition, at the right price (e.g. Shapiro & Heskett, 1985). Seen from an alternative angle, Taiichi Ohno (1988) in his description of the Toyota production system identified seven forms of 'muda' (waste) that do not add value to the customer and should be eliminated. These were: over-production, waiting, unnecessary transportation, inappropriate processing, unnecessary inventory, excessive motion and defects.

The concept of customer value in logistics has traditionally been associated with customer-received benefits that stem from high levels of service (see e.g.

Langley & Holcomb, 1992). However, besides the customer oriented view, also other stakeholders need to be considered. For example Rutner and Langley (2000) mention shareholder value involving productivity, price realisation, returns and profits of the shareholders. A somewhat similar conceptualisation of value is the trade-off between the buyer's and seller's benefits and sacrifices (see e.g. Day, 1990; Blois, 2003, 2004). These value equation models offer mechanisms for understanding value as a function of the perceived benefits (e.g. improved performance, reduced operating costs and reduced working capital) and the perceived life-cycle cost of a product or service (e.g. ordering costs, purchasing price, set-up costs, operating and maintenance costs, and financing costs).

Despite a growing recognition of value as a key element in logistics and supply chain management there is still some degree of ambivalence related to its definition and formation. As stated by Fawcett and Waller (2011), logistics and supply chain services have features that make logistics value comparably hard to perceive and harder to resolve. Recent discussions especially in marketing and service management research concerning service dominant logic (Vargo & Lusch, 2004) and service logic (Grönroos, 2008; Grönroos & Voima, 2013) are raising additional questions about the real nature of value creation or co-creation in interactive processes between the provider and the customer. This 'co-creationist' view is not yet widely used in logistics and supply chain management, but some ideas for its application have been presented also in supply chain management contexts (Yazdanparast et al., 2010; Lusch, 2011; Ren et al., 2015), including health care supply chains (Chakraborty et al., 2014).

Value co-creation is generally defined as a joint, collaborative, peer-like and concurrent process of producing new material and symbolical value (Galvagno & Dalli, 2014). Within business-to-business relationships both parties are suggested to aim at the creation of mutual value and to share the outcomes received in this way (Gummerus, 2013). Recent studies emphasise the perspective of seeing value in the context of customer experiences (e.g. Helkkula et al., 2012). Thus, the focus is no longer primarily on a customised bundle of products or services exchanged for a price, but value creation becomes an ongoing process that emphasises the customer's experiences, logic, and ability to extract value out of products and other resources used (Grönroos & Voima, 2013).

In the service logic view (Grönroos, 2008, 2011), value is understood as value-in-use, created by, or emerging for the user during the use of processes and resources. The outcomes can be divided to direct and indirect outcomes as well as monetary and non-monetary value-in-use perceived by the customer (Möller &

Törrönen, 2003). Any supporting interactions between the service provider and the customer affect the value of a service instead of one particular item or service (Grönroos, 2011). Thus, value co-creation is based on interaction.

Different forms of value co-creation take place in three spheres: the provider's sphere, the customer's sphere and the joint sphere (Grönroos & Voima, 2013). In the provider sphere, service the provider gathers resources to facilitate the customer's value creation, which takes place in the other two spheres. In the customer sphere, value is created by customers and other actors in their setting. The customer sphere has no direct connection to service provider, but in the joint sphere, interaction between the provider and customer is possible. In the joint sphere the service provider's and customer's processes can merge, and the actors may influence each other's processes and, hence, influence the value formation process. Thus, the joint sphere is important from a value co-creation perspective (Grönroos et al., 2013).

The value co-creation process calls for collaboration between the service provider and the customer (Macdonald et al., 2011). Grönroos and Voima (2013) see the customer and service provider in changing roles of facilitating value creation and creating value. If a service provider manages to engage with the customer's value creation process in the joint sphere, opportunities for value co-creation with the customer exist. Ideally, they would develop into a merged, dialogical, coordinated process where both parties operate within each other's processes. The existence of this joint sphere, with its direct interactions, provides a platform for value co-creation.

3.2 Service modularity

The history of modularity can be traced back to the standardisation efforts of the industrial era, for instance concerning operations management Rutenberg (1971) addressed the need for commonality across product variants. Fundamental to modular designs are modules that have a specific function; these should be relatively independent and have standardised interfaces to enable integration (Baldwin & Clark, 2000). Later, the concept of modularity has also been adopted in many other disciplines including logistics services (e.g. Bask et al., 2010; Pekkarinen & Ulkuniemi, 2008) and health care (Vähätalo & Kallio, 2015; Broekhuis & Eissens-van der Laan, 2017; Silander et al., 2017). In the service domain, modularity is defined as being formed of one or many bundles of tasks which are highly interdependent of each other but loosely dependent on other

modules thus creating value for the customer through efficiency and customisation (see e.g. Kriegel et al., 2013; Ulkuniemi & Pekkarinen, 2011).

According to Pekkarinen and Ulkuniemi (2008) modular services may be recognised, developed and designed on service, process and organisational levels. A service module can include one or more service elements offering a unique service characteristic for the customer. One example of modular service in health care is the surgery-specific kit (see e.g. Cardoen et al., 2015) that can significantly reduce the points of touch needed to get medical materials ready for surgery. Process modules are standardised, indivisible process steps, while modular organisation is composed of internal functions and/or external partners. Methods for increasing modularity in organisation can include aspects such as outsourcing, contract manufacturing and forming alliances (Schilling & Steensma, 2001).

Logistics service providers also use modularity in their service strategies and network management (Rajahonka et al., 2013). Strategically, modularisation enables new service development and better customer fit in new service extensions. The increase in complexity challenges traditional logistics service delivery systems but also requires new and more flexible resources by the LSP and also the customers (Menor et al., 2002). Modularity can serve as an instrument to reduce complexity and thus increase the opportunities for flexible service delivery.

In the health care service context modularisation is affected by a variety of unique conditions. For instance, in the specialised health care setting, Silander et al. (2017) found that fragmented service delivery, professional autonomy, hierarchy, information asymmetry, and the requirement to treat all patients either constrained or enabled modularisation. Factors such as the clear division of work tasks and well-defined patient criteria have a favourable impact on the modularisation process.

Modularity may offer tools for identifying opportunities for improvement in the care processes of health care institutions. Modular care and care services may be divided into parts that can be further combined in several ways to address individual patient needs (Soffers et al., 2014). For example, de Blok et al. (2014) identified three steps of service package adaptation in elderly care: detecting changes in demand, reconfiguring packages and components, and aligning service providers. Typical interfaces during the three steps by which each organisation aimed to support elderly customers to live independently included continuous needs assessment, established communication lines, and customer meetings.

Standardisation increases the efficiency of activities, their measurability and control opportunities (Sandoff, 2005). However, as the standardisation of service

components increases, so do the opportunities for customisation (Voss & Hsuan, 2009). Modular services provide flexibility and enable firms to serve various customer needs (Schilling & Steensma, 2001) and modularisation makes it possible to integrate and disintegrate potential new business components efficiently and effectively, either by sharing modular components internally or by outsourcing modular components to external suppliers (Janssen & Joha, 2008).

3.3 Resilience

The concept of resilience has been widely used in many disciplines, originating in the development theory of social psychology. Thus, the definitions vary (Ponomarov & Holcomb, 2009). According to the British Standard BS 65000 (2014), organisational resilience is the ability to anticipate, prepare for, respond and adapt to events—both sudden shocks and gradual change. This means being adaptable, competitive, agile and robust. The United Nations International Strategy for Disaster Reduction (2004) provided this definition: “Resilience is the capacity of the system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure”. According to Hollnagel (2014), a resilient organisation possesses certain features, such as the ability to respond to changes, errors and possibilities. Such an organisation monitors its actions and environment to identify the changes that may affect its opportunities. It also learns from experiences and anticipates its evolution and the consequences that are not yet visible in everyday life.

Within logistics services, resilience has also been defined in various ways over time. The concept has been under discussion over the past few years, and there is no universal, widely accepted definition for it. Nevertheless, the definitions have similarities, highlighting readiness, response, recovery and growth (Hohenstein et al., 2015). According to Eltantawy (2016), supply management resilience is a meta-capability that helps the buyer resist damage and quickly recover from disturbances to reach performance goals. Christopher & Peck (2004) define supply chain resilience as “the ability of a system to return to its original state or move to a new, more desirable state after being disturbed”. Implicit in this definition is the notion of flexibility and given that the desired state may be different from the original one, ‘adaptability’ earns a place in our thinking too. Based on the social, psychological and economic standpoints of resilience, from the supply chain risk-management perspective, Ponomarov and Holcomb (2009) developed the concept of supply

chain resilience. They defined the concept as “the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function”.

Being a resilient service provider requires dynamic capabilities (Eltantawy, 2016; Pettit et al., 2010), enabling it to adapt to changes or threats and be competitive, flexible, agile and robust (Ponomarov & Holcomb, 2009). Herrera & Janczewski (2016) summarise the aspects of supply chain resilience as agility, responsiveness, visibility, flexibility, redundancy, structure and knowledge, reduction of uncertainty, complexity, reengineering, collaboration, integration, operational capabilities and transparency.

It has been recognised that maximum safety, high performance and strong resilience do not necessarily go together very well because of the natural trade-off between supervision to optimise safety and standardisation and a culture of innovation and personalisation and autonomy of individuals and groups that are required for adaptivity. In health care, performance, resilience and safety have traditionally been developed in separate silos. Resilience is needed, especially in cases where the complexity and the variety of the medical system dominate; at the same time, less resilience should be applied to the standard cases to ensure safety (Amalberti, 2013).

In health care, different kinds of medical, nursing and support service personnel perform a broad range of both caring and support roles. The case studies by Braithwaite et al. (2013) show the importance of an improvised, responsive approach to the task of producing safe care in the context of unpredictability that is inherent in health care, as well as the interaction among staff members from different occupations, departments and organisations. Gaps between the different departments and professional groups (physicians, nurses, support service personnel, etc.) lead to a lack of awareness of the actors in one unit about the work of others. These manifold gaps pose a threat to the resilience of the health care system (Braithwaite et al., 2013).

3.4 Accessibility

Accessibility is defined by Paéz et al. (2012) as the potential for reaching geographically discrete opportunities (for employment, health care services, social interaction, etc.). Therefore, accessibility can be regarded as one of the main outputs of the geographical distribution of activities. Accessibility is typically

measured by two components: the number of opportunities available and the cost of travel. These two factors offer a number of ways to be deployed to produce location- or person-based indicators of accessibility. Analyses typically concern the situation of the network, different modes of transportation, and inherent differences in the mobility of individuals.

In the logistics literature and practice, distance is approached through optimisation (Geoffrion & Powers, 1995; Graves et al., 2000). Optimisation can mean, for instance, that facility locations are designed in a manner that the total logistics costs of material deliveries to hospitals and other health care units are minimised at required service levels (Ahmani-Javid et al., 2017; Jarrett, 1998). The service level of the distribution network is improved through faster responses by increasing the service points. This raises customer satisfaction, but at the same time increases the total logistics costs such as transportation costs, inventory costs and facility costs (Heizer et al., 2017, p. 497; Croxton & Zinn, 2005.) In other words, there is a trade-off relationship between the service level and the logistics costs (e.g. Christopher, 1998, p. 51) which can also be applied to accessibility analyses in distribution networks for optimising delivery efficiency (the amount of freight delivered in relation to time) and service quality (e.g. coverage or geographic reach).

Designing and analysing hub locations of freight and passenger transport have been a central field of logistics studies in the last decades (Campbell & O'Kelly, 2012). Different kinds of location-allocation models that share a common theoretical background have been developed for diverse analytical needs (see Lei et al., 2016; Polo et al., 2015), including geographical analysis of warehouse location optimisation problems (Brahimi & Khan, 2014; Rodrigue et al., 2013, p. 176–179, 306–317). Geographic information systems (GIS) are applied widely to solving geographical location problems (Miller & Shaw, 2001; Tong & Murray, 2012). In the context of health care logistics, GIS offers an adaptive framework for location-allocation analyses of warehousing facilities and for the geographical optimisation of delivery routes (see Cromley & McLafferty, 2011; Bozkaya et al., 2010).

In addition to the geographic analyses of facility locations in health care, smaller-scale studies for accessibility can be conducted for instance to re-locate medical supplies in nursing units. According to Belanger et al. (2018), decentralising the storage areas in nursing units reduces the time needed for nurses to handle medical supplies. However, this will also require additional logistics resources to manage the increased number of storage points.

In the value co-creation literature distance is not much addressed. Holmqvist et al. (2015) examine the role of the psychological distance as the customer's sense of closeness to the service interaction and its implications for the different value spheres. The concept of psychological distance can aid in understanding how interaction influences the way in which value is co-created. The willingness of service customers and providers to interact with each other in the joint value sphere seems to increase as the psychological distance is reduced. This does not necessarily apply to the physical distance the implications of which on value creation have not been explicitly researched. However, the physical presence has been addressed in the context of customer experiences concerning the physical participation of the individual (e.g. Carù & Cova, 2003) and as part of co-creation in retail store settings (e.g. Russo Spena et al., 2012).

In health care settings some services are inseparable which makes a physical presence essential in operations such as surgeries that cannot be performed without the physical presence of both the physician and the patient (Corbin et al., 2001). In health care management this kind of thinking is applied also to many support services since most of the logistics facilities are located inside hospital buildings close to points of use. In contrast, logistics services in industrial and retail contexts have been mostly centralised during the last decades. In those cases digital platforms have been important solutions for maintaining accessibility (see e.g. Speranza et al., 2018). Eventually, physical distance and its implications for personal interaction in value co-creation are seldom studied and health care logistics offers a suitable context to study the phenomenon.

3.5 Theory synthesis

Value co-creation together with service modularity, resilience of work and accessibility form the conceptual field of this dissertation which is combined with logistics literature in the health care context. The resilience of work is utilised to clarify the task allocation between multiple actors in health care logistics services in hospital environments. Service modularity is used as a cognitive frame to depict the relationships between organisations, processes and services that are needed in managing health care logistics. Lastly, the concept of accessibility is used to describe the implications of the distance between the health care service units and their supporting logistics service facilities. These attributes affect the value co-creation processes between the stakeholders of health care logistics services (see Fig. 2).

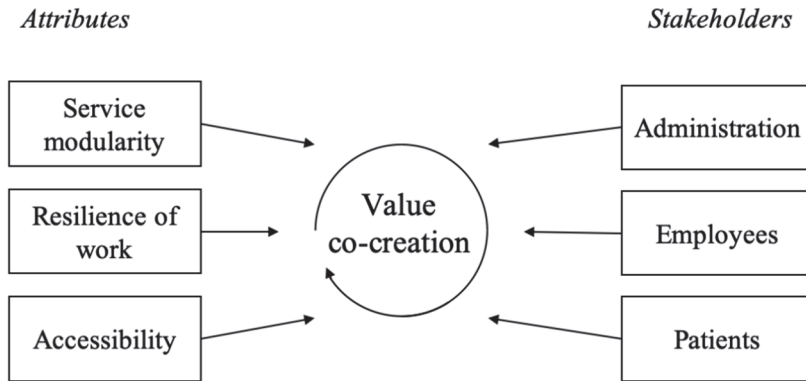


Fig. 2. Framework for understanding the transformation of health care material logistics services through value co-creation.

The purpose of this dissertation is to describe how value is created within the health care logistics setting, especially considering the context of sparsely populated areas where distances play a critical role in service management. This is approached through the previously presented conceptual background. The description of value that we have discussed forms the basis for understanding health care logistics services. More specifically, the main concept in this dissertation is value co-creation and this is researched as a dynamic process involving and benefitting patients, employees of both health and logistics organisations and administrative stakeholders such as hospital and municipality management. The dynamics of value co-creation is approached through the attributed concepts of service modularity, resilience of work and accessibility which all affect the interaction between the stakeholders and therefore have implications on the value co-creation processes and their outcomes in health care logistics services.

4 Methodology

This research focuses on describing features of the selected phenomenon—how value is co-created in the health care logistics context. Answering these questions is possible by adopting a qualitative approach (Töttö, 1997, p. 128; Yin, 2013). This chapter presents the research philosophy, usage of a multidisciplinary perspective and abductive case research process. Then the empirical context is described together with the data collection and analysis.

4.1 Research philosophy

Philosophical grounds guide the researcher to identify the research strategy and methods (Eriksson & Kovalainen, 2008). According to Burrell and Morgan (1979, p. 1–2), the methodological, epistemological and ontological questions determine how the researcher interprets and sees the nature and form of reality, the bases of knowledge, and the association between people and their environments. This explicitly and implicitly forms a paradigm that refers to a set of beliefs guiding the action.

Ontology indicates the nature of reality, and the way we see the world (Eriksson & Kovalainen, 2008). This study applies a relativist ontological positioning based on moderate constructionism which refers to subjective realities without assuming an objective reality (Järvensivu & Törnroos, 2010). Actors in health care logistics see the phenomena from their own view that influences their actions in the development of the logistics services. Thus, studying the viewpoints and the differences in stances of the actors offers a basis for building a joint understanding and this helps to configure the conceptual development in the context. This constructed understanding may differ from single viewpoints, but it is needed in the interaction of the actors.

The nature of the relationship between the researcher and what can be known is defined through epistemology (Guba & Lincoln, 1994). This dissertation applies a subjectivist epistemological position (Denzin & Lincoln, 2000). This means focusing on the ways in which reality is constructed as a topic for empirical inquiry (Kjellberg & Helgesson, 2007). Through empirical observations bounded by subjectivity it is possible to understand local truths and community-based knowledge creation (Järvensivu & Törnroos, 2010). Knowledge is available through the activities of social actors (Eriksson & Kovalainen, 2008). This dissertation focuses on the perceptions of health care logistics and value that is

perceived, co-created and constructed collectively and individually by the actors in the service processes.

4.2 Multidisciplinary approach

All four papers of this dissertation utilise a case study approach that provides a multidimensional view of the situation in a specific context and captures the dynamics of the studied phenomenon (Eisenhardt, 1989). With regard to the scientific positioning, this study represents moderate constructionism and recognises the multiple constructed, community-bounded realities that most case studies involve (see Järvensivu & Törnroos, 2010). The four studies of this dissertation are conducted together with researchers from a variety of disciplines (logistics, marketing, work science and geoinformatics) and apply methods from various fields to answer the paper-specific research questions. During the research processes the co-authors from the different disciplines brought in methodological expertise required for the analysis of the different papers.

Papers I, II and III are qualitative case studies with embedded units of analyses (Yin, 2013). This kind of approach can be useful for generating additional insights when issues are complex and research alternates between the empirical field and different theoretical frameworks (Orton, 1997; Yin, 2013). Through the constant dialogue between empirical research and theoretical conceptualisation, new knowledge can be abductively elaborated to crystallise the studied phenomena (see Järvensivu & Törnroos, 2010). Case studies are suitable also in exploring complex phenomena within its context (Baxter & Jack, 2008). The three papers focus especially on the contextualised logic of logistics and, hence, aim at theory elaboration. In the logistics and supply chain management discipline, qualitative case research is justified when people and their interaction are examined (see Gammelgaard, 2004; Aastrup & Halldórsson, 2008). Furthermore, case studies are vital as most of the discussed real-life situations in logistics and supply chain management are unique and contain details that cannot be the same in every case (Hilmola, 2018, 1).

Paper III also uses action research, which is a collective, self-reflective inquiry carried out by the participants in a social situation or an organisation in order to improve the rationality of their own social or educational practices. Through participation and social change, action research features the acquisition of knowledge and empowerment of the participants in collaboration (Masters, 1995). Ethnography-based observation is a participatory design and development

technique that is a natural companion of action research which is useful for generating and implementing real-life development ideas (Spinuzzi, 2005). In Paper III, participatory design and development were used to find new solutions and courses of action and to obtain information on the current state of task allocation. Furthermore, the method opened the employees' views on the characteristics of a well-functioning relationship between the nursing staff and the support service providers in the target organisations.

In Paper IV, calculations of delivery routes were carried out by using Geographic Information System (GIS)-based transport accessibility methods (Miller & Shaw, 2001), with actual road and health care facility data. GIS-based transport analyses enable the measurement of the travel time and distance for different types of vehicles routed from origins to destinations in a graph model of a road network. A GIS-analysis was conducted to find a solution for locating one warehouse or a combination of a few warehouses to a limited number of potential sites using a tour-based location-allocation method. The efficiency of the sites concerning the freight delivery accessibility was evaluated on the basis of optimised delivery routes as a sum of the delivered freight and transport time accumulation (see e.g. Bosona & Gebresenbet, 2011). The analysis aimed to find a suitable optimum between transport costs, the reach of the delivery network, and the number of warehouses via realistic route generation. Delivery routes were optimised using heuristic computation methods which minimised the tour time while the share of delivered freight and delivered freight per time were the key constraints. This kind of combined analysis with GIS-methods offers a holistic view of the accessibility problem, involving trade-offs between the location and number of facilities and logistics costs, all under assumed constraints, such as driving time regulations and vehicle capacities. Separately, these optimisation tasks could be carried out with logistics planning tools such as the savings or sweep method for route planning and the gravity method for facility locations (see e.g. Ballou, 2004, p. 235–253).

4.3 Abductive case research process

This study adopts an abductive, systematic combining approach. The research process is a nonlinear, path-dependent process that combines efforts to match reality and theory. Therefore, the case analysis, empirical fieldwork and theoretical framework evolve simultaneously throughout the research process. Various research activities and continuous movement between theory and empirical

observations expands the understanding of both theory and empirical phenomena (Dubois & Gadde, 2002). The findings can be abductively inferred from the data in a simultaneous matching and reflection process against the proposed theoretical underpinnings (see Kovács & Spens, 2005).

The researcher's interest in health care logistics arose during the pre-study in 2012. The project described logistics support services and material logistics processes in a university hospital raising multiple questions that seemed to offer good potential for both academic discussion and practical development by providing guidelines for enhancing logistics processes and services. Overall, the research process began with an empirical interest that guided the work towards the academic discussion on the topic.

Later the academic literature helped to position the research and also to look for possibilities for multidisciplinary studies. Matching research interests were found together with researchers from work science, accounting and geoinformatics. Theoretical discussions of these fields were applied together with health care logistics literature and lenses from marketing and logistics disciplines. In practice, the research was conducted in small groups of researchers each aiming to explore their specific research questions. The used concepts and views were carefully discussed and planned for each paper. The article processes, therefore, included multiple theoretical and empirical rounds forming a cyclic progression towards drawing the conclusions and determining the implications. Later the four papers were summarised in this dissertation including multiple views but forming an entity around value co-creation in health care logistics.

4.4 Description of the empirical context

This dissertation describes health care logistics development by examining cases from different hospitals in Finland. The hospitals studied were: a university hospital (and its special responsibility area), two regional hospitals (A and B), and a new private hospital (see Table 4). These organisations have different approaches to health care material logistics in terms of the services, processes and organisations. To simplify the research setting, the logistics services in this study mainly concentrate on health care supplies, including clinical assortments such as bandages, single-use gloves, basic examination and surgical instruments. However, logistics support services in health care cover a wide range of services such as material and pharmacy supply, instrument maintenance, food supply, assistive device service and laundry service. These services provide the required materials

and instruments for the care chains and are therefore considered in the data collection and also addressed in the papers.

Table 4. Case organisations.

Organisation(s)	Location in Finland	In paper
University Hospital	Northern Ostrobothnia	I, II, III, IV
Regional Hospital A	Lapland	II, III, IV
Regional Hospital B	Satakunta	II
Private Hospital	Southern Finland	II
Special responsibility area of the Oulu	Northern Finland	IV
University hospital (Northern Ostrobothnia hospital district, Lapland hospital district and municipalities of Northern Finland)		

The *University Hospital* in this study is located in Northern Finland and represents one of the five university hospitals in the country. The hospital provides specialised and demanding health care services for some 750,000 patients in its responsibility area covering more than a half of the country’s geographical area. An in-house logistics unit takes care of material operations in the university hospital. The ward has had some unofficial discussions with external service providers about the possibilities of using new logistics services for supporting their operations, but no concrete steps were taken in this direction during the dissertation process.

In the university hospital’s special area of responsibility there are four regional hospitals, including the Regional Hospital of Lapland (*Regional Hospital A*) that offers special health services to some 120,000 inhabitants. An in-house logistics unit handles logistics and purchasing services in the hospital and between different facilities in the area. The unit also serves outside customers such as the health centres and military unit in the hospital district. The logistics unit offers a shelving service for the wards and outpatient clinics of the hospital consisting of assortment management, ordering and shelving of goods. At the time of the case study, the service was used by the majority of wards and outpatient clinics and was also offered to outside customers such as local health centres. In addition, the unit offers courier services and a delivery service for food, laundry and medicines and medical equipment for the wards.

As a comparison to the two public hospitals in Northern Finland described above, this study also covers a regional hospital Southern Finland (*Regional Hospital B*). This hospital has adopted centralised model in their material logistics by forming a joint logistics centre with the surrounding municipalities that take care

of basic health care through the health centres. The logistics centre of the regional hospital offers assortment management, purchasing and other logistics support services of the hospital and the health centres. The logistics centre operates under the hospital district's service organisation which also includes units which provide catering, facility, cleaning and procurement services. In the last years, the support services have undergone several reforms which include building a new logistics centre and warehouse outside the hospital campus area to serve all the public health care units in the hospital district.

Another comparative case is a new *Private Hospital* owned by an insurance company in Finland. The hospital, which was founded in 2013, specialises in orthopaedic day surgeries and operates also as an emergency unit. The hospital uses external service providers for many activities that are performed in-house by the public hospitals. In addition, the remaining support activities are carried out by the nursing staff alongside their normal duties. Thus, the organisation for logistics and support activities is extremely lean and the processes are streamlined. It should, however, be remembered that the hospital's services are limited to orthopaedics and therefore the hospital cannot be fully compared to public hospitals that offer a broader array of health care services.

In terms of support services, the cases focus on the logistics and material services provided by an in-house operator that offers purchasing and material logistics as well as stock refill and shelving services to units inside the hospital and to other health care customers in the area outside the hospital. The stock refill service provides the medical material and instrument assortment in the ward storage rooms by handling the purchasing and shelving operations in the wards using the service. The logistics services include the material delivery inside the hospital as well as internal laundry, waste disposal, food delivery, medical instrument and pharmacy transportation.

4.5 Data collection

The case study data was collected through various methods and from multiple sources to add breadth and depth to understanding the phenomenon (Yin, 2013). Firstly, background knowledge was obtained through a pre-study (2012) and through discussions with the case hospitals and the LSP (2013-2014). Then the researchers worked closely in association with the case organisations in a multidisciplinary research project (2014-2016).

The data collection methods included interviews, and various forms of group discussion. Focus groups are especially useful for identifying important qualifiers or contingencies that may be associated with an answer to a structured question. In focus group discussions the participants in a group setting can engage in discussions on a subject or a theme introduced by the facilitator (Langford & McDonagh, 2003). Furthermore, focus groups offer an opportunity for feedback from other participants and allow the participants to respond to the comments of others (Stewart & Shamdasani, 2014, p. 178).

The primary data of this dissertation was obtained through 21 individual events including semi-structural interviews (15), focus group discussions (4), visits, a phone discussion and a seminar group discussion (see Table 5).

Table 5. Primary data.

Organisation	Position(s)	Type	Length	Date	In paper(s)
University Hospital	Staff nurse and nurse, anaesthesiology, surgery ward.	Interview	1h 7min	8.1.2015	I, II, III
University Hospital	Procurement manager	Interview	1h 3min	12.1.2015	I, II, III
University Hospital	Staff nurse, surgery ward	Interview	46 min	13.1.2015	I, II, III
University Hospital and LSP	Staff nurse and area manager	Focus group	1h 58min	4.2.2015	I, II, III,
Private Hospital	Nurse and IT-service provider	Visit, interview, memo	2h 30min 16pages	13.2.2015	II
University Hospital	Transport manager, warehouse manager, procurement manager	Group discussion	2h 7min	5.5.2015	IV
Regional Hospital B	Head of logistics and procurement	Interview	1h 7min	15.5.2015	II
Regional Hospital B	Assist departmental manager	Interview	30min	16.5.2015	II
Regional Hospital. City procurement	Development manager, procurement expert	Focus group	17 min	27.5.2015	II, III, IV
University Hospital, Consulting company	Procurement manager, CEO	Focus group	23 min	27.5.2015	II, III, IV
University & Regional Hospital A, Municipal, LSP, IT-service provider.	Procurement manager, warehouse manager, logistics manager, development manager, area manager, CEO	Seminar group discussions	2h 51min	18.2.2016	II, III
Regional Hospital A	Logistics manager	Interview	1h 32min	23.3.2016	II
University Hospital	Head of procurement	Interview	33 min	1.4.2016	II
LSP	Area manager	Interview	56 min	13.4.2016	II
IT-service provider	CEO	Phone discussion	12 min	14.2.2017	II
LSP	Area manager	Interview	87 min	7.12.2017	I
University Hospital	Logistics manager and warehouse manager	Interview	1h 11 min	7.2.2018	I
University Hospital	Head of procurement	Interview	40 min	7.2.2018	I
University Hospital	Staff nurse, surgery ward	Interview	44 min	12.2.2018	I
Logistics Unit	Transport manager	Interview	1 h 18 min	18.2.2019	I
Logistics Unit	Warehouse manager	Interview	1 h 2 min	22.2.2019	I

Additional data for this dissertation consists of interviews, visits and observations (Table 6) from the pre-study that was conducted between 2011 and 2012. The pre-study aimed at framing the logistics support services in the hospital environment. Additionally, memos of project meetings, steering group minutes and other internal documentation of the case organisations are used as secondary data. Moreover, statistical data, location and road data were used especially in the GIS-analyses.

Table 6. Pre-study data.

Type	Organisation	Date
Interview and visits	Hospital transportation	16.12.2011, 13.4.2012
	Central warehouse	12.1.2012, 21.2.2012, 10.4.2012
	City of Oulu purchasing	2.2.2012, 10.2.2012
	Hospital pharmacy	24.2.2012
	Assistive devices service	28.2.2012
	Food supply	22.2.2012
	City of Oulu warehouse	3.4.2012
	Instrument maintenance	4.5.2012
Observations	Central warehouse	6–16.3.2012
	Food supply	19. 23.3.2012
	Hospital pharmacy	6–16.3.2012
	City of Oulu warehouse	4–5.4.2012

The empirical data for this dissertation was mostly acquired during three research and development projects. The pre-study (2011-2012) covered all the logistics support services in the University Hospital, which also funded the project together with the University of Oulu. The pre-study resulted in multiple suggestions to develop logistics inside the hospital and opened opportunities for larger projects with multiple researchers and a larger funding consortium. This materialised in 2014-2016 when the “Innovations in Social and Health care Services” programme of Tekes (now Business Finland) together with the Northern Ostrobothnia Hospital District, Lapland Hospital District, City of Oulu and Posti funded the “Effective, user-centred and scalable support service models in long-distance healthcare systems” project. Most of the data used in this dissertation was collected, analysed and reported during that multidisciplinary project. Additional interviews and analyses were also carried out during the SOLOGS project (2018-2020) funded by the European Regional Development Fund (Council of Oulu Region), Northern Ostrobothnia Hospital District, and multiple health care organisations in the region.

The author of this dissertation has acted as researcher in all of the three projects and was project manager in the last two projects.

5 Review of the results of the papers

This chapter summarises the four original papers of this dissertation. Each article answers their individual research questions that together aim to answer the main questions of the dissertation. The theoretical backgrounds, methods, findings and implications of each paper are presented in a condensed manner.

5.1 Getting closer by increasing distance: the dynamics of value creation spheres in health care logistics

Paper I by Pohjosenperä and Komulainen studies the question of if, and if so, how does the increasing physical distance influence value creation in the context of health care logistics and why? The theoretical setting is based on a service logic view of value co-creation (see Grönroos, 2008; Grönroos & Voima, 2013) which is linked to the health care material logistics literature (see e.g. Ageron et al., 2018; Kumar et al., 2008; Volland et al., 2017). In this study, logistics value was defined as the value-in-use, created by users, or which emerged for the users when they used resources and or engaged in processes (Grönroos, 2008). Thus, value co-creation is based on the service provider's and customer's interaction in three value spheres: the customer's sphere, the provider's sphere and the joint sphere (Grönroos & Voima, 2013).

The research data consisted of interviews, focus group discussions and observations about the development of health care logistics in the case hospital during the years 2012-2019. In 2017 the warehouse facilities moved to a new location outside the hospital campus. The change resulted in the re-organisation of the logistics processes and affected the relationship between the actors.

The suppliers now send the goods to the new warehouse, where the goods are selected and either stored or transported directly to the hospital. The physical distance does not allow the items to be selected ad hoc by the nursing staff, which was quite usual before the change. The warehouse organisation further delivers the items to the points of use in the hospital.

In this new process there are multiple actors and a somewhat vague understanding of their roles in value creation. In the health services, the patient's view is critical, but the study points out that the nursing staff typically use the supplied items and therefore they have the main role when it comes to perceiving and creating the value of health care logistics services. Furthermore, the perceived value is associated with the nursing staff's wellbeing, safety and reliability.

Before the change the logistics service provider and the users seem to have grown together into a situation in which there was little interaction and limited efforts were made to develop the service relationship. The study revealed that the change forced the parties to arrange opportunities for the co-creation of value, such as having joint meetings to plan the inventory levels at the points of use and designing planographs. Moving the warehouse has increased the interaction between the actors thereby widening the joint value creation sphere. Furthermore, the study found that during the discords caused by the change the customer needs were recognised and the risks and inefficiencies of the old system became visible.

The joint meetings were arranged often at the start of the change but became less frequent as the problems were solved. This was reflected in the dynamics of the joint value creation sphere: first widening and then diminishing along with the catalysing changes and discords. As a result of the co-creation, the task allocation between the actors became clearer, allowing the logistics service organisation to make their processes more efficient and this helped the nursing staff to concentrate more on patient care.

5.2 Service modularity in health care logistics

Paper II by Pohjosenperä, Kekkonen, Pekkarinen and Juga (2018) aimed to answer the question of: *how modularity is used for enabling value creation in managing health care logistics services*. The theoretical framework in their paper was formed from discussions in the service modularity literature (e.g. Pekkarinen & Ulkuniemi, 2008; Bask et al., 2010), and involved value (e.g. Day, 1990; Woodruff, 1997), service value (Grönroos & Voima, 2013), logistics value (Lambert et al., 1998; Fugate et al., 2010) and value co-creation (Macdonald et al., 2011). In this paper the supply chain partnership model (Lambert et al., 1996) was applied to the study of antecedents, components and outcomes of value creation and modularity in health care logistics.

The empirical study consisted of descriptions of health care logistics in four different hospitals: a university hospital, two regional hospitals and a privately owned orthopaedical hospital. The data was formed from interviews and group discussions with the hospital management, personnel and professionals in the field.

The drivers for value creation initially arose from cost pressures. This phenomenon is global, and it is accentuated in Finland as the government is aiming to reform the public health care system. The changes that will occur due to the government reforms will rely largely on reforming the health services, but interest

in the potential impact of developing the support services has also been noted. In this paper modularity is seen as a cognitive frame to manage complex organisations with heterogeneous needs.

The study found that facilitators which enabled process modularisation firstly included information technology systems. These help automate work intensive processes such as ordering. Furthermore, the study found that standardisation enabled modularity in health care logistics by clarifying the assortments, replenishment processes and information management both inside the organisations and between them. Lastly, the study found that collaboration with LSPs offers the possibility to increase modularity as the LSP organisations, processes and services seem largely modularised.

The components of value creation in modularity in health care logistics are divided into processes, organisations and offerings. The paper found that the organisational modularity appears in the specialisation of roles and tasks of both the nursing staff and logistics personnel. Additionally, centralising logistics tasks for support service organisations seems to be a good direction to go in to obtain benefits from modularisation. According to the study, processes can be modularised by decoupling and differentiating processes. The former means separating support processes from patient processes and the latter involves differentiating routine and complex processes and standardising ordering and delivery processes. The study also indicated that modular offerings can mean firstly unitised entities such as shelves, planographs and kits, and secondly categorised products and services such as standardised assortment management and storage layouts. Thirdly modular offerings appeared in the segmentation of service users based on the logistics needs depending on the variety, quantity, frequency or level of preparation.

The study concluded that modularisation offers potentially positive impacts on security and reliability providing well-being and less stress for the nursing staff. This positively affects the health services as the care personnel have more time for patient work. In addition modularity increases coherence, scalability and replicability, which all increase the operational efficiency of health care organisations.

5.3 Rational and participative task allocation between the nursing staff and the logistics support service provider in health care

Paper III by Kekkonen, Pohjosenperä, Kantola and Väyrynen (2017) examines the health care logistics interface through the question: *How rational task allocation*

between the nursing staff and the support service provider increase the positive output and minimise the negative output of the work system? This multidisciplinary study has its conceptual background in both organisational resilience (Ponomarov & Holcomb, 2009; Hollnagel, 2014; BS 65000, 2014; Braithwaite et al., 2013) and task allocation in a work system model (Carayon & Smith, 2000). A resilient organisation has the ability to respond to errors, changes and possibilities and to monitor its own actions and environment to identify the changes that may affect its opportunities. A resilient organisation also learns from experience and anticipates potential evolution and consequences that are not yet obvious (Hollnagel, 2014).

The paper presents two cases from different public hospitals. Case 1 employs a participatory approach to find solutions which clarify the task allocation between nursing staff and in-house logistics personnel. In turn, Case 2 aims to find solutions for better task allocation through the co-creation of value between the members of the nursing staff and an external LSP.

The nursing staff in the case studies performed many kinds of logistics tasks inside the hospital. Some tasks were related to preparing surgeries, using the automated closets and cleaning the operation theatre. In the surgery wards nurses ordered required spare parts and possibly missing items and instruments. Nurses did even go to the warehouse to get missing items during surgery and deliver mail in the ward.

The offered solutions highlighted understanding customer needs in developing the logistics services. If a ward could be seen more clearly as a customer, the needs would be mapped as they would in new business relationship. The actors would then have a natural need to arrange joint meetings to adapt to one another's needs and resources. Furthermore, logistics service providers could offer resources to ensure reliable processes and necessary open hours. LSPs could proceed firstly to undertake manual work supporting the operations in the surgery ward. Secondly the introduction of new services such as parcel lockers and retail store displays could help the nursing staff concentrate on patient care instead of logistics tasks.

The care chain along which the patient proceeds can be viewed as a path that is intersected by the logistics services. The interfaces between these paths are located in the nodes where these services and care chain cross. The observations, interviews, and group discussions in the study revealed that even if logistics services and the care chain intersect on a process level, the people in these processes did not encounter each other in their everyday work. Communication and cooperation occurred only by arousing problems that needed to be solved. The research processes in Case 1 and 2 offered the organisations facilitated discussions

that functioned as a tangible interface for the co-creation of value between nursing staff and the logistics services.

In health care logistics services, resilience is needed to support the nursing staff in their fast-tempo and varied work under quickly changing conditions. The scaling of resources is challenging due to the trade-off between efficiency and the ability to respond to changing circumstances. Therefore, resilience can be seen as adaptivity between the defined tasks of the logistics services and the needs of the nursing staff. The outcomes of the clarified task allocation in this study were found to be positive. The smoother flow of work and increased communication between the working groups, reduced stress and provided an opportunity for the nursing staff to concentrate on nursing work. These elements appeared as positive outcomes. Additionally, employee well-being was experienced by the logistics personnel and the nursing staff.

5.4 Accessibility in designing centralised warehousing: Case of health care logistics in Northern Finland

Paper IV by Pohjosenperä, Kotavaara, Rusanen and Juga (2018) provides a geographical perspective on health care logistics by answering the question: *How extensive must a delivery network be to produce adequate logistics services for health care in sparsely populated areas?* The theoretical background relies on a trade-off analysis and is embodied in a total cost concept (Ballou, 2004, p. 44). In this case, this especially involved the relationship between the service level and logistics costs (see e.g. Christopher, 1998, p. 51). The service level in a distribution network can be enhanced by increasing the number of service points and this generally leads to faster responses (Heizer et al., 2017, p. 497; Croxton & Zinn, 2005).

The paper applies a geographic information system (GIS) analysis and a qualitative case study. The GIS-analysis is a numerical analysis that gives accurate results through broad, precise location data. The analysis can be applied to many disciplines by using adequate theory, context description and a description of the results. The case and its context were explored in interviews and a compilation of key figures to quantify the demands of health care logistics numerically. The primary data was collected in interviews and group discussions with health care logistics managers in Northern Finland and comparable hospital districts in Northern Sweden and Southern Finland. The data helped to gain a better understanding of health care logistics in sparsely populated areas and revealed key

figures which could be used to support logistics planning based on the quantitative estimations of deliveries.

The study found that in Northern Finland, health centres and hospitals have variable needs for delivery frequencies and freight volumes. Hospitals and specialised health care require deliveries either daily or several times a week. In contrast, primary-level health care organisations and major health centres need a delivery frequency of twice-a-week and health centres only once a week. The volumes for these units can vary from a truck load to one trolley per delivery.

An analysis and model, with road data, driving times and speed regulations taken into account was developed during the study. This showed that the majority of the weekly demand in the case area could be fulfilled by using a one-warehouse system. This scenario offers good efficiency because most of the big users are located close to the central warehouse. The study found that adding one warehouse to the system would increase the efficiency only slightly. However, in this added scenario the geographic coverage of the network increased significantly as the optimal location was surrounded by large areas with low demand. Due to the trade-off between the geographic reach and delivery efficiency the optimal number of health care logistics warehouses in Northern Finland according to this analysis was 1 or 2 depending on decision makers' priorities.

Both scenarios leave a small minority of delivery demand outside the delivery network. These small health centres are located in very remote populated areas with small quantities and long distances. Decent health care logistics services to these areas could be arranged through various frugal solutions, for instance, these might consist of possible integration with delivery networks from industry and retail sectors and collaboration with taxi and non-urgent ambulance transport.

Generally, the analyses in this study provided opportunities for rationalising service levels and increasing cost efficiency in health care logistics also in sparsely populated areas. Hence, the study clearly found that a geographical analysis with GIS-methods could be utilised as a systematic tool to develop solutions for accessible health care logistics services and to find opportunities for the co-creation of value between the logistics service providers and health organisations.

6 Conclusions

This chapter firstly answers the research questions of the dissertation including an updated version of the research framework. The answers are linked to the results of the research Papers I-IV in square brackets after each paragraph. Later the theoretical contributions and managerial and social implications are presented, followed by an evaluation of the study. Finally, the limitations of the study and ideas for future research are discussed.

6.1 Answers to research questions

This dissertation connects discussions on health care logistics services, value co-creation, service modularity, accessibility and resilience of work. The purpose is to describe how value is created within the health care logistics setting, especially considering the context of sparsely populated areas where distances play a critical role in service management. Three specific research questions were formed:

1. *How do different stakeholders contribute to value generation in health care logistics services?*
2. *What implications does distance have on the co-creation of value of health care logistics services?*
3. *How is the dynamics of value co-creation manifested in health care logistics processes?*

How do different stakeholders contribute to value generation in health care logistics services?

Logistics services in health care involve multiple stakeholders and actors. More specifically the value co-creation processes involve patients, employees of both health care and logistics organisations and administrative stakeholders such as hospital management and municipality management. The roles related to value generation in health care logistics are not self-evident because of a somewhat blurred view of who the providers are and who the customers are. However, it is important to consider all the participants in value co-creation on a more specific level to clarify the network of actors and specific actor roles. [Papers I, II and III]

The health care logistics service process begins when the nursing staff order the items that are needed in the health services. These orders are based on the

purchasing contracts that are tendered and negotiated by the procurement unit. After the ordering process, the suppliers supply the items to the hospital's central warehouse, from where the goods are delivered by the hospital transportation to the wards and clinics for the nursing staff to use them while working with the patients. [I]

In health services the patient's view is always central but the patient is not necessarily the one who perceives or creates the value of health care logistics services. Instead, in hospital environment wards and clinics are considered customer organisations in which the nursing staff use the supplied items. The nursing staff play a key role in both perceiving and creating value in health care logistics during the usage of items, processes and resources. Therefore, nurses are the main users of the health care logistics services who create value, whereas the support service organisation facilitates the value creation process. [I, II, III]

The functioning of the logistics chain is crucial for successful health services and therefore the logistics service providers are expected to build safety and trustworthiness for the users of the logistics service. Creating and maintaining well-functioning health care logistics services requires thorough planning and long-term trust building to ensure that the nursing staff can rely on the required items always being available. If the logistics service is trustworthy, the nursing staff will have peace of mind and less stress and thus more time to concentrate on the health service they provide. [I, II, III]

Recognising the nursing staff as the actual customers of the logistics service provider and, thus, as key actors who are able to perceive the usefulness of the logistics services helps to clarify the role of health care logistics services. For the patients, well-functioning logistics support services are mostly invisible, and the value appears only in faulty situations. Therefore, in developing the services the focus could be on how the nursing staff experience the service they are using. With this understanding, the logistics services can be managed to provide more efficient processes and to directly support the nursing work and indirectly also the patient healing process. The critical role of the nursing staff comes from their position in the interface between the patients and the support services. To concentrate on actual nursing work, efficient and reliable support processes are needed. [I, II, III]

Despite the critical role of the nursing staff as users of health care logistics services, a lot of manual logistics work is performed by the nurses themselves. These tasks involve for instance using automated closets and shelves, preparing the items needed in surgeries, ordering missing goods and instruments and delivering items in the ward. Many of these tasks could be undertaken more efficiently by the

logistics personnel. Despite the reality that the nurses and logistics personnel work in the same physical facilities, the members of the different personnel groups do not naturally encounter each other in their everyday work. Therefore, there are no natural events for co-creating the service. During the study, the facilitated workshops with both working groups and simulated co-creation events with an external logistics provider resulted in many improvements, for example, specifying shelf locations in the storage rooms and optimising the order sizes. This clarified task allocation and provided opportunities to adjust working practices. It also helped to increase the resilience at the interface between the logistics personnel and the nursing staff. [II, III]

Clarifying task allocations and becoming a resilient service provider allows logistics organisations to co-create services with their customers. In the study, a part of this involved offering manual logistics work to support the health services. Furthermore, this opened possibilities for the logistics service provider to offer even broader services such as parcel lockers and retail store displays to aid the nursing work leaving the nursing staff to concentrate solely on direct patient work. This resulted in positive outcomes, cost effectiveness and employees' well-being at work. [III]

Increasing the resilience of work can make life easier in small scale organisations. However, the current health care reforms are making the systems larger, meaning that the procedures are being developed towards a more formal and standardised form. This is where modularity can bring value, for example, through standardised layouts of storage and shelf space and assortment planning to provide timely replenishments. This would help nurses to find the needed materials without delays. Developing modular offerings requires time, resources, and co-creation between the stakeholders, but once conceptualised, the service can be easily extended to other units. In addition, the flexibility in the use of external providers for logistics and material supply services can be increased through the modular offerings. [II, III]

Modular logistics services in health care can result in well-being for the nursing staff, and operational efficiencies, replicability, coherence and volume advantages for the logistics service provider. Through modularity, efficiency can be increased without compromising availability and reliability requirements. Additionally, patient process lead times can be shortened, which contributes to the overall cost and operational efficiency of the health care system. From an economic perspective, modularity offers the potential for monetary benefits, which should be visible for the strategic level actors in health care organisations. [II]

The selected attributes of value co-creation—resilience of work, service modularity, and accessibility—affect the interaction between the stakeholders and therefore have implications on the value co-creation processes and their outcomes in health care logistics services. Figure 3 summarises the most prominent outcomes of value co-creation regarding the key stakeholders together with the co-creation attributes introduced above in the theoretical discussion. [I, II, III, IV]

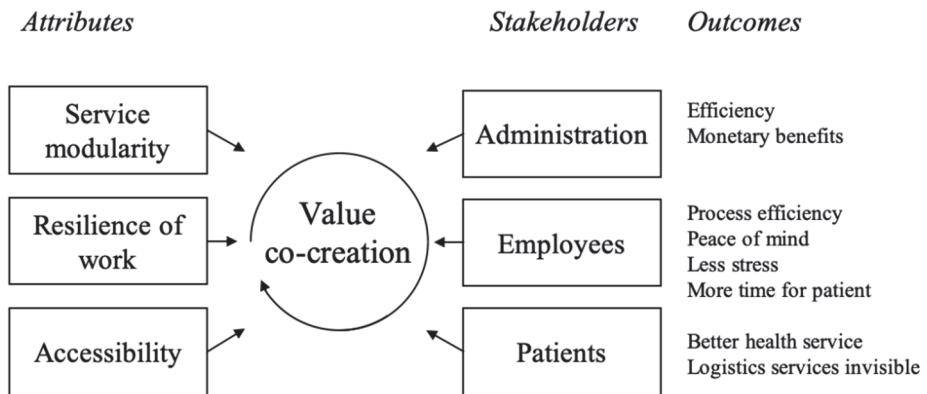


Fig. 3. Outcomes of value co-creation for the key stakeholders.

Both increasing the resilience of work and modularising services improves process efficiency, which is especially important for the employees in the logistics service organisation. Through efficient and trustworthy services, the nursing staff have less stress and more peace of mind, which results in more time for the patients. This also becomes visible to the patients as they see well-delivered and smooth health services, while the logistics services operate more on a back-office basis and are thus invisible to the patients. On the administrative level, the increased value co-creation through modularity, accessibility and resilience increases efficiency, which can be observed by monetary indicators too. [I, II, III]

What implications does distance have on the co-creation of value of health care logistics services?

In the case area of Northern Finland, health care logistics services appear geographically fragmented. Hospitals and health centres typically have their own

logistics service arrangements, such as their own warehouses and logistics personnel. However, the majority of health centres and hospitals could be effectively reached by a delivery network based on just one or two warehouses. Furthermore, the efficiency of the delivery network would not increase significantly by adding more warehouses, when measured by driving time. Centralised warehouses can offer sufficient accessibility for points of use in the health care system with storage rooms that are located in sparsely populated areas. [IV]

Centralising health care logistics services increases the distance between the warehouse and the point of use. Moreover, increasing the distance changes the value creation between the customer and the provider, i.e. between the nursing staff at the points of use and the logistics service provider. Having logistics service facilities in a different location to the point of use requires planning and adjusting the delivery frequencies, volumes, and inventory levels to ensure safe deliveries and to avoid stockouts. This requires value co-creation between the members of staff at the point of use and logistics service provider. [I, IV]

Increasing distance has implications for health care logistics services in a large geographical area and in the hospital setting. Moving the hospital warehouse to a more distant location was considered a major change with various effects on a variety of processes and the image of trustworthiness of the logistics services. However, the increased distance also resulted in a natural need for collaboration between the logistics service provider and customer units in hospital as safe and trustworthy deliveries and inventory levels had to be planned together without resorting to a warehouse within walking-distance. This led to the co-creation of value in terms of the cooperation and service provided. Therefore change was needed in the service structure for securing operations in the new situation. This has resulted in both a better service level and increased efficiency. [I]

To facilitate co-creation, various digital platforms are being increasingly used also in health care logistics. With digital platforms, inventory levels, delivery frequencies, ordering methods and ordering processes are set to ensure more accurate and quicker information flows to drive the material flows. This opens opportunities for rationalising service levels and increasing cost efficiency in health care logistics with systematic tools also in sparsely populated areas. Furthermore digital platforms assist in developing solutions for accessible health care logistics services and help find opportunities for value co-creation between the logistics service providers and both close and distant health organisations. [II, IV]

Implementing centralised warehouse services for health care logistics offers cost efficiencies but also many other benefits. Firstly, the centralised organisation can invest in sufficient warehouse facilities with enough room and all the required equipment. Secondly, a centralised organisation can be developed to become an expert organisation and thus can provide specialist services, such as shelving services, in addition to inventory and planography planning. Thirdly, a centralised warehouse also encourages the implementation of a centralised delivery network with services such as shelving services also for more distant points of use. Therefore, through careful planning and co-creation, the accessibility of adequate health care logistics services can be secured despite the physical distance between the service facilities and points of use. [I, II, IV]

How is the dynamics of value co-creation manifested in health care logistics processes?

Despite their physical proximity, there was little interaction between the nursing staff and the logistics support personnel while the logistics service unit was located close-by. Therefore, the logistics unit and its customer organisations had, over time, got used a situation in which the logistics services were provided very routinely without actually developing or co-creating them. Both parties were lacking proper interaction and simply tried to maintain the ongoing processes. The close location allowed the actors to merely react to everyday situations by themselves and this led them to avoid contact with each other. Therefore, no sustained improvements were necessarily required. This caused inefficiencies related to unclear task allocation, unnecessary searching for items, and also stress for the nursing staff. [I, III]

Moving the warehouse to a more distant location made it impossible for the nursing staff to pick the urgently needed items directly from the warehouse which used to be the backup procedure in error situations. The change forced the actors to make the logistics processes more systematic together by co-creating the services. Thus, the service processes such as ordering, shelving arrangements, inventory levels and delivery frequencies needed to be re-structured. This gave rise to a natural need to develop the services by the customer and provider in their own value spheres and also together in the joint sphere. [I]

The co-creation process took place in joint meetings between the logistics unit and the customer organisation. The new situation clarified the actor roles by recognising the nursing staff as the actual customers of the logistics service provider and recognising them as key actors in perceiving the usefulness of the

logistics services. The focus of the logistics service provider is now on how the nursing staff experience the service they are using. With this understanding, the logistics services are better able to directly support the nursing work. [1]

As a result of the co-creation process, the ad-hoc attitude was replaced by a more systematic form of collaboration and interaction involving both the logistics unit and the customer. This indicates that value co-creation was intensified because of the increased distance between the parties. Furthermore, the increased interaction between the parties resulted in widening the joint value creation sphere and making the customer needs more visible as the inefficiencies and potential risks were identified. [1]

After the change, the new processes became routinised and the frequency of the meetings decreased. However, the meetings are easy to arrange when needed as the co-creation routines are now well-established. Therefore, the actors have become more used to changes and how to react to them. Thus, the joint value creation sphere is dynamic as widens and diminishes according to emerging demands. In the future, the joint value creation sphere might grow further during upcoming changes as the case hospital is being renewed and the sphere may open further during the planned reforms to the health care systems. This will further emphasise the need for value co-creation dynamics in health care logistics in the future. [1]

6.2 Theoretical contributions

This study contributes to the evolving literature on health care logistics and to discussions on value co-creation, service modularity, resilience and accessibility. Firstly, this dissertation contributes to the research on value co-creation by providing new understanding of the development of value creation spheres in the context of health care logistics and also the dynamics of value co-creation. The existing research generally assumes the co-creation spheres to be stable (see Grönroos & Voima, 2013; Holmqvist et al., 2015; Sorrentino et al., 2016). This dissertation proposes the spheres between the customer and the service provider to be dynamic and changing with the development of the relationship. The empirical analysis shows that at the beginning the service provider's and the customer's spheres were separated but came closer together making the joint sphere stronger, more important and more visible as parts of the service process were moved to a distant location.

Secondly, the dissertation proposes empirically grounded observations for the theory-building around the service modularity concept especially in the logistics domain (e.g. Bask et al., 2010) and health care context (e.g. Vähätalo & Kallio, 2015). The constituent elements of modularity are detailed on three levels: organisations, processes and service offerings (Pekkarinen & Ulkuniemi, 2008). These elements show similarities in the modularisation of logistics services between retail and health care settings. Additionally, the link between modularity and the desired outcomes through value co-creation is clarified through practical examples of the changing conditions in health care logistics.

Thirdly, the study of task allocation between the logistics support service personnel and the nursing staff contributes to the literature on organisational resilience, especially in the health care context (see Hollnagel, 2014; Amalberti, 2013; Braithwaite et al., 2013). The dissertation suggests that logistics support services in health care are characterised by resilience in order to respond to changes, errors and opportunities. This can increase both employee well-being and productivity by increasing awareness of the actors in the same environment about the work of others. To achieve positive outcomes, resilience of work is needed to adapt the tasks of the nursing staff and the logistics support service personnel to the changing health care environment.

Fourthly, considering the accessibility and distribution of the health care logistics services over a broad geographical area, this study contributes to the discussion on the trade-off between the efficiency of deliveries and the reach of the delivery network. Even in sparsely populated areas, nearly all service points could be served efficiently through the most centralised scenario. Increasing the number of warehouses has only a marginal influence on efficiency of the delivery network. This also supports lower inventory costs, which are known to increase with the number of warehouses (see Croxton & Zinn, 2005). However, the most distant health centres are challenging to reach efficiently using a centralised delivery network. Focusing only on delivery efficiency without considering the coverage of the delivery network is problematic, especially in public health care services, where all citizens in all areas need to be served equally. However, maximising the coverage would produce a very inefficient network. Therefore, the accessibility of health care logistics services needs to be sufficient despite the physical distance between service facilities and points of use. This requires careful planning of the services using systematic methods such as GIS-tools. This would provide accurate and objective information for value co-creation processes in health care logistics,

and would be especially important when locations, service levels and distribution networks are being rationalised.

6.3 Managerial and social implications

Managing health care logistics services requires an understanding of the concept of value: how value is created, who creates it and what kinds of benefits can be perceived by the different actors. This dissertation proposes answers to these questions and broadens the topic in further directions for the management of hospitals and health care logistics services. Value co-creation in changing situations such as new hospital constructions has been especially clarified through practical examples. In the case study of this research paper, co-creation between the nursing staff and logistics service personnel clarified the task allocation and resilience of work, thus improving the front-office services, while also enhancing the back-office logistics processes in the hospital environment.

Understanding modularity as a cognitive frame for managing health care logistics services clarifies the actor roles and responsibilities in health care organisations. This applies to both in-house service organisations and considerations of using external service providers for logistics support services. However, the modularisation process can be challenging to manage. Standardising product assortments can especially raise various views among the different actors, but attitudes may change with successful experiences.

Regarding the question of accessibility, this dissertation gives a big picture of health care logistics under the influence of the long distances of Northern Finland. Redesigning the logistics system through transport route optimisation and inventory centralisation can help reveal potential improvements. These can also open possibilities for health care logistics management to utilise competitive tendering from external logistics service providers for driving-time-based transport services and capacity acquisition.

Moreover, understanding the value co-creation dynamics and accessibility of health care logistics services opens opportunities for re-organising the service structures. This means, for example, allowing new warehouse locations and possibly outsourcing certain modules of the service. These changes in organisations and facility locations may appear both dramatic and simple, but, overall, they provide options to create positive outcomes for different actors, including the patients.

For health care management, this dissertation recommends conceptual tools and practical solutions for developing their operations. This requires understanding logistics in a broader sense than just viewing them as purchasing or transport organisations. Moreover, logistics services should be designed together with the health operations in close collaboration with manager- and employee-level representatives from both organisations. This can lead to some tasks being re-allocated to logistics personnel, which increases the resource needs of the logistics organisations. However, this should not be seen as a problem as the overall effectiveness and outcomes of health care can also increase considerably.

The focus of this dissertation is mainly on the logistics services that support the health processes in hospitals and health centres. Developing these support services helps nursing staff to focus on patient work which results in better health services. Understanding value co-creation, modularity, resilience of work, and accessibility in the context of health care logistics ideally helps the health service organisations to improve both cost-efficiency and to provide better care for the patients. On a more general level, logistics research thus helps health care systems and societies to cope with the growing cost and quality pressures worldwide.

6.4 Evaluation of the research

According to Lincoln and Guba (1985, 294–301), the trustworthiness of qualitative research can be evaluated through criteria including credibility, transferability, dependability and confirmability. These four components are utilised widely for assessing the quality of interpretivist research approaches (Erlandson et al., 1993) also in logistics studies (Halldórsson & Aastrup, 2003).

Transferability means the degree to which the results can be transferred to other contexts or settings with other respondents (Eriksson & Kovalainen, 2008, p. 294). Firstly, the empirical setting of the Finnish health care system has unique features together with the sparsely populated area of Northern Finland with extremely long distances. Therefore the studies were conducted with the selected cases and the results are in many ways unique to this specific context. However, on a more general level, this dissertation offers conceptual methodological tools that can be applied in the health care sector and possibly in other sectors too also outside this particular geographic context. Secondly, it is possible to examine the question of transferability from an alternative perspective. As mentioned in chapters 1 and 2, it is often argued that health care sectors have unique features that make it difficult to apply concepts and methods from industrial and retail logistics domains. This

dissertation, however, shows that concepts such as modularity and resilience, with or without linking them to the enfolding discussions about value creation or co-creation, can be applied to health care organisations and logistics analysis.

Credibility is sought through triangulation (Lincoln & Guba, 1985, p. 269). This means firstly having broad data that includes different views presented in the way they were intended by multiple sources from different organisations. The organisations involved in this research attended to the research very actively during the 8 years of the study period. Secondly, the studies have involved multiple researchers, many theoretical schemes and a variety of methods to ensure that the research findings represent information drawn from the original data and to provide a correct interpretation of the participants' original views.

Dependability means the stability of findings over time acquired through the participants' evaluation of the findings, interpretation and recommendations that all are supported by the data as received from participants of the study (Eriksson & Kovalainen, 2008, p. 294). The studies of this dissertation were conducted in research and development projects in which the results were regularly presented to and commented on by the steering group members representing the case organisations. This strengthened the understanding of health care as a field and guided the researcher towards relevant questions and observations.

Confirmability refers to the degree to which the findings of the study could be confirmed by other researchers (Korstjens & Moser, 2018). The dissertation process has taken shape along a several-year long path while also the case organisations have developed their logistics processes, organisations, and services to meet the changing requirements of the health care environment. Therefore, repeating the whole set of studies would be demanding and possibly superfluous. However, all the conducted studies clearly present the research processes with a substantial number of citations from recognisable sources in a manner that offers authenticity and the possibility for the research to be replicated. Furthermore, the studies were conducted in groups of researchers who have attended and examined the research process and data analysis to ensure that the findings are consistent. Lastly, the large number of blind review rounds of all four papers have made it possible for external reviewers to evaluate and acknowledge the confirmability of the research.

6.5 Limitations and ideas for further studies

This dissertation has various limitations that have to be taken into account when considering its contributions and implications and from which some future research suggestions can be derived. Firstly, the research focuses on a specific context which offers a source of rich contextual understanding. However, further studies of aspects such as the dynamics of value co-creation spheres in other contextual settings would strengthen the results and bring potentially new views into the academic discussion on the topic.

The case studies were conducted in multidisciplinary research projects in a largely exploratory manner focusing on the particular actors without attempting to cover all the cases that could have the same issues. Instead, the cases and data sources were selected carefully to cover the relevant viewpoints adequately. Future studies could describe and explain the issues in health care supply chains by, for instance, carrying out structured case studies of several hospitals, and studying each engaged party with carefully pre-designed questionnaires or interview protocols. For instance, an item-level analysis of different product categories in the health care units, together with their replenishment models, would give more detailed and structured views on the development of health care logistics.

Multiple methods and contextual backgrounds were used to increase the credibility of the research. This required a significant amount of collaboration with the co-authors to fit the various backgrounds and discussions under one linking context. Now as the research co-operation practices have been routinised, continuing research projects with the co-authors can be initiated smoothly. For instance the GIS-methods used in this dissertation could be further utilised in wider scale research settings including more factors such as carbon emissions and patient locations in the analyses. Therefore utilising the full potential of GIS-methods would open new avenues for health care logistics research.

The research conducted in this dissertation focuses mainly on the Finnish health care system and especially the situation in the sparsely populated northern part of the country. The studies could be further undertaken in other areas to see how long distances affect health care logistics in different health care systems and other kinds of geographical areas, perhaps involving opportunities for cross-border cooperation in logistics and other support services. Moreover synergy in logistics with both public organisations and the growing number of private companies that have entered the health care business would offer new contributions.

The health care services are changing rapidly which requires changes in logistics services too. Therefore continuous research is needed to understand how to adapt to the changing circumstances. One plausible direction would be to examine the role and tasks of a patient participating in his or her own care. Furthermore, preventative care and health maintenance settings may open rewarding opportunities for future research in health care logistics.

References

- Aastrup, J., & Halldórsson, Á. (2008). Epistemological role of case studies in logistics: A critical realist perspective. *International Journal of Physical Distribution & Logistics Management*, 38(10), 746–763.
- Abdulsalam, Y., Gopalakrishnan, M., Maltz, A., & Schneller, E. (2015). Health care matters: Supply chains in and of the health sector. *Journal of Business Logistics*, 36(4), 335–339.
- Ageron, B., Benzidia, S. & Bourlakis, M. (2018). Health care logistics and supply chain—issues and future challenges. *Supply Chain Forum: An International Journal*, 19(1), 1–3.
- Ahmadi-Javid, A., Seyedi, P., & Syam, S. S. (2017). A survey of healthcare facility location. *Computers & Operations Research*, 79, 223–263.
- Amalberti, R. (2013). Resilience and safety in health care: Marriage or divorce? In E. Hollnagel, J. Braithwaite, & R. L. Wears (Eds.). *Resilient health care* (pp. 27–38). Farnham, U.K.: Ashgate.
- Baldwin, C. Y., & Clark, K. B. (2000). Design rules, Vol. 1: The Power of Modularity, Cambridge, MA: MIT Press.
- Ballou, R. H. (2004). *Business Logistics/Supply Chain Management: Planning, Organizing and Controlling the Supply Chain*. (5th ed.). London: Prentice Hall.
- Bamford, D., Thornton, H., & Bamford, J. (2009). Health-care logistics redesign. *OR Insight*, 22(3), 140–152.
- Bask, A., Lipponen, M., Rajahonka, M., & Tinnilä, M. (2010). The concept of modularity: Diffusion from manufacturing to service production. *Journal of Manufacturing Technology Management*, 21(3), 355–375.
- Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report*, 13(4), 544–559.
- Beier, F. J. (1995). The management of the supply chain for hospital pharmacies: A focus on inventory management practices. *Journal of Business Logistics*, 16(2), 153.
- Bélanger, V., Beaulieu, M., Landry, S., & Morales, P. (2018). Where to locate medical supplies in nursing units: An exploratory study. *Supply Chain Forum: An International Journal*, 19(1), 81–89.
- Bijvank, M., & Vis, I. F. (2012). Inventory control for point-of-use locations in hospitals. *Journal of the Operational Research Society*, 63(4), 497–510.
- Blois, K. (2003). Using value equations to analyse exchanges. *Marketing Intelligence & Planning*, 21(1), 16–22.
- Blois, K. (2004). Analyzing exchanges through the use of value equations. *Journal of Business & Industrial Marketing*, 19(4), 250–257.
- Bosona, T. G., & Gebresenbet, G. (2011). Cluster building and logistics network integration of local food supply chain. *Biosystems Engineering*, 108(4), 293–302.
- Bozkaya, B., Yanik, S., & Balcisoy, S. (2010). A GIS-based optimization framework for competitive multi-facility location-routing problem. *Networks and Spatial Economics*, 10(3), 297–320.

- Brahimi, N., & Khan, S. A. (2014). Warehouse location with production, inventory, and distribution decisions: A case study in the lube oil industry. *4OR*, *12*, 175–197.
- Braithwaite, J., Clay-Williams, R., Nugus, P., & Plumb, J. (2013). Health care as a complex adaptive system. In E. Hollnagel, J. Braithwaite, & R. L. Wears (Eds.). *Resilient health care* (pp. 57–74). Farnham, U.K.: Ashgate.
- British Standard BS65000 (2014). Guidance for organizational resilience. British Standards Institution.
- Broekhuis, M., Eissens Van der Laan, M., & Van Offenbeek, M. (2017). What professionals consider when designing a modular service architecture. *International Journal of Operations and Production Management*, *37*(6), 748–770.
- Burrell, G., & Morgan, G. (2019). *Sociological paradigms and organisational analysis: Elements of the sociology of corporate life*. London: Routledge.
- Campbell, J. F., & O'Kelly, M. E. (2012). Twenty-five years of hub location research. *Transportation Science*, *46*, 153–169.
- Carayon, P., & Smith, M. J. (2000). Work organization and ergonomics. *Applied Ergonomics*, *31*, 649–662.
- Cardoen, B., Beliën, J., & Vanhoucke, M. (2015). On the design of custom packs: Grouping of medical disposable items for surgeries. *International Journal of Production Research*, *53*(24), 7343–7359.
- Carù, A., & Cova, B. (2003). Revisiting consumption experience: a more humble but complete view of the concept. *Marketing theory*, *3*(2), 267–286.
- Chakraborty, S., Bhattacharya, S., & Dobrzykowski, D. D. (2014). Impact of supply chain collaboration on value co-creation and firm performance: A healthcare service sector perspective. *Procedia Economics and Finance*, *11*, 676–694.
- Christopher, M. (1998). *Logistics and Supply Chain Management – Strategies for Reducing Cost and Improving Service*. London: Prentice Hall.
- Christopher, M., & Peck, H. (2004). Building the resilient supply chain. *International Journal of Logistics Management*, *15*(2), 1–14.
- Corbin, C. L., Kelley, S. W., & Schwartz, R. W. (2001). Concepts in service marketing for health care professionals. *The American Journal of Surgery*, *181*(1), 1–7.
- Cromley, E. K., & McLafferty, S. L. (2011). *GIS and public health*. New York: Guilford Press.
- Croxton, K. L., & Zinn, W. (2005) Inventory considerations in network design. *Journal of Business Logistics*, *26*(1), 149–168.
- Dacosta-Claro, I. (2002). The performance of material management in health care organizations. *The International Journal of Health Planning and Management*, *17*(1), 69–85.
- Day, G. S. (1990). *Market-driven strategy: Processes for creating value*. New York: The Free Press.
- de Blok, C., Luijkx, K., Meijboom, B., & Schols, J. (2010). Modular care and service packages for independently living elderly. *International Journal of Operations & Production Management*, *30*(1), 75–97.

- de Blok, C., Meijboom, B., Luijkx, K., Schols, J., & Schroeder, R. (2014). Interfaces in service modularity: A typology developed in modular health care provision. *Journal of Operations Management*, 32(4), 175–189.
- de Vries, J., & Huijsman, R. (2011). Supply chain management in health services: an overview. *Supply Chain Management: An International Journal*, 16(3), 159–165.
- Denzin, N. K., & Lincoln, Y. S. (2000). Introduction: The discipline and practice of qualitative research. In: N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 1–28). Thousand Oaks, C. A.:Sage.
- Dobrzykowski, D., Deilami, V. S., Hong, P., & Kim, S. C. (2014). A structured analysis of operations and supply chain management research in healthcare (1982–2011). *International Journal of Production Economics*, 147, 514–530.
- Dubois, A., & Gadde, L. E. (2002). Systematic combining: an abductive approach to case research. *Journal of Business Research*, 55(7), 553–560.
- Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review*, 14(4), 532–550.
- Elmuti, D., Khoury, R., Omran, O., & Abou-Zaid, A. (2013). Challenges and opportunities of health care supply chain management in the United States. *Health Mark. Q.* 30(2), 128–143.
- Eltantawy, R.A. (2016). The role of supply management resilience in attaining ambidexterity: A dynamic capabilities approach. *Journal of Business & Industrial Marketing*, 31(1), 123–134.
- Eriksson, P., & Kovalainen, P. (2008). *Qualitative methods in business research*. London: Sage.
- Erlandson, D. A., Harris, E. L., Skipper, B. L., & Allen, S. D. (1993). *Doing naturalistic inquiry: A guide to methods*. London: Sage.
- Farahani, R. Z., Hekmatfar, M., Arabani, A. B., & Nikbakhsh, E. (2013). Hub location problems: A review of models, classification, solution techniques, and applications. *Computers & Industrial Engineering*, 64(4), 1096–1109.
- Fawcett, S. E., & Waller, M. A. (2011). Making sense out of chaos: Why theory is relevant to supply chain research. *Journal of Business Logistics*, 32(1), 1–5.
- Fugate, B. S., Mentzer, J. T., & Stank, T. P. (2010). Logistics performance: Efficiency, effectiveness, and differentiation. *Journal of Business Logistics*, 31(1), 43–62.
- Galvagno, M., & Dalli, D. (2014). Theory of value co-creation: A systematic literature review. *Managing Service Quality*, 24(6), 643–683.
- Gammelgaard, B. (2004). Schools in logistics research? A methodological framework for analysis of the discipline. *International Journal of Physical Distribution & Logistics Management*, 34(6), 479–491.
- Geoffrion, A. M., & Powers, R. F. (1995). Twenty years of strategic distribution system design: An evolutionary perspective. *Interfaces* 25(5), 105–127.
- Graves, S. C., Willems, S. P., & Zipkin, P., (2000). Optimizing Strategic Safety Stock Placement in Supply Chains. *Manufacturing & Service Operations Management*, 2(1), 68–83.

- Grönroos, C. (2008), Service logic revisited: Who creates value? And who co-creates?. *European Business Review*, 20(4), 298–314.
- Grönroos, C. (2011). Value co-creation in service logic: A critical analysis. *Marketing Theory*, 11(3), 279–301.
- Grönroos, C., & Voima, P. (2013). Critical service logic: Making sense of value creation and co-creation. *Journal of the Academy of Marketing Science*, 41(2), 133–150.
- Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105–117). Thousand Oaks, C. A.: Sage.
- Gummerus, J. (2013). Value creation processes and value outcomes in marketing theory: Strangers or siblings? *Marketing Theory*, 13(1), 19–46.
- Halldórsson, A., & Aastrup, J. (2003). Quality criteria for qualitative inquiries in logistics. *European Journal of Operational Research*, 144(2), 321–332.
- Halldórsson, A., Kotzab, H., Mikkola, J. H., & Skjoett-Larsen, T. (2007). Complementary theories to supply chain management. *Supply Chain Management: An International Journal*, 12(4), 574–586.
- Handfield, R. B., & Nichols, E. L. (1999). *In Introduction to supply chain management (Vol. 183)*. Upper Saddle River, NJ: Prentice Hall.
- Harrison, A., & van Hoek, R. (2005). *Logistics Management and Strategy*. Harlow: Pearson Education Limited.
- Kjellberg, H., & Helgesson, C. (2007). On the nature of markets and their practices. *Marketing Theory*, 7(2), 137–162.
- Heizer, J., & Render, B., (2014). *Operations Management: Sustainability and Supply Chain Management*. Harlow: Pearson Education Limited.
- Heizer, J., Render, B., & Munson, C. (2017). *Operations Management: Sustainability and supply chain management*. Harlow: Pearson Education Limited.
- Helkkula, A., Kelleher, C., & Pihlström, M. (2012). Characterizing value as an experience: implications for service researchers and managers. *Journal of Service Research*, 12(1), 59–75.
- Herrera, A., & Janczewski, L. (2016). Cloud supply chain resilience model: Development and validation. Proceedings - 49th Hawaii International Conference on System Sciences (HICSS), 3938–3947.
- Hilmola, O. P. (2018). *Supply Chain Cases, Leading Authors, Research Themes and Future Direction*. Palgrave Macmillan, UK Pivot Series.
- Hohenstein, N. O., Feisel, E., Hartmann, E., & Giunipero, L. (2015). Research on the phenomenon of supply chain resilience: A systematic review and paths for further investigation. *International Journal of Physical Distribution & Logistics Management*, 45(1/2), 90–117.
- Hollnagel, E. (2014). Resilience engineering and the built environment. *Building Research & Information*, 42(2), 221–228.
- Hollnagel, E., Braithwaite, J., & Wears, R. L. (2013). *Resilient health care*. Farnham, UK: Ashgate.

- Holmqvist, J., Guest, D., & Grönroos, C. (2015). The role of psychological distance in value creation. *Management Decision*, 53(7), 1430–1451.
- Jacobson, P. D., & Neumann, P. J. (2009). A framework to measure the value of public health services. *Health Services Research*, 44(5p2), 1880–1896.
- Janssen, M., & Joha, A. (2008). Emerging shared service organizations and the service oriented enterprise: Critical management issues. *Strategic Outsourcing: An International Journal*, 1(1), 35–49.
- Jarrett, G.P. (1998). Logistics in the health care industry. *International Journal of Physical Distribution and Logistics Management*, 28(9/10), 741–772.
- Järvensivu, T., & Törnroos, J. (2010). Case study research with moderate constructionism: Conceptualization and practical illustration. *Industrial Marketing Management*, 39(1), 100–108.
- Kaplan, R. S., & Porter, M. E. (2011). How to solve the cost crisis in health care. *Harvard Business Review*, 89(9), 46–52.
- Ketokivi, M., & Choi, T. (2014). Renaissance of case research as a scientific method. *Journal of Operations Management*, 32, 232–240.
- Korstjens, I., & Moser, A. (2018). Series: Practical guidance to qualitative research. Part 4: trustworthiness and publishing. *European Journal of General Practice*, 24(1), 120–124.
- Kovács, G., & Spens, K. M. (2005). Abductive reasoning in logistics research. *International Journal of Physical Distribution & Logistics Management*, 35(2), 132–144.
- Kriegel, J., Jehle, F., Dieck, M., & Mallory, P. (2013). Advanced services in hospital logistics in the German health service sector. *Logistics Research*, 6(2–3), 47–56.
- Kumar, A., Ozdamar, L., & Ning Zhang, C. (2008). Supply chain redesign in the health care industry of Singapore. *Supply Chain Management: An International Journal*, 13(2), 95–103.
- Kwon, I. W. G., Kim, S. H., & Martin, D. G. (2016). Healthcare supply chain management: Strategic areas for quality and financial improvement. *Technological Forecasting and Social Change*, 113, 422–428.
- Lambert, D. M., Cooper, M. C., & Pagh, J. D. (1998). Supply chain management implementation issues and research opportunities. *The International Journal of Logistics Management*, 9(2), 1–20.
- Lambert, D. M., Emmelhainz, M. A., & Gardner, J. T. (1996). Developing and implementing supply chain partnerships. *The International Journal of Logistics Management*, 7(2), 1–18.
- Landry, S., & Philippe, R. (2004). How logistics can service health care. *Supply Chain Forum*, 5(2), 24–30.
- Landry, S., & Beaulieu, M. (2013). The challenges of hospital supply chain management, from central stores to nursing units. In B. T. Denton (Ed.), *Handbook of Healthcare Operations Management* (pp. 465–482). New York, NY.: Springer.
- Langford, J., & McDonagh, D. (Eds.). (2003). *Focus groups: Supporting effective product development*. London: Taylor & Francis.
- Langley Jr, C. J., & Holcomb, M. C. (1992). Creating logistics customer value. *Journal of Business Logistics*, 13(2), 1–27.

- Lapierre, S. D., & Ruiz, A. B. (2007). Scheduling logistic activities to improve hospital supply systems. *Computers & Operations Research* 34, 624–641.
- Ledlow, G. R., Manrodt, K. B., & Schott, D. E. (2017). *Health care Supply Chain Management: Elements, Operations and Strategies*. Burlington, MA.: Jones & Bartlett Learning.
- Lehtimäki, T., Komulainen, H., Oinonen, M., & Salo, J. (2018). The value of long-term co-innovation relationships: Experiential approach. *International Journal of Business Innovation and Research*, 16(1), 1–23.
- Lei, T. L., Church, R. L., & Lei, Z. (2016). A unified approach for location-allocation analysis: integrating GIS, distributed computing and spatial optimization. *International Journal of Geographical Information Science*, 30(3), 515–534.
- Leroy, J., Cova, B., & Salle, R. (2013). Zooming in VS zooming out on value co-creation: Consequences for BtoB research. *Industrial Marketing Management*, 42(7), 1102–1111.
- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiry*. Newbury Park: Sage.
- Little, J., & Coughlan, B. (2008). Optimal inventory policy within hospital space constraints. *Health Care Management Science* 11, 177–183.
- Lusch, R. F. (2011). Reframing supply chain management: A service-dominant logic perspective. *Journal of Supply Chain Management*, 47(1), 14–18.
- Macdonald, E., Wilson, H., Martinez, V., & Toossi, A. (2011). Assessing value-in-use: A conceptual framework and exploratory study. *Industrial Marketing Management*, 40(5), 671–682.
- Masters, J. (1995). The history of action research. In I. Hughes (Ed.), *Action research electronic reader*. Sydney, Australia: The University of Sydney.
- Meijboom, B., Schmidt-Bakx, S., & Westert, G. (2011). Supply chain management practices for improving patient-oriented care. *Supply Chain Management: An International Journal*, 16(3), 166–75.
- Menor, L. J., & Johnson, P. F. (2012). Service operations management and service supply network triadic arrangements. *Proceedings - 4th World Conference Production & Operations Management*, Amsterdam.
- Miller H., & Shaw S.-L. (2001). *Geographic Information Systems for Transportation Principles and Application*. Oxford: Oxford University Press.
- Möller, K. E., & Törrönen, P. (2003). Business suppliers' value creation potential. A capability-based analysis. *Industrial Marketing Management*, 32(2), 109–118.
- Nachtmann, H., & Pohl, E. A. (2009). *The state of healthcare logistics: Cost and quality improvement opportunities*. Center for Innovation in Healthcare Logistics, University of Arkansas.
- Ohno, T. (1988). *Toyota production system: beyond large-scale production*. Boca Raton, F. L.: CRC Press.
- Olsson, O., Wiger, M., & Aronsson, H. (2014). Developments in the field of health care logistics and SCM: A patient flow focus. *Proceedings - 26th Conference of the Nordic Logistics Research Network*, 409–422.
- Orton, J. D. (1997). From inductive to iterative grounded theory: Zipping the gap between process theory and process data. *Scandinavian Journal of Management*, 13(4), 419–438.

- Páez, A., Scott, D. M., & Morency, C., (2012). Measuring accessibility: positive and normative implementations of various accessibility indicators. *Journal of Transport Geography*, 25, 141–153.
- Pekkarinen, S., & Ulkuniemi, P. (2008). Modularity in developing business services by platform approach. *The International Journal of Logistics Management*, 19(1), 84–103.
- Perks, H., Gruber, T., & Edvardsson, B. (2012). Co-creation in radical service innovation: A systematic analysis of microlevel processes. *Journal of Product Innovation Management*, 29(6), 935–951.
- Pettit, T. J., Fiksel, J., & Croxton, K. L. (2010). Ensuring supply chain resilience: Development of a conceptual framework. *Journal of Business Logistics*, 31(1), 1–21.
- Polo, G., Acosta, C. M., Ferreira, F., & Dias, R. A. (2015). Location-allocation and accessibility models for improving the spatial planning of public health services. *PLoS one* 10(3), 1–14.
- Ponomarov, S. Y., & Holcomb, M. C. (2009). Understanding the concept of supply chain resilience. *International Journal of Logistics Management*, 20(1), 124–143.
- Porter, M. E., & Lee, T. H. (2013). The strategy that will fix healthcare. *Harvard Business Review*, 91(12), 50–70.
- Poulin, E. (2003). Benchmarking the hospital logistics process: A potential cure for the ailing healthcare sector. *CMA Management*, 77(1), 20–23.
- Prodhon, C., Prins, C. (2014). A survey of recent research on location-routing problems. *European Journal of Operational Research*, 23(1), 1–17.
- Rajahonka, M., Bask, A., & Lipponen, M. (2013). Modularity and customisation in LSP's service strategies. *International Journal of Services and Operations Management*, 16(2), 174–204.
- Ren, S. J., Hu, C., Ngai, E. W. T., & Zhou, M. (2015). An empirical analysis of inter-organisational value co-creation in a supply chain: A process perspective. *Production Planning & Control*, 26(12), 969–980.
- Rivard-Royer, H., Landry, S., & Beaulieu, M. (2002). Hybrid stockless: A case study: lessons for health-care supply chain integration. *International Journal of Operations and Production Management*, 22(4), 412–24.
- Rodrigue J-P, Comtois, C., & Slack, B. (2013). *The Geography of Transport Systems*. (3rd ed.). New York: Routledge.
- Russo Spena, T., Caridà, A., Colurcio, M., & Melia, M. (2012). Store experience and co-creation: the case of temporary shop. *International Journal of Retail & Distribution Management*, 40(1), 21–40.
- Rutenberg, D.P. (1971). Design commonality to reduce multi-item inventory: Optimal depth of a product line. *Operations Research*, 19(2), 491–509.
- Rutner, S. M., & Langley Jr, C. J. (2000). Logistics value: definition, process and measurement. *The International Journal of Logistics Management*, 11(2), 73–82.
- Sandoff, M. (2005). Customization and standardization in hotels – a paradox or not? *International Journal of Contemporary Hospitality Management*, 17(6), 529–535.
- Schilling, M. A., & Steensma, H. K. (2001). The use of modular organizational forms: An industry-level analysis. *Academy of Management Journal*, 44(6), 1149–1168.

- Shapiro, R. D., & Heskett, J. L. (1985). *Logistics Strategy: Cases and Concepts*, St Paul, M.N.: West Group.
- Silander, K., Torkki, P., Lillrank, P., Peltokorpi, A., Brax, S.A., & Kaila, M. (2017). Modularizing specialized hospital services: Constraining characteristics, enabling activities and outcomes. *International Journal of Operations & Production Management*, 37(6), 791–818.
- Soffers, R., Meijboom, B., van Zaanen, J., & van der Feltz-Cornelis, C. (2014). Modular health services: A single case study approach to the applicability of modularity to residential mental healthcare, *MMC Health Services Research*, 14(1), 1–10.
- Sorrentino, M., De Marco, M., & Rossignoli, C. (2016). Health care co-production: Co-creation of value in flexible boundary spheres. *Proceedings - International Conference on Exploring Services Science*, 649–659.
- Speranza, M. G. (2018). Trends in transportation and logistics. *European Journal of Operational Research*, 264(3), 830–836.
- Spinuzzi, C. (2005). The methodology of participatory design. *Technical Communication*, 52(2), 163–174.
- Stewart, D. W., & Shamdasani, P. N. (2014). *Focus Groups: Theory and Practice (Vol. 20)*. Thousand Oaks, C.A.: Sage publications.
- Stock J.R. (1997). Applying theories from other disciplines to logistics. *International Journal of Physical Distribution & Logistics Management* 27(9/10), 515–539.
- Tong, D., & Murray, A. T. (2012). Spatial optimization in geography. *Annals of the Association of American Geographers* 102(6), 1290–1309.
- Töttö, P. (1997). *Pirullinen positivismi - Kysymyksiä laadulliselle tutkimukselle*. Jyväskylä: Kampus kustannus.
- Ulkuniemi, P., & Pekkarinen, S. (2011). Creating value for the business service buyer through modularity. *International Journal of Services and Operations Management*, 8(2), 127–141.
- Vähätalo, M., & Kallio, T. J. (2015). Organising health services through modularity. *International Journal of Operations & Production Management*, 35(6), 925–945.
- Vargo, S. L., & Lusch, R. F. (2004). Evolving to a new dominant logic for marketing. *Journal of Marketing*, 68(1), 1–17.
- Vissers, J., & Beech, R. (2005). *Health Operations Management: Patient Flow Logistics in Health Care*. New York, N.Y.: Routledge.
- Volland, J., Fügener, A., Schoenfelder, J., & Brunner, J. O. (2017). Material logistics in hospitals: A literature review. *Omega*, 69, 82–101.
- Voss, C. A., & Hsuan, J. (2009). Service architecture and modularity. *Decision Sciences*, 40(3), 541–569.
- Wetter-Edman, K., Sangiorgi, D., Edvardsson, B., Holmlid, S., Grönroos, C., & Mattelmäki, T. (2014). Design for value co-creation: Exploring synergies between design for service and service logic. *Service Science*, 6(2), 106–121.
- Woodruff, R. B., & Gardial, S. F. (1996). *Know your customer: New approaches to understanding customer value and satisfaction*. Cambridge, M.A.: Blackwell Publishers.

- Woodruff, R.B. (1997), Customer value: the next source for competitive advantage. *Journal of the Academy of Marketing Science*, 25(2), 139–153.
- Yazdanparast, A., Manuj, I., & Swartz, S. M. (2010). Co-creating logistics value: A service-dominant logic perspective. *The International Journal of Logistics Management*, 21(3), 375–403.
- Yin, R. K. (2013). *Case Study Research. Design and Methods*. Thousand Oaks: Sage Publications.

Original papers

- I Pohjosenperä, T. & Komulainen H. Getting closer by increasing distance: The dynamics of value creation spheres in health care logistics. Accepted to *Journal of Business and Industrial Marketing*.
- II Pohjosenperä, T., Kekkonen, P., Pekkarinen, S. & Juga, J. (2019). Service modularity in managing healthcare logistics. *International Journal of Logistics Management*, 30(1), 174–194.
- III Kekkonen P., Pohjosenperä T., Kantola H. & Väyrynen S. (2018). Rational and participative task allocation between the nursing staff and the logistics support service provider in healthcare. *Human Factors and Ergonomics in Manufacturing and Service Industries*, 28(3), 117–129.
- IV Kotavaara, O., Pohjosenperä, T., Juga, J., & Rusanen, J. (2017). Accessibility in designing centralised warehousing: Case of health care logistics in Northern Finland. *Applied Geography*, 84, 83–92.

Reprinted with permission from Emerald Publishing Ltd. © (I, II), John Wiley & Sons Inc. (III) and Elsevier Ltd. © (IV).

Original publications are not included in the electronic version of the dissertation.

99. Tan, Teck Ming (2018) Humanizing brands : the investigation of brand favorability, brand betrayal, temporal focus, and temporal distance
100. Tan, Irene (2018) Essays on the effects of investor protection and financial structure on firm decisions and outcomes
101. Pikkujäämsä, Pauliina (2018) Place marketing and foreign direct investments in the changing ICT era
102. Huikari, Sanna (2018) Empirical studies on economics of suicides and divorces
103. Haapalainen, Tuomo (2018) Essays on the effects of past gains on subsequent risk-taking and stock returns
104. Alapeteri, Anna (2018) The effects of using English as a business lingua franca on spoken brand co-creation communication : a discursive approach
105. Haukipuro, Lotta (2019) User-centric product and service development in a multi-context living lab environment : case OULLabs and PATIO
106. Keränen, Outi (2019) Developing public-private partnerships in centralized public procurement
107. Ruokamo, Enni (2019) Household preferences for energy goods and services : a choice experiment application
108. Olaleye, Sunday (2019) The role of mobile devices in online retailing : empirical evidence from Finland and Nigeria
109. Brahman, Paskaran (2019) Cultural practices in the project based construction companies : its impact on information system implementation
110. Kallunki, Jenni (2019) Corporate insiders' personal characteristics and insider trading
111. Torvinen, Hannu (2019) It takes three to tango : end-user engagement in innovative public procurement
112. Xu, Yueqiang (2019) Open business models for future smart energy : a value perspective
113. Salehi, Hamed (2020) The use of ETFs and protective option strategies by delegated asset managers
114. Hatami, Akram (2020) Keep Others in mind : a way to proceed with ethical decisions under uncertainty

S E R I E S E D I T O R S

A
SCIENTIAE RERUM NATURALIUM
University Lecturer Tuomo Glumoff

B
HUMANIORA
University Lecturer Santeri Palviainen

C
TECHNICA
Postdoctoral researcher Jani Peräntie

D
MEDICA
University Lecturer Anne Tuomisto

E
SCIENTIAE RERUM SOCIALIUM
University Lecturer Veli-Matti Ulvinen

E
SCRIPTA ACADEMICA
Planning Director Pertti Tikkanen

G
OECONOMICA
Professor Jari Juga

H
ARCHITECTONICA
University Lecturer Anu Soikkeli

EDITOR IN CHIEF
University Lecturer Santeri Palviainen

PUBLICATIONS EDITOR
Publications Editor Kirsti Nurkkala



ISBN 978-952-62-2616-3 (Paperback)
ISBN 978-952-62-2617-0 (PDF)
ISSN 1455-2647 (Print)
ISSN 1796-2269 (Online)