



Turun yliopisto
University of Turku

MODULARITY IN HEALTH AND SOCIAL SERVICES

Perspectives on Organization and Management

Mervi Vähätalo

University of Turku

Turku School of Economics

Pori unit

Organization and management

Supervised by

Adjunct Professor Tomi J. Kallio
Turku School of Economics, Pori Unit
University of Turku, Finland

Reviewed by

Professor Petri Virtanen
School of Health Sciences
University of Tampere, Finland

Professor Juliana Hsuan
Department of Operations Management
Copenhagen Business School, Denmark

Opponent

Professor Juliana Hsuan
Department of Operations Management
Copenhagen Business School, Denmark

The originality of this thesis has been checked in accordance with the University of Turku quality assurance system using the Turnitin OriginalityCheck service.

Sarja E 1

ISBN 978-951-29-6428-4 (PRINT)

ISBN 978-951-29-6429-1 (PDF)

ISSN 2343-3159 (Print)

ISSN 2343-3167 (PDF)

Juvenes Print - Tampere 2016

SUMMARY

Modularity in Health and Social Services: Perspectives on Organization and Management

Organizations that provide health and social services operate in a complex and constantly changing environment. Changes occur, for example, in ageing, technology and biotechnology, and customers' expectations, as well as the global economic situation. Organizations typically aim to adapt the changes by introducing new organizational structures and managerial practices, such as process and lean management.

Only recently has there been an interest in evaluating whether organizations providing health and social services could apply modularity in order to respond to some of the changes. The concept of modularity originates from manufacturing, but is applied in many other disciplines, such as information technology and logistics. However, thus far, the literature concerning modularity in health and social services is scarce. Therefore the purpose of this thesis is to increase understanding concerning modularity and the possibilities to apply modularity in the health and social services context. In addition, the purpose is to shed light on the viewpoints that are worth taking into account when considering the application of modularity in the health and social services context.

The aim of the thesis is to analyze the way in which the modular structures are applied in the health and social services context and to analyze what advantages and possible barriers, as well as managerial concerns, might occur if modularity is applied in the health and social services context.

The thesis is conducted by using multiple methods in order to provide a broad aspect to the topic. A systematic literature review provided solid ground for pre-understanding the topic and supported the formulation of the research questions. Theoretical reasoning provided a general overview of the special characteristics of the health and social services context and their effect on application of modularity. Empirical studies concentrated on managerial concerns of modularity particularly from the perspective of health and social services for the elderly.

Results of the thesis reveal that structures in products, services, processes, and organizations are rather modular in health and social services. They can be decomposed in small independent units, while the challenges seem to occur especially in the compatibility of the services. It seems that health and social services managers have recognized this problem and they are increasingly paying attention to this challenge in order to enhance the flexible compatibility of services.

Advantages and possible barriers of modularity are explored in this thesis, and from the theoretical perspective it could be argued that modularity seems to be beneficial in the context of health and social services. In fact, it has the potential to alleviate several of the challenges that the health and social services context is

confronting. For example, modular structures could support organizations in their challenging task to respond to customers' increasing demand for heterogeneous services. However, special characteristics of the health and social services context create barriers and provide significant challenges in application of modularity. For example, asymmetry of information, negative externalities, uncertainty of demand, and rigid regulation prevent managers from extensively drawing benefits from modularity.

Results also reveal that modularity has managerial implications in health and social service. Modularity has the potential to promote and support new service development and outsourcing. Results also provide insights into network management and increases managerial understanding of different network management strategies. Standardization in health and social services is extensive due to legislation and recommendations. Modularity provides alternative paths to take an advantage of standardization while still ensuring the quality of the services.

Based on this thesis, it can be concluded, both from a theoretical perspective and from empirical results concerning modularity in health and social services, that modularity might fit well and be beneficial. However, the special characteristics of the health and social services context prevent some of the benefits of modularity and complicate its application.

This thesis contributes to the academic literature on the organization and management of health and social services by describing modularity as an alternative way for organizing and managing health and social services. In addition, it contributes to the literature of modularity by exploring the applicability of modularity in the context of health and social services. It also provides practical contribution to health and social services managers by evaluating the pros and cons of modularity when applied to health and social services.

Keywords: organization, management, modularity, health and social services

TIIVISTELMÄ

Modulaarisuus sosiaali- ja terveydenhuollossa: Näkökulmia organisointiin ja johtamiseen

Sosiaali- ja terveystaloudellisia tuottavien organisaatioiden toimintaympäristö on kompleksinen ja alati muuttuva. Toimintaympäristön muutokset liittyvät muun muassa väestön ikääntymiseen, teknologisiin ja bioteknologisiin muutoksiin, asiakkaiden muuttuviin odotuksiin sekä maailman kokonaistaloudellisen tilanteen muutoksiin. Organisaatioilla on taipumusta sopeutua muutoksiin ottamalla käyttöön uusia organisointimalleja ja johtamistapoja, kuten esimerkiksi prosessi-johtaminen tai lean-johtaminen.

Viimeaikoina on herännyt kiinnostus arvioida, voisivatko sosiaali- ja terveydenhuollon organisaatiot hyödyntää modulaarisuutta toimintaympäristön muutoksiin sopeutumisessa. Modulaarisuus käsitteenä on peräisin valmistavasta teollisuudesta, mutta sitä on sovellettu myös muilla aloilla, muun muassa tietotekniikassa ja logistiikassa. Modulaarisuuden hyödyntämisestä sosiaali- ja terveydenhuoltoon on toistaiseksi vain vähän tietoa. Tämän tutkimuksen tavoitteena onkin lisätä ymmärrystä modulaarisuudesta ja mahdollisuuksista soveltaa modulaarisuutta sosiaali- ja terveydenhuoltoon. Lisäksi tavoitteena on tuoda esille näkökulmia, joiden huomioon ottaminen on tärkeää pohdittaessa modulaarisuuden käyttöönottoa sosiaali- ja terveydenhuollossa.

Tutkimuksen tarkoituksena on analysoida, miten modulaariset rakenteet näyttäytyvät sosiaali- ja terveydenhuollossa. Lisäksi tarkoituksena on analysoida, mitä etuja modulaarisuudella voidaan saavuttaa ja mitä mahdollisia esteitä sen käyttöönotolle voi olla. Lisäksi tarkastellaan, mitä johtamiseen liittyviä näkökulmia modulaarisuuden soveltamisessa tulisi huomioida.

Näkökulmien monipuolisuuden turvaamiseksi, tutkimuksessa hyödynnettiin useita erilaisia tutkimusmenetelmiä. Perehtyminen aiheeseen systemaattisen kirjallisuuskatsauksen avulla auttoi muodostamaan esiyymmärryksen aiheesta ja tarkentamaan tutkimuskysymyksiä. Teoreettisen päättelyn avulla tarkasteltiin sosiaali- ja terveydenhuollon erityispiirteitä ja niiden vaikutuksia modulaarisuuden sovellettavuuteen. Empiirisissä tutkimuksissa tarkasteltiin modulaarisuutta johtamisen, erityisesti vanhuspalveluiden johtamisen, näkökulmasta.

Tutkimuksen tulosten perusteella voidaan todeta, että tuotteiden, palveluiden, prosessien ja organisaatioiden rakenteet ovat varsin modulaarisia sosiaali- ja terveydenhuollossa. Rakenteiden pilkkominen pienempiin osakokonaisuuksiin on jokseenkin yksinkertaista. Sen sijaan haasteita ilmenee erityisesti osien yhteenliitettävyydessä. Sosiaali- ja terveydenhuollon johtajat ovat kuitenkin tunnistanee ongelman ja kiinnittävät asiaan enenevässä määrin huomiota mahdollistaakseen osakokonaisuuksien joustavan yhdistelyn.

Teoreettisen tarkastelun perusteella voidaan todeta, että sosiaali- ja terveydenhuolto voi hyötyä modulaarisuuden soveltamisesta. Modulaarisuus voi auttaa kohtaamaan joitakin sosiaali- ja terveydenhuoltoon kohdistuvista haasteista, esimerkiksi asiakkaiden heterogeenisiin tarpeisiin vastaamista voidaan tukea modulaaristen rakenteiden avulla. Sosiaali- ja terveydenhuollon erityispiirteet voivat kuitenkin aiheuttaa esteitä tai ainakin merkittäviä haasteita modulaarisuuden soveltamiselle. Esimerkiksi, tiedon epäsuhta, negatiiviset ulkoisvaikutukset ja alan voimakas sääntely heikentävät modulaarisuudesta saatavia hyötyjä.

Tutkimuksen tulokset paljastivat myös modulaarisuuden vaikutuksia sosiaali- ja terveydenhuollon johtamiseen. Modulaarisuus voi edistää uusien palveluiden kehittämistä ja tukea tuotteiden ja palveluiden alihankintaa. Tulokset avaavat uusia näkökulmia verkostojohtamiseen ja edistävät erilaisten verkostojohtamisstrategioiden ymmärtämistä. Rakenteiden näkeminen modulaarisena auttaa hahmottamaan, miltä osin tuotteiden ja palveluiden standardointi edistää vaikuttavuutta ja innovaatioita.

Tämän tutkimuksen perusteella voidaan sekä teoreettisesti että empiirisesti tarkasteltuna todeta, että modulaarisuus soveltuu sosiaali- ja terveydenhuoltoon melko hyvin. Sosiaali- ja terveydenhuollon erityispiirteet heikentävät osittain modulaarisuudesta saatavia hyötyjä ja hankaloittavat modulaarisuuden käyttöönottoa.

Tutkimus edistää teoreettista ymmärrystä sosiaali- ja terveydenhuollon organisoinnista ja johtamisesta kuvaamalla modulaarisuutta yhtenä vaihtoehtoisena organisointitapana ja siihen liittyviä johtamisen näkökulmia. Lisäksi tutkimus syventää modulaarisuuteen liittyvää kirjallisuutta kuvaamalla, miten modulaarisuutta voidaan hyödyntää juuri tässä kontekstissa. Tutkimus kuvaa myös modulaarisuutta sosiaali- ja terveydenhuollossa käytännön hyödyntämisen näkökulmasta ja tuo esille niitä etuja ja haittoja, joita modulaarisuuden soveltamisesta voi aiheutua.

Asiasanat: Organisointi, johtaminen, modulaarisuus, sosiaali- ja terveystalvet

ACKNOWLEDGEMENTS

I believe this story began in 1994 in England, where I worked as an au pair for two scholars, Joanna Latimer and Rolland Munro. I remember sitting at the dinner table at 10 pm every day, listening to how they discussed and debated societal issues, especially organizing health and social service. Although I was nearly asleep, I was still interested in their academic discussions: I was fascinated. Later, in nursing school, unlike most of my student colleagues, I loved methodology and research. I knew I would one day undertake doctoral studies. When and where, I did not know yet.

For the opportunity to start my doctoral studies I wish to thank our former development director Pertti Laine, who hired me, a nursing scientist, to work in the Turku School of Economics, Pori Unit, in 2009. In his mind, “multidisciplinary” was not only a word: instead, he had multidisciplinary team that I had the privilege to be a part of. I am thankful for Professor Timo Sneek, who first introduced me to the topic of modularity in health and social services, and for my first supervisor, Professor Ismo Rähkä, who got me started and helped me with my first article.

I am most grateful to my supervisor, Adjunct Professor Tomi J. Kallio, who kept me going all these years. As a co-author, he provided sharp comments on the manuscripts annoyingly quickly. Tirelessly, he pointed out my mistakes in academic writing but also provided encouraging feedback. Despite of many moments of disillusionment he never made me feel that I should not carry on. Thank you, Tomi. I appreciate your support.

I am also grateful to Professor Ulla Hytti for helping me through all the bureaucracy during the final six months.

I wish to thank my pre-examiners, Professor Petri Virtanen and Professor Juliana Hsuan, who provided valuable comments on my thesis. I am grateful for Petri Virtanen, who has incomparable practical expertise in organizing and managing health and social services, for pointing out important aspects of practical contributions on my thesis. I am also grateful to Juliana Hsuan, who, being one of the most respected modularity researchers agreed to act as my pre-examiner and opponent and provided encouraging comments and useful suggestions on my thesis.

As I was the only one studying modularity in the Turku School of Economics, I sometimes felt I was alone with my substantial questions. Therefore, I wish to thank the European Network for Service Modularity; its senior scholars Juliana Hsuan, Anu Bask, Chris Voss, Saara Pekkarinen, and Carolien De Blok, to name a few, offered kind and incisive comments in our yearly seminars. I believe it has been unique to have such respected scholars providing comments and having unreserved discussions with junior scholars. I am grateful also to my PhD

colleagues in modularity, Eija-Liisa Heikka and Regine Dörbecker, with whom I could share my thoughts about modularity but also have pleasant times in our yearly seminars.

My deepest gratitude goes to my financial supporters. Without them, this work would not have been possible. I wish to thank the Regional Council of Satakunta (Satakuntaliitto), the Finnish Cultural Foundation, the Satakunta regional fund (Suomen Kulttuurirahaston Satakunnan rahasto), the Turku University Foundation (Turun yliopistosäätiö), and the Finnish Work Environment Fund (Työsuojelurahasto) for enabling me to focus fully on the research. In addition, I am grateful to the Foundation for Economic Educations (Liikesivistysrahasto) for supporting my participation in conferences and network seminars that have had remarkable significance for me. Also, the Hilda Kauhanen Memorial Fund (Hilda Kauhasen muistorahasto), the Satakunta Higher Education Foundation (Satakunnan korkeakoulusäätiö), and the Turku School of Economics Association (Turun kauppakorkeakouluseura) have provided financial support for me. I am also grateful to Turku School of Economics, Pori Unit, for being my employer since 2009.

My dear former and current PhD colleagues and workmates in the Turku School of Economics, Pori Unit have been great support. Not only are they to be thanked for providing the social pressure to finish the thesis but they are also to thank for sharing the joys and sorrows of working in the university as a researcher. Thank you to Kirsi-Mari Kallio, Terhi Tevamäri, Annika Blomberg, Tanja Lepistö, Kati Suomi, Saku Vähäsantanen, Tiina Mäkitalo-Keinonen, Aki Lehtivuori, Jaana Määttä, Päivikki Kuoppakangas, Enni Airasmaa, Kari Hietala and Mervi Luonila. In addition, my former workmate Hanna Suontausta provided technical help to save my nerves in the final moments of putting this thesis together. Thank you.

Suuret kiitokset kuuluvat vanhemmilleni, jotka lukemattomia kertoja hoitivat lapsia ja tarjosivat monenlaista apua arjen helpottamiseksi. Olen kiitollinen heiltä opitusta asenteesta, että asiat etenevät parhaiten toimeen tarttumalla eivätkä murehtimalla. Parhaat kiitokset myös appivanhemmilleni lastenhoitoavusta.

My family has provided perspective by making it difficult to bury myself in academic work. I wish to thank my husband for countless times massaging my jammed shoulders and making sure that, during his evening shifts, we ate something other than noodles and fish fingers. My children have been asking for two years how many more pages I need to write until my thesis is finished. Now I can tell them zero. It is ready. I hope this process has shown them that it is not that difficult to live out one's dreams. Anyone can do it. If only one has will and determination, the road is open.

Tämä kirja on omistettu Ylvalle ja Ottolle. Toivoakseni hekin tekevät unelmistaan totta.

Porissa 8th March, 2016

Mervi

TABLE OF CONTENTS

ABSTRACT

TIIVISTELMÄ

ACKNOWLEDGEMENTS

PART I: SYNTHESIS

1	INTRODUCTION	17
1.1	The background and the research gap of the thesis.....	17
1.2	The aim and the purpose of the thesis	19
1.3	The positioning of the thesis	22
1.4	The structure of the thesis	24
2	CHARACTERISTICS OF THE HEALTH AND SOCIAL SERVICES CONTEXT	25
2.1	Asymmetry of information.....	26
2.2	Uncertainty	27
2.3	Externalities.....	28
2.4	Strong regulation	28
2.5	Unclear outcomes	29
2.6	Complex environments	30
3	MODULARITY	31
3.1	Definitions and characteristics of modularity	31
3.2	Modularity in products, production, services, processes, and organizations	34
3.2.1	Modularity in products and in production.....	35
3.2.2	Modularity in services and in delivery processes	37
3.2.3	Modularity in organizations	39
3.3	Taking advantage of modularity	41
3.4	Managerial concerns related to modularity.....	43
3.4.1	New service development	44
3.4.2	Standardization and customization.....	45

3.4.3	Outsourcing.....	46
3.4.4	Network management.....	47
4	SUMMARIES OF THE ORIGINAL STUDIES.....	51
4.1	Study 1: Modularity in health and social services – a systematic review.....	51
4.2	Study 2: Organizing health services through modularity	52
4.3	Study 3: Supply chain management in health and social services – tightly integrated or loosely coupled?.....	53
4.4	Study 4: Public procurement for innovations – Perspectives from health and social services.....	54
4.5	Research data and methods of original studies.....	55
4.5.1	Systematic literature review.....	57
4.5.2	Theoretical reasoning.....	58
4.5.3	Interpretative qualitative research.....	59
5	MODULARITY IN HEALTH AND SOCIAL SERVICES.....	61
5.1	Modular characteristics and structures in health and social services.....	61
5.1.1	Modular products in health and social services.....	62
5.1.2	Modular services and delivery processes in health and social services.....	63
5.1.3	Modular organizations in health and social services	65
5.2	Context-related challenges in applying modularity in health and social services.....	67
5.2.1	Asymmetry of information and modularity	67
5.2.2	Uncertainty and modularity	68
5.2.3	External factors and modularity.....	69
5.2.4	Unclear outcomes and modularity	70
5.2.5	Complex environment and modularity	71
5.3	Managerial concerns related to modularity in health and social services.....	71
5.3.1	New service development in health and social services.....	72
5.3.2	Standardization and customization in health and social services ..	74
5.3.3	Outsourcing in health and social services.....	76

5.3.4	Network management in health and social services	78
6	CONCLUSIONS.....	81
6.1	Summarizing the results	81
6.2	Theoretical contributions.....	84
6.3	Practical contributions.....	86
6.4	Evaluation of the thesis	88
6.5	Suggestions for future research	90
	REFERENCES	93
	APPENDIX 1: THE AUTHOR’S ROLE AND HER CONTRIBUTION TO THE ORIGINAL STUDIES.....	105
	PART II: ORIGINAL STUDIES 1-4	
Study 1	Vähätalo, M. (2012) Modularity in health and social services – a systematic review. <i>International journal of public and private healthcare management and economics</i> , Vol. 2 (1), 7–211.....	109
Study 2	Vähätalo, M. – Kallio, T. J. (2015) Organizing health services through modularity. <i>International Journal of Operations and Production Management</i> , Vol. 35 (6), 925–945.	127
Study 3	Vähätalo, M. – Kallio, T. J. (2015) Supply chain management in health and social services – tightly integrated or loosely coupled? <i>Paper presented in 6th International Seminar on Service Modularity: Architectures, Platforms and Interfaces, January 15-16, Aalto University School of Business, Helsinki, Finland.</i>	151
Study 4	Vähätalo, M. – Kallio, T. J. (2015) Public Procurement for Innovations – Perspectives From Health and Social Services. <i>Paper presented in XIX IRSPM Conference, March 30-April 2, Birmingham, England.</i>	181

LIST OF FIGURES

Figure 1 Perspectives of modularity in health and social services
discussed in this thesis.....21

LIST OF TABLES

Table 1 Examples of definitions of modularity32
Table 2 Approaches, objectives, and data of the original studies56

**PART I:
SYNTHESIS**

1 INTRODUCTION

The aim of this chapter is to introduce the readers to the essentialities of this thesis. This chapter describes the changes emerging in the context where health and social services are produced. In addition, this chapter explicates the research gap, aims, and purpose of the thesis. Finally, the positioning of the thesis is described and the structure of the thesis is presented.

1.1 The background and the research gap of the thesis

Organizations providing health and social services have confronted changes in environments. For example, ageing, technological and biotechnological achievements in medicine, and customers' increasing expectations (Shortell & Kaluzny 2006, 9) constitute a challenging equation due to which the costs of health and social services have inevitably increased.

The ageing of the Western population is an unavoidable phenomenon (Shortell & Kaluzny 2006). According to statistics, the share of those aged 65 and over in the total population is increasing rapidly in European countries, as well as in OECD countries (Goll 2010; OECD 2015). It is clear that ageing means health eventually deteriorates, and thus more services are needed. Consequently, the increasing demand for heterogeneous services should to be met. However, it is important to emphasize that not only old people's needs increase. In addition, people's expectations concerning the amount and the quality of health and social services have increased in general (Shortell & Kaluzny 2006, 9).

Researchers in medicine and providers of medical technology are eager to meet the heterogeneous needs with more effective guidelines, care protocols, and devices. Unfortunately, new medical innovations are seldom cheaper than the current practices (Santerre & Neun 1996). The growing demand is one of the factors affecting the increasing costs in health and social services. Although the growth of health service expenditures has been moderate in recent years, their share of gross domestic products has increased in most OECD countries (<http://stats.oecd.org/>).

The above-mentioned changes cause challenges to health and social services management. Managerial challenges together with the accusation of the public sector being inefficient (Teperi et al. 2009, 17; Lloyd & Wait 2006, 7; Nolte et al. 2012, 126) have led to requirements for changes in the organization and

management of health and social services. In order to overcome the challenges and to improve efficiency and effectiveness, many changes in organizational structures, as well as in managerial practices, have been made in health and social services organizations. Greenwood and Miller (2010, 79) argue that organizations can tackle the challenges that they confront by managing the organizational design. As a part of their design, health and social services organizations have applied structures and practices from other disciplines, such as from manufacturing, examples of which include process structures (Fältholm & Jansson 2008; Tevameri 2014), lean management (Aronsson et al. 2011) and outsourcing (Machado Guimarães & Crespo de Carvalho 2013).

Modularity can be considered as one of the practices originating from manufacturing and operations management that has been applied to other disciplines. Modularity has been studied in manufacturing for almost five decades since the seminal work of Simon (1962), and there exists a wide range of different applications of modularity (Starr 2010, 7). In particular, there is extensive literature on modular product construction and design (e.g., Baldwin & Clark 2000, Ulrich 1995, Schilling 2000, Hsuan 1999). With regard to other disciplines, modularity has been applied to biology (see Andrews 1998; Bolker 2000), psychology (see Fodor 1983) mathematics (see Edwards 2007), and organization studies (see Weick 1976, Orton & Weick 1990).

More recently, in the past ten years, the idea of modularity has also been applied in services (Bask et al. 2010; Sundbo 1994, 245). However, the theory, development, and systematic use of the concept of modularity in the services context are only just emerging (see Pekkarinen & Ulkuniemi 2007). Currently, there is a growing interest to apply modularity to information systems (Starr 2010) and service-oriented architectures (Bask et al. 2010). Modular services have also been studied in areas such as logistics (Pekkarinen & Ulkuniemi 2008; Bask et al. 2010), the cruise business, and in banking services (Voss & Hsuan 2009). However, despite the increasing number of studies in service modularity, academic discourse concerning the application of modularity in the health and social services context is still quite scarce and features only in few studies (e.g., Chorpita et al. 2005; De Blok et al. 2009; 2010a; 2010b; 2013; 2014; Eissens-van der Laan 2015).

It has become more common to apply the theories across the discipline borders, but this does not come without problems. For example, it has been reported that many of the organizational structures and managerial practices derived from other disciplines to the health and social services context have faced challenges in their application (see e.g., Fältholm & Jansson 2008; Tevameri 2014). In fact, due to the ethically sensitive nature of health and social services, the imprudent application of new organizational structures and managerial practices might have serious consequences. Therefore, there is a need for a continuous exploration on how the organizational structures and managerial practices, found useful in other contexts,

work in health and social services. This means a critical evaluation and careful consideration before new structures and practices are applied. For example, it is essential to appraise how new practices fit together with special characteristics – such as uncertainty of demand and complex environment—in the health and social services context. Therefore, it is important both to analyze the possibilities to apply modularity in the health and social services context as well as pursue the understanding of the managerial concerns that the application might cause.

1.2 The aim and the purpose of the thesis

The purpose of this thesis is to increase the understanding concerning modularity and the possibilities of applying it in the health and social services context. In addition, the purpose is to shed light on the viewpoints that are worth taking into account when considering the application of modularity in the health and social services context.

The aim of this thesis is to analyze, on the one hand, (I) the way in which modular structures are applied in the health social services context and, on the other hand, (II) what advantages and possible barriers, as well as (III) managerial concerns might occur if modularity is applied in the health and social services context.

This thesis attempts to answer three research questions:

RQ 1. *How do modular structures appear in the context of health and social services?*

RQ 2. *How do the context-related special characteristics of health and social services support or prevent the application of modularity?*

RQ 3. *How do managerial concerns related to modularity appear in the health and social services context?*

Below, the aim of the thesis is discussed in more detail from the perspective of each research question.

Research question 1: The aim of the first research question is to analyze how modular structures appear in the context of health and social services. With regard to the first research question, this thesis discusses the products, services, processes, and organizations of health and social services from the perspective of modularity, and analyses how the characteristics of modularity appear in this context. The analysis, thereby, explores the current manifestation of modularity in the health and social services context. The discussion is mainly based on Studies 1 and 2 (see 4.1 and 4.2 below), supplemented with the most recent literature on modularity in health and social services.

Research question 2: The aim of the second research question is to analyze how the context-related special characteristics of health and social services support or

prevent the application of modularity in the health and social services context. Related to the second research question, this thesis discusses how the special characteristics of health and social services either positively or negatively affect the attractiveness of modularity when considered applying modularity. The discussion is mainly based on Studies 2 and 4 (see 4.2 and 4.4 below).

Research question 3: The aim of the third research question is to analyze how managerial concerns related to modularity appear in the health and social services context. The thesis discusses the managerial issues – new service development, standardization, and customization, as well as outsourcing and network management – that are typically related to the management of modularity, from the perspective of health and social services. The discussion is mainly based on studies 2, 3 and 4 (see 4.2, 4.3, and 4.4 below).

The research frame is illustrated in Figure 1. The background of the thesis is in the literature of modularity. When the modularity is “brought to” the context of health and social services and the research questions RQ1, RQ2 and RQ3 are presented, the results reveal the way in which the modular structures are applied in health and social services context and what advantages and possible barriers, as well as managerial concerns, can potentially occur.

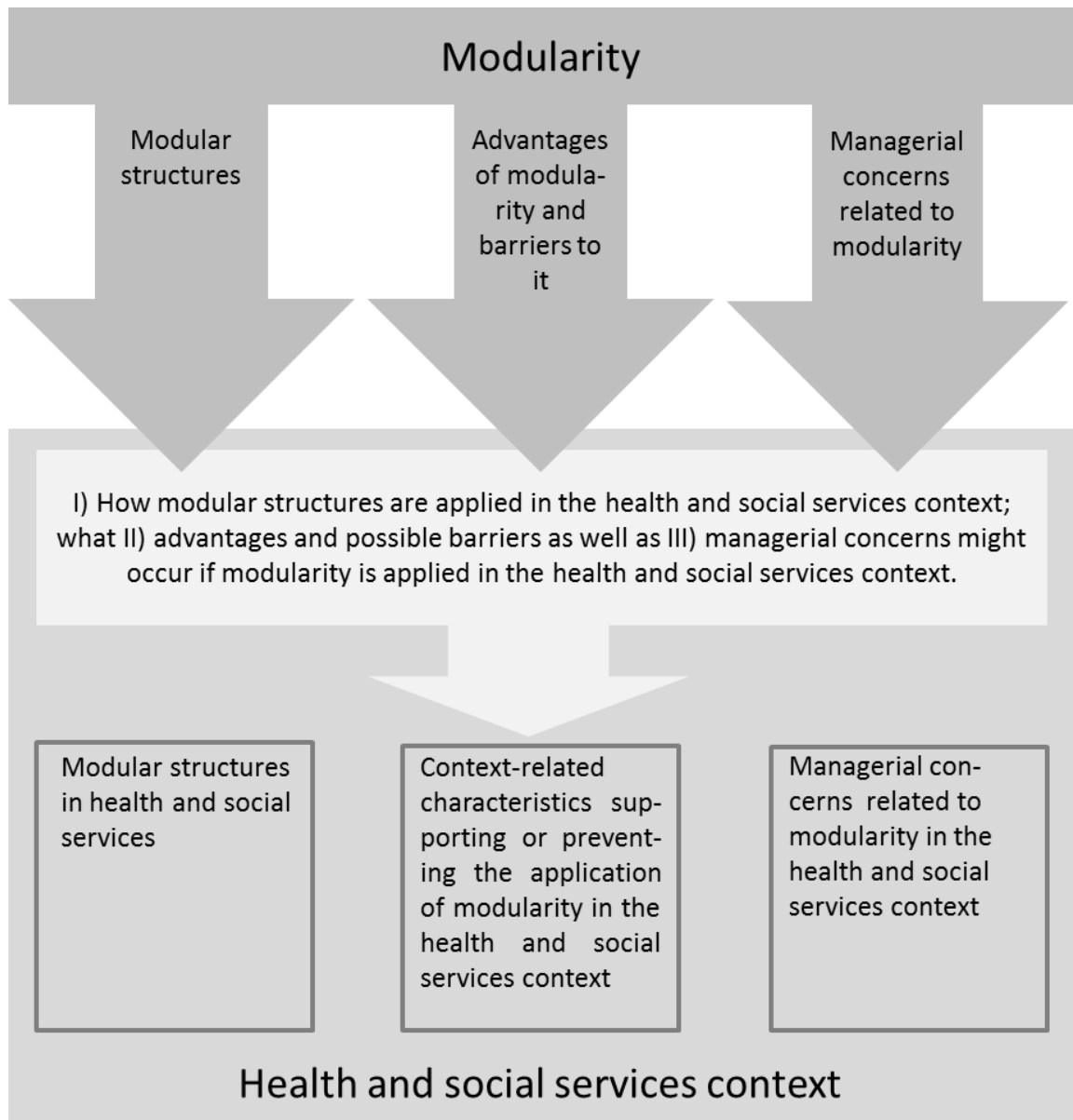


Figure 1 Perspectives of modularity in health and social services discussed in this thesis

This thesis consists of two parts: synthesis and four original studies. The original studies are independent entities that shed light on modularity in the health and social services context from different perspectives. The synthesis not only repeats the results of the original studies but, importantly, has an aim and purpose of its own. The research questions of the synthesis are answered with the help of the original studies while other literature is also explored.

1.3 The positioning of the thesis

In order to increase the validity of the thesis and to provide a clear picture for readers, some essential concepts are defined. The positioning of this thesis is conducted in relation to health services and social services, public services and private services, structures of modularity, and managerial concerns. The positioning is explicated below.

In this thesis, health services and social services are considered as one group of services. It is recognized that this group of services constitute of numerous heterogeneous services with different natures. However, in many respects health and social services are related to the welfare state ideology and are not discussed separately (see e.g., Tuomala 2009). In Finland, for example, public health and social services are administratively combined both at the local and at the national governmental level. In addition, some services, such as homecare services for the elderly, constitute both health and social services and are provided often simultaneously by the same public or private organizations. Consequently, in the original Studies 1, 3 and 4 (see 4.1, 4.3, and 4.4 below) health and social services are discussed inseparably. However, Study 2 discusses only the special characteristics of health services and excludes the social services at the theoretical level. Nevertheless, most of the examples in the study are from care of the elderly, where health and social services are intertwined. The theoretical exclusion of social services in Study 2 was due to the original literature on health economics, which traditionally concerns only health services. In this synthesis section the special characteristics of the health service context are extended to concern also the social service context.

Public services and private services are not separated in this thesis. Although the organization of health and social services differs from country to country in many respects, including the extent to which services are publicly or privately produced, the differences between the health-service market and the basic market are rather similar in every country (Mooney 1992). This assumption leads to the fact that the special characteristics of the health and social services context affect managerial tasks regardless of whether the service is publicly or privately produced. In addition, while, for instance, discussing the providers, this thesis makes no difference between public or private providers. Hence, the assumption is made that the arguments presented in this thesis are valid regardless of whether the purchasers or providers are public or private. If this assumption cannot be made, it is separately mentioned in the text.

In the extant literature, the structural categories of modularity are defined differently, based on varying viewpoints. Based on the studies of e.g., Campagnolo and Camuffo (2010), Bask et al. (2010), Voss and Hsuan (2011), as well as Pekkarinen and Ulkuniemi (2008), this thesis includes products, production,

services, processes and organization in the structural categories of modularity. Modularity in production is described briefly in Chapter 3, together with product modularity. It is not, however, brought up in Chapter 5 in relation to modular products in health and social services. As the thesis concentrates on health and social services, the product manufacturing was outside of the scope of this thesis. Although modular products are included in Chapter 5, they are not discussed as thoroughly as services. This focus is due to the assumption that services form the core value for customers in health and social services and products are often provided together with intangible services. Despite the fact that services form the core value to the customers, products have an important role, e.g., in standardization and in health and social services purchasing. To summarize, this thesis recognizes products, production, services, processes, and organizations as structural categories of modularity; however, it explores only modular products, services, processes, and organizations from the perspective of health and social service.

With regard to managerial concerns, the positioning of this thesis is related to network management in health and social services. In the literature of operations management, from where the concept of modularity originates, the supply chains are the focus of academic discourse. Also in Study 3, the literature of supply chain management was used as a background for the study. However, in the health and social services context supply chains constitute the complex network with multiple stakeholders (Gittell et al. 2009; Virtanen & Stenvall 2014, 102). Some of the stakeholders are in a contractual relationship with each other, some are not. Private providers, for example, who are selected via a procurement process, have formal contracts with purchasers. In this respect, the providers form a supply chain, as is understood in the literature on operations management. However, there are also other suppliers that participate in service production. Associations, for instance, consisting of volunteers, provide services while not in a contractual relationship with purchasers. In addition, different units inside the public sector might participate strongly in health and social services production while the collaboration is not contractual (e.g., units providing cultural activities for health and social services customers). Based on these facts, health and social services production in its entirety reminds us more of a network than a supply chain. Due to the special characteristics of the health and social services context, the service provision networks need to be managed. In this thesis, health and social services managers are considered as working in such networks and having tasks related to network management.

1.4 The structure of the thesis

This thesis constitutes the synthesis section and four original studies. The synthesis section has six chapters and proceeds as follows: Chapter 1 forms an introduction to the thesis. It describes the changes in operational environments as a background for the health and social services context and identifies the research gap. In addition, in Chapter 1 the aim and the research questions, as well as the positioning and the structure, of the thesis are presented. Chapters 2 and 3 represent the theoretical background of the thesis. Chapter 2 describes the special characteristics of the health and social services context upon which modularity is later reflected on. The chapter is important in order to understand the nature of health and social services. Chapter 3 describes modularity, its characteristics, elements, and structures. In addition, Chapter 3 describes what makes modularity attractive as well as what kind of managerial implications modularity entails. Chapter 4 contains the summaries of the original studies and describes the methodological choices that were used in the original studies. Chapter 5 answers the research questions and discusses the results of the thesis. Finally, Chapter 6 summarizes the results and presents the theoretical and practical contributions of the thesis, as well as evaluates the thesis and suggests paths to future studies. The four original articles are attached at the end of the thesis.

2 CHARACTERISTICS OF THE HEALTH AND SOCIAL SERVICES CONTEXT

The health and social services context is said to have special characteristics that separate it from other service contexts (Mooney 1992, 21). This thesis mainly concentrates on special characteristics – uncertainty, asymmetry of information and externalities – mentioned in the literature on health economics. In addition, some other characteristics – strong regulation, complex environments, and unclear outcomes (e.g., Shortell & Kalunzy 2006; Williams 2004)—mentioned as being unique to the health and social services context are discussed.

In theory, the market for health services differs substantially from the basic market (Mooney 1992, 10; Arrow 1963). This has produced a subfield of economics known as health economics (Mooney 1992; Santerre & Neun 1996). The characteristics that are argued to be typical of basic markets include certainty, lack of externalities, perfect market information, customer sovereignty, lack of actors with the power to set prices, and no barriers to entry or exit of the markets (Mooney 1992; Santerre & Neun 1996). However, health service markets do not have any of the above-mentioned characteristics. Instead, in the literature on health economics, the asymmetry of information, uncertainty, and externalities, are said to be typical characteristics of the health services markets (Van der Gaag & Perlman 1981; Mooney 1992; Arrow 1963).

In addition to the characteristics mentioned in the literature on health economics, other characteristics also exist that are said to be unique to the context of health and social services. Shortell and Kalunzy (2006) mention several of these characteristics, such as the difficulties of defining the outcome, the complexity of the work, the need for a high degree of coordination among diverse professional groups, a high degree of specialization, and professionals' loyalty to the profession rather than to the organization. Within the scope of this thesis, it is not possible to engross all the special characteristics mentioned in the literature. Therefore some are explored in more detail and some are mentioned only briefly.

Some of the special characteristics (e.g., unclear outcome and uncertainty) are particularly related to the nature of health and social services itself. In this respect the exact concept would be “the special characteristics of health and social services.” This concept was mainly applied in Study 2. However, most of the health and social services characteristics discussed in this thesis are related to the context and the environment where the health and social services are produced. All characteristics are, at least to some extent, intertwined with the context. Therefore

in this thesis, the concept of “the special characteristics of the health and social services context” is used as a common term for uncertainty, asymmetry of information, externalities, strong regulation, complex environments and unclear outcomes.

Although the principles of health economics may not operate in real life similarly as they do in theory, they provide a common background enabling the characteristics of the health service context to be scrutinized. Moreover, as explained in the first chapter, this thesis contains the assumption that arguments established in health economics also apply in social services. Therefore health services and social services are not discussed separately in the following sections.

2.1 Asymmetry of information

Based on the assumptions of economics, customers in basic markets have high autonomy and are capable of making rational decisions (Mooney 1992). Also in health and social services, the current trend of demand-based care and patient centeredness emphasizes the importance of providing enough information for the patient to enable rational decision making (Lako & Rosenau 2009; Wilmot 2007). However, the assumption of the rational consumer is problematic in health and social services. It can even be argued that customer sovereignty does not apply in health services. Despite more information than ever being available from different sources, customers seem to suffer from a lack of information (*ibid.*). Typically, customers are uncertain about what services to demand or use in order to improve their health (Van der Gaag & Perlman 1981; Mooney 1992; Arrow 1963). Related to the information asymmetry, Mooney points out that: “... first, the patient’s ability to make his own decisions is impaired and second, he becomes very much dependent on the doctor to make decisions on his behalf” (Mooney 1992, 28). It has been argued that, although lot of information is available, customers are typically unwilling to make choices and they have a tendency to pass on the decision making to the professionals (Mooney 1992; Lako & Rosenau 2009). While asymmetry of information is common in health and social services in general, it is more likely to be prevalent amongst customer groups whose cognitive capabilities have declined, for example, amongst elderly people or people with mental disorders (Wilmot 2007, 69).

The asymmetry of information does not prevail only between end users and professionals but also between professionals and other stakeholders. Financial authorities, for example, are in similar roles as end users; they might not have the same information as the professionals. Therefore it is difficult for them to make financial decisions without consulting the professionals. The asymmetry of information combined with the ethical sensitivity of health and social services has

brought up the need to regulate and standardize the production of health and social services. Global, as well as national, regulations aim at protecting those who do not have the same information as health and social services professionals. Protection includes standardizing service provision with e.g., healthcare education, licensing providers, and evidence-based care protocols (Parvinen et al. 2005; Van der Gaag & Perlman 1981; Arrow 1963). The way in which the regulations are obeyed and applied is naturally monitored by health and social services authorities.

2.2 Uncertainty

Arrow (1963, 948) brought up the problems related to irregularity and unpredictability of demand separating medical services from other services. In health and social services, uncertainty prevails, particularly at the individual level. Customers are unable to predict their illnesses or their need for medical or social services in general. Nevertheless, health and social services organizations must be prepared for a quick response in case of acute demand. (De Blok et al. 2009; Van der Gaag & Perlman 1981.)

In order to be prepared for uncertainty, both public and private insurance systems have been created (Santerre & Neun 1996). However, insurance has brought up the problem of the moral hazard. The moral hazard prevails both on the customers' and the providers' side. From the customer perspective, insurance might increase the likelihood of adverse events. Customers' risk behavior is likely to increase if the insurance makes the illness appear less burdensome. In addition, compensation received from insurance companies might encourage customers to require more, even unnecessary, services. (Santerre & Neun 1996; Arrow 1963.) However, because resources are scarce, financial authorities restrict the availability of services (Lillrank et al. 2004) and restrict the compensation received from insurance.

From the perspective of professionals, the moral hazard means that insurance encourages professionals to over-treat customers (Van der Gaag & Perlman 1981; Arrow 1963). Professionals might be pressured by the patients or their relatives to provide ineffective or unnecessary services (cf. Saarni 2010). In addition, providers are highly committed to the medical profession and the Hippocratic Oath (Shortell & Kalunzy 2006; Sade 2013; see also Van der Gaag & Perlman 1981). This leads to a situation where professionals are more committed to promoting the well-being of customers than ensuring the economic efficiency of their organizations. However, organizations aim to prevent the moral hazard of professionals by fixed or cost-per-capita payment and by encouraging professionals to use the care facilities efficiently (Sintonen & Pekurinen 2006).

2.3 Externalities

Santerre and Neun (1996, 552) define externality as follows:

“Externality exists when the actions of a market participant affect another participant in either an adverse or a beneficial fashion and no financial compensation takes place. An externality can emanate from either the demand or the supply side of the market.”

In the other words, externality means that the production or the consumption of services has positive or negative implications either to the user or to other individuals (Mooney 1992). Services, such as vaccination, that promote health can have positive implications, whereas e.g., drinking alcohol and drunk driving or smoking are likely to have negative implications (Sintonen & Pekurinen 2006). From the perspective of financing authorities (as well as from the perspective of national health promotion) tangible and intangible costs of these implications give a good reason to intervene in supply and demand, in other words, in customer behavior (Mooney 1992). Society will benefit if customers are encouraged to request services that have positive implications and discouraged from those having negative ones.

Promoting positive externalities means subsidizing production or consumption, while restricting negative externalities means sanctioning production and consumption. Children’s vaccination, for example, is provided free of charge or some employers support their employees’ well-being by providing discount on sports activities. On the contrary, negative externalities, for example, drunk driving are regulated with legislation and violators punished. In a similar vein, the production of alcohol is regulated with many standards and providers are sanctioned if necessary.

2.4 Strong regulation

Strong regulation is essentially a part of the health and social services context (Shortell & Kalunzy 2006). It can be discussed separately or in relation to the above-mentioned characteristics. All of these characteristics – the asymmetry of information, uncertainty and externalities – promote the need for regulation, which manifest in the form of legislation (e.g., legislation concerning the health service providers), recommendations (e.g., quality recommendations), and evidence-based practices (e.g., scientific information concerning the effectiveness of the practices in medicine, nursing, and social services provision).

In Finnish law concerning health service providers, for instance, the aim of the law is stated “... to promote patient safety and the quality of health and social

services” (Laki terveydenhuollon ammattihenkilöistä 28.6.1994/559). It can be argued that all regulations in health and social services have the similar aim. Due to problems potentially caused by asymmetry of information, customers have to be protected from the services or the products that are either harmful or are not proven to be effective. Similarly, customers have to be protected from the providers with insufficient or inappropriate capabilities. Uncertainty related to demand leads to obligatory insurance in order to protect customers from financial disaster in the case of severe illness. Due to scarce resources, insurance providers are eager to regulate the production of recoverable services. In addition, they are eager to regulate the recoverability, because they are unwilling to pay for ineffective services. In addition, with the help of regulations authorities are able to interfere in the consumption and the production of services and thereby promote positive externalities and prohibit negative ones.

Regulation aims at providing standards according to which the products, services, processes, and organizations can be evaluated. However, standards have a dual role: they can either support high-quality production or constrain it. On the one hand, standards support the economies of scale as they provide predictability. On the other hand, it is costly to change standards and therefore potentially beneficial changes might be constrained. (Langlois & Savage 2001, 151.)

2.5 Unclear outcomes

Unclear outcomes bring challenges to health and social services in many respects. Challenges are related to, for instance, defining the outcome, measuring it, collecting the outcome-oriented data, and analyzing it, among many others. (Williams 2004, 2033; Shortell & Kalunzy 2006, 16.) First, defining the outcome is problematic, given that no universal definition for health or social well-being exists. The customer and the professional might not have the same expectations concerning the desired outcome; their expectations can differ significantly. One might, for example, prefer long life whereas the other might prefer quality of life.

Second, measuring the outcome is problematic. While many objective indicators do exist, such as clinical results, they are not applicable when the customers’ subjective experience is measured. If the customers’ subjective experiences are measured, the problem of indicator selection occurs. There might not be a mutual understanding concerning what the measurement tools and indicators actually describe. For instance, there are various measurement instruments with various indicators available for providers to measure the quality of life. In addition to measurement indicators, there are also other issues for providers to decide, such as the time of measurement (e.g., right after the

intervention or later) and whose subjective experiences are measured (e.g., customers' or their near ones') (Williams 2004, 20-33).

2.6 Complex environments

The work in health and social services organizations is regarded as complex and more varied than in many other organizations (Shortell & Kalunzy 2006, 16; Glouberman & Mintzberg 2001a; Gittel et al. 2009). Stepanovich and Uhrig (1999), for example, consider health services as a high-velocity environment. Vähätalo & Kallio (2015) establish their argument on McCarthy et al.'s (2010) work and conclude that the health service environment can be considered as a conflicted-velocity environment where the rate and the direction of change are not homological.

Not only the constant change makes the health and social services context a complex environment but also the complicated network of different stakeholders increases the complexity of the context. High expertise, specialization, and independence are expected from health and social services professionals (Shortell & Kalunzy 2006, 16). However, at the same time, professionals are expected to collaborate within and across disciplines in order to provide seamless and efficient service processes to customers. Despite the requirement for specialization, few services in the health and social services context are provided by a single provider, or even by a single organization. Instead, health and social services typically have a process nature, and treatment takes place over a long period of time and involves multiple providers (Casalino 2003; De Blok et al. 2010a; 2014). Therefore professional knowledge and willingness to collaborate, both at the operational and managerial level, are important capabilities. Unfortunately, different specialties among professionals form sharp boundaries both between subspecialties within the profession as well as between different professions (Langlois & Savage 2001). Consequently, this is likely to complicate collaboration.

Complex environments have effects also on outcome measurement. Due to complex environments, outcome measurement is difficult to accomplish as responsibility for the outcome is often distributed across the organizations (Williams 2004, 20-33; Voss & Hsuan 2011, 241). Large numbers of providers complicate outcome measurement, and thus it might be difficult to reward the right providers for the positive outcome (or give sanctions for the negative outcome). Moreover, it might be difficult to distinguish when the outcome is a result of provider input or when it is a result of external factors, such as help from a friend or, in fact, any event in life.

3 MODULARITY

With the special characteristics of the health and social services context presented in Chapter 2, this chapter describes the other important theoretical perspective of this thesis: modularity is presented as discussed in the extant literature. First, modularity is defined and its characteristics and essential elements described. Second, the categories of modular structures are presented in short. The third subsection describes the potential advantages of modularity and the environmental circumstances where modularity is said to work at its best. Finally, this chapter describes four perspectives on managerial concerns related to modularity.

3.1 Definitions and characteristics of modularity

There is no universal definition for modularity (Gershenson et al. 2003, 296; Bask et al. 2010; Campagnolo & Camuffo 2010); instead, the concept of modularity has several definitions in the extant literature. While the definitions seem to differ to some extent, they are not contradicting. Examples of definitions are provided in Table 1.

Four suggestions can be found in the literature for why finding a common definition for modularity seems to be difficult. First, the challenge in defining modularity might be related to the fact that characteristics of modularity seem to be intertwined with the benefits drawn from it (Campagnolo & Camuffo 2010, 276). This is the case, for example, in the definition provided by Baldwin and Clark (1997), which describes efficiency as a benefit related to modularity. The second challenge might be due to the great variety of different applications of modularity; for example, modularity in warehouse logistics and modularity in furniture inevitably manifests differently (Starr 2010, 7; Campagnolo & Camuffo 2010, 260).

Third, modularity is applied by different disciplines (Gershenson et al. 2003, 308; Campagnolo & Camuffo 2010, 260; Schilling 2002): Sundbo's (1994) definition, which represents the discipline of service management, and Baldwin and Clark's (2000) definition, which represents engineering sciences. Fourth, modularity can be used at different levels of abstraction (Gershenson et al. 2003, 308; Salvador 2007, 220; Campagnolo & Camuffo 2010, 260), such as at the level of detailed components (e.g., Jacobs et al. 2007; Lau et al. 2007, 1040) or at the system level (Schilling 2000, Bask et al. 2010).

This thesis adopts the definition of Vähätalo and Kallio (2015). Although their definition (the original Study 3 of this thesis) remains at a rather general level, it can be considered particularly appropriate for this thesis as it highlights the important features of the health and social services context, such as the heterogeneous needs and complex systems of multiple providers.

Table 1 Examples of definitions of modularity

Author (Year, Page)	Definition
Baldwin & Clark (1997, 86)	“Modularity is a strategy for organizing complex products and processes efficiently.”
Baldwin & Clark (2000, 63)	“A module is a unit whose structural elements are powerfully connected among themselves and relatively weakly connected to elements in other units.”
Bask et al. (2010, 366)	“[A] modular system is built of components, where the structure [“architecture”] of the system, functions of components [“elements”, “modules”], and relationships [“interfaces”] of the components can be described so that the system is replicable, the components are replicable, and the systems are manageable.”
Jacobs et al. (2007, 1048)	“[Product modularity is] the use of standardized and interchangeable parts of components that enable the configuration of a wide variety of end products.”
Lau et al. (2007, 1040)	“Product modularity is a continuum describing separateness, specificity and transferability of product components in a product system.”
Schilling (2000, 312)	“[Modularity] is a continuum describing the degree to which a system’s components can be separated and recombined, and it refers both to the tightness of coupling between components and the degree to which the ‘rules’ of the system architecture enable (or prohibit) the mixing and matching of components.”
Sundbo (1994, 245)	“[S]ervices are created out of standard elements – modules – that can be combined for the individual customer at the moment of purchase. Thus, the content of the services is standardized but the standard elements can be combined in many ways when delivered.”

Vähätalo & Kallio (2015, 926)	“[A] highly modular health service consists of numerous services modules that are flexibly and uniquely compatible, and which are typically produced by multiple providers.”
----------------------------------	--

In addition to multiple definitions, there has also been a different opinion concerning what modularity actually is (Eissens-van der Laan 2015, 12). On the one hand, modularity has been understood as a form of design with a high independence of components and standard interfaces between them (Sanchez & Mahoney 1996; Jacobs et al. 2007, 1047; Sanchez 1995, 142). On the other hand, modularity can be understood as a strategy for organizing complex products and processes efficiently (Baldwin & Clark 1997; Bask et al. 2010, 362).

In order to understand modularity, it is important to describe its characteristics and elements that are typically presented in the extant literature. The characteristics – the independency of the components, decomposable architecture, and the compatibility of the components – describe the general nature of modularity. The essential elements of modularity – hidden and visible design rules – describe the elements of modular architecture that are critical to all modules. The characteristic and the essential elements of modularity are described below.

Several authors have argued that modularity is essentially related to the *independency of components* (e.g., Sanchez & Mahoney, 1996; Schilling, 2000; Schilling & Steensma, 2001) or to the loose coupling of components, as Orton and Weick (1990) put it. In modularity, interdependency prevails within and independency across the modules. This means that the internal structural elements are strongly connected with each other while weakly connected with elements in other modules, thus strong interdependencies between modules are avoided. Modules are independent units which act together as a larger system. (Baldwin & Clark 1997; Langlois & Robertson 1992; Sanchez & Mahoney 1996; Baldwin & Clark 2000; Bask et al. 2010; Gershenson et al. 2003, 307.)

Modularity is said to consist of *decomposable architecture* (Sanchez & Mahoney 1996; Schilling & Steensma 2001; Gershenson et al. 2003, 295), meaning that complex entities can be decomposed into smaller, more manageable units (Mikkola 2003, 441). In addition to decomposability, the *compatibility of components* is also important in modularity. Modular architecture enables components to be flexibly combined (mixed and matched) in order to create unique bundles (Bask et al. 2010; Sanchez 1995, 135; Ulrich 1995).

The essential elements of modularity are *hidden design rules* and *visible design rules* (Baldwin & Clark 1997; Baldwin & Clark 2000). Hidden design rules constitute parameters that have no effect on other modules. Hidden design rules can be changed during the development of new modules or during the production process and there is no need to share the information beyond the design team or

production unit. However, they have a significant effect on the other design parameters inside the modules (Baldwin & Clark 1997, 86). Particularly in engineering, hidden design rules are typically presented in the form of a design structure matrix (see e.g., Baldwin & Clark 2000, 41).

Visible design rules constitute parameters that have an effect on subsequent decisions concerning the other modules. It is recommended that the visible design rules should be decided and communicated with the providers at as early a stage of the design process as possible (Baldwin & Clark 1997, 86), after which they should be kept untouched. Baldwin and Clark (1997, 86) argue that visible design rules include architecture, interfaces, and standards. Architecture specifies what modules are involved in the system and what their functions will be. Standards are defined in order to, for instance, measure the module's performance when compared with other modules (*ibid.*). Interfaces define the communication between modules and the way in which modules are connected with each other. Once interfaces are agreed, they cannot be altered, for example, during the product development process (Sanchez 1995, 142).

In this thesis, interfaces are understood similarly to De Blok et al. (2014, 186), who argue that interfaces “are the set of rules and guidelines governing the flexible arrangement, interconnections, and interdependence of service components and service providers.” Interfaces enable subsystem independence while at the same time they support subsystems working as a whole (De Blok et al. 2014, 176). Interfaces, in fact, enable typical characteristics of modularity: they enable independence and flexible mixing and matching of components. This means that components can be changed and substituted with other components (De Blok et al. 2014; Bask et al. 2010; Starr 2010) without negatively affecting the service entity (Sanchez & Mahoney 1996, Sanchez 1995 142). In the case of products, interfaces may be a physical characteristic or, for example, a software as in information technology (Baldwin & Clark 2000). Services interfaces include people, information, and rules governing the flow of information (Voss & Hsuan 2009, 545).

3.2 Modularity in products, production, services, processes, and organizations

Discussion concerning modularity in the extant literature is typically divided into categories that describe modularity in products, processes, and organizations (Gershenson et al. 2003, 308; Campagnolo & Camuffo 2010, 260). In their systematic literature review, Campagnolo and Camuffo (2010), for example, recognized three categories (or clusters, as they call them) of modularity where discussion takes place in the literature: products, production systems, and

organizational design. Voss and Hsuan (2011, 231) criticize the fact that service modularity is often understood as an extension of product modularity. According to them, service-related modularity should be considered as its own form of modularity. This is understandable due to the special nature of services, which differs from the nature of products. Differences occur, for example, in customers' roles in value co-creation (Pekkarinen & Ulkuniemi 2008, 86; Jaakkola & Halinen 2006) and simultaneous production and consumption of services (Sundbo 1994, 245; Pekkarinen & Ulkuniemi 2008; De Blok 2010a, 4; Jaakkola & Halinen 2006).

In addition to Campagnolo's and Camuffo's systematic literature review, Bask et al. (2010) also conducted one and recognized somewhat similar categories as Campagnolo and Camuffo: the modularity of products, including the modularity of product development, the modularity of production or manufacturing and processes, as well as the modularity of organizations and supply chains. However, they found a fourth category, modularity of services, in which they included the modularity of the service product, the modularity of the service development, the modularity of service production or process, and the modularity of service organizations and supply chains. In a similar vein, Pekkarinen and Ulkuniemi (2008, 88) emphasize the independent role of service modularity. They argue that in order to develop services three dimensions of modularity – modularity in services, processes and organizations – needs to be combined.

This thesis follows the suggestion provided by Voss and Hsuan (2009, 545) and discusses modular products and services separately. In the following subsections, the categories of modularity (products and production, services and their delivery process, as well as organizations) are described in the way in which they are typically presented in the extant literature.

3.2.1 Modularity in products and in production

According to Gershenson et al. (2003, 307), no common understanding of what modules actually are prevails in the literature of modularity. However, the modularity of products is typically said to consist of independent components. These components interact through interfaces that also enable the interchangeability of components (Baldwin & Clark 2000). Furthermore, standardized and interchangeable components have the same functional purpose in different systems (Bask et al. 2010). Thus interchangeability of components allows a wide variety of end products to be configured according to customers' preferences (Jacobs et al. 2007). The overall aim of modularity is to enable a large variety of functional changes with minimum changes in physical structure (Mikkola 2003, 442). Ulrich (1994, 220) puts this another way and argues that the fundamentals of product modularity are related to similarity between physical and

functional architecture of the design and minimization of incidental interactions among physical components.

Product modularity, similarly as modularity in general, is not an either/or stage. Modular products can be imaged in a continuum where some products are more modular than the others. The degree of modularity depends on the extent to which products are specific, how independent or separate modules are, and how transferable or reusable they are (Lau et al. 2007, 1040; Baldwin & Clark 2000; Schilling 2000; Ulrich 1995). The continuum of product architecture is typically divided into integral and modular products. In integral architecture, the interfaces are coupled, and making changes to one component also requires making changes to the other components. In modular architecture, in contrast, functional elements can be changed independently.

Modular products can be classified into different categories depending on their architecture and their interfaces. Ulrich (1995), for example, describes three types of modular architecture: slot, bus, and sectional. If modular architecture is slot, the product consists of separate parts, while the parts have only one function and their interfaces are different from each other. Therefore, the various components cannot be interchanged. In the bus type of modularity, components are connected via the same type of interfaces. However, all the components are connected to a single main element, such as a keyboard and mouse into the central unit of a computer. In sectional architecture, interfaces are all similar to each other, and there are no single elements to which the components would be attached. Instead, components can be connected to each other in various ways, such as in sectional furniture.

Modular products are typically illustrated with examples from the computer industry (e.g., Schilling 2000, Ulrich 1995; Langlois & Robertson 1992; Baldwin & Clark 2000). The literature describes how computers changed from inseparable units manufactured by one company into decomposable devices which flexibly enable mixing and matching additional devices from different manufacturers. The automotive industry is comprehensively present in the literature of modularity (e.g., Mikkola 2003; Novak & Eppinger 2001; Sako & Murray 1999; Doran et al. 2007). An auto, as a product, consists of multiple parts designed, manufactured, and assembled separately. The automotive industry is regarded as a complex system in which product development and assembly responsibilities are increasingly delegated to the suppliers (Mikkola 2003). In addition, this industry has many variations in terms of how the production is organized, how new service developments are arranged, and how supply chains are managed (see, e.g., Mikkola 2003; Novak & Eppinger 2001).

Vordijk et al. (2006) uses the concept of process modularity and refers to manufacturing techniques, that is, how the product is made. In this thesis, however, process modularity refers mainly to service delivery processes, whereas production modularity refers to the manufacturing of the product. Therefore, modularity in

production means that design, manufacturing, and assembly are separated. These different phases can be conducted by different suppliers in different locations at different periods of time. In production modularity, the prefabrication degree is high (Vordijk et al. 2006), starting with the smallest components and putting together larger entities that can then be moved toward the main assembly line. Complex parts of the assembly are kept off-line, and the work in the main assembly line is standardized. In this way, the time spent in the main assembly line is reduced. Flexibility in production means possibility for variation with little extra cost (Sako & Murray 1999).

Based on the “independence” assumption often presented in the literature of modularity, it could be argued that, due to the standard interfaces, the design has no effect on the production. However, different opinions have also been presented. Sako and Murray (1999) agree with Ulrich (1995) and argue that production modularity depends on the degree of modularity in products. Kupota et al. (2015) provide a literature review concerning modularity in design and modularity in production and how they appear in the automotive industry. They came to conclusion that the connection between these two types of modularity exists. However, the way in which design modularity and production modularity affect each other is not straightforward. Instead, they argue, several elements such as outsourcing, standardization, product variety, and functionality affect the relationship between design and product modularity (Kupota et al. 2015).

3.2.2 Modularity in services and in delivery processes

The service module represents the smallest service unit that can be provided for a customer in itself or as a part of a service offering in order to create value for the customer (Rahikka et al. 2011, 358; Pekkarinen & Ulkuniemi 2008; De Blok 2010a, 4; Eissens-van der Laan 2015). As Eissens-van der Laan et al. (2016) suggest, the way in which the services module is defined depends significantly on how the service is decomposed. The literature describes multiple ways of decomposing services. Services can be decomposed into services and service processes (Pekkarinen & Ulkuniemi 2008), or they can be decomposed according to the level of offering (Voss & Hsuan 2009). These levels can represent, for example, industry, service company, service bundle, and service component (Voss & Hsuan 2009), or they can represent modules, sub-modules, and components, as De Blok et al. (2010a) suggest. Appropriate decomposition also provides an opportunity to tailor configurations efficiently to customers (Bask et al. 2014).

It has been proposed that service modularity is a more complex entity than product modularity (Bask et al. 2010, 336). Complexity is increased because the process itself is an important part of service modularity, not just the outcome of

the process. In addition, complexity increases due to the fact that services are produced and consumed simultaneously. This means that customers are involved in production and service is co-created together with providers and customers. (Sundbo 1994, 245; Voss & Hsuan 2009, 545.)

Another important difference between service and product modularity is the significant role of people in service customization (Voss & Hsuan 2009). The customization of modular services means that a customer can compose the final service from standard service components (Pekkarinen & Ulkuniemi 2008; Sundbo 1994; De Blok 2010a, 4) or the customization can be done inside the components (Vähätalo 2012; De Blok et al. 2013). Either way, customers play an essential role in customization. Support for customization is available from many sources, and selection or modifications can be made together with providers. However, eventually it is the customer him/herself who makes the service customized. The important role of people, this so-called human touch, in service production and in customization is also the reason why the interfaces between services are different from interfaces between products (Bask et al 2010, 366). Interfaces between services entail people, information, and rules guiding the information flows (Voss & Hsuan 2009).

Increasing need to respond to customers' demand requires looking for new modular service architectures and service process designs that would better enable tailoring (Bask et al. 2014). These new service processes could, perhaps, be modular. Modularity in processes is related to physical operations or information processing (Pekkarinen & Ulkuniemi 2008, 87). Pekkarinen and Ulkuniemi (2008, 87), as well as Rahikka et al. (2011, 358), argue that in physical operations the modular process is a standardized and an invisible step, which is essential to conduct in order to deliver the service to the customer. In fact, service process modularity can be defined as "the usage of reusable process steps that can be combined to accomplish flexibility and customization for different customers or situations in service implementation" (Bask et al. 2010, 368). Customization can be conducted by decomposing processes to standard and customized sub-processes. The standard sub-processes should be placed before the customized sub-processes in order to maximize flexibility. (Bask et al. 2010.) In this way, the final customization can take place even on the customer site. The service configuration process is conducted as back-office functions in order to provide the impressions of unique service bundles (Pekkarinen & Ulkuniemi 2008, 93). Another option to customize the process is to provide extensions or modifications. Processes can be stretched by adding extensions, either by applying reuse or variation of processes. Reuse of processes requires no adjustments in action, whereas variation requires new or modified actions either from the customer or from the supplier. (Bask et al 2014.)

According to Bask et al. (2014), there are both managerial levels and operational levels in modular processes. At the operational level, service processes can be decomposed to sub-processes and modules. The smallest level of a module can be called options (compared to components in products), as it refers to customers' opportunities to make choices. At the managerial level, modular service processes include sales, order-delivery processes, modularization principles to design, and ICT. When services are complex and provided by multiple providers, it is important to ensure that back-office processes are fluent. Customers are evaluating the services in regard to fulfilled value propositions, not by a single provider's process, such as sales or delivery (Bask et al. 2014).

Similarly to Bask et al. (2014), Pekkarinen and Ulkuniemi (2008) highlight the importance of fluent information flows in service processes. Information processes can either prevent or support modular production. On the one hand, if all stakeholders have their own information systems, their configuration consumes resources and might cause problems for fluent information flow. On the other hand, if information processes are standardized, it provides advantages in service development, production, and delivery. (Pekkarinen & Ulkuniemi 2008, 93.)

3.2.3 Modularity in organizations

Modular organizations are formed by groups of weakly connected subsystems (Pekkarinen & Ulkuniemi 2008, 87). They consist of loosely coupled teams, units, firms, or networks that provide value through coordination according to customer preferences (Rahikka et al. 2011, 359). Modular organization structure also allows for the flexible use of resources (Pekkarinen & Ulkuniemi, 2008, 88; Baldwin & Clark 1997). Modular organizations are argued as being loosely coupled networks of organizational actors (Hoetker 2006, 501; see also Orton & Weick 1990).

Schilling and Steensma (2001) describe reasons for organizations moving towards or away from modularity. Heterogeneity in inputs and in demand are important conditions when considering the attractiveness of modularity. Modular structure in organizations supports the possibilities for suppliers to respond to heterogeneous demand with heterogeneous inputs. Availability of standard, technological change and competitive intensity act as catalysts when moving towards modularity. Availability of standards enables construction of interfaces and thereby supports compatibility. Modular structures also enable high-speed technological change and intensive competition, as modularity increases opportunities to combine and changes components from different suppliers.

Hoetker (2006) argues that modular products lead to more configurable organizations but do not, however, automatically lead to shifting activities out of the hierarchy. In addition, modular products do not automatically lead to modular

organizations. Although products would be modular, organizations do not need to be. It is important to carefully analyze the possible costs and risks of moving towards modular organizations. Losing architectural power and knowledge or increasing opportunism are some of the possible risks related to modular organizations (Hoetker 2006).

There are two ways of conducting modularity in organizations (Pekkarinen & Ulkuniemi 2008, 88). On the one hand, production can be arranged across the units inside the organization. If modularity is applied inside the organization, employees work in divisions (or teams), and each division is responsible for their own development work and production (Baldwin & Clark 1997, 92; Campagnolo & Camuffo 2010). On the other hand, modularity can be applied in different organization forms and relations between organizations (Pekkarinen & Ulkuniemi 2008, 88; Baldwin & Clark 1997, 92; Rahikka et al. 2011, 358).

Modularity in organizations can manifest in contract manufacturing, alternative work arrangements, or in the formation of alliances or partnerships (Schilling & Steensma 2001; Pekkarinen & Ulkuniemi 2008). Contract manufacturing or outsourcing reduces the activities that firms have to pursue in house (Ethiraj & Levinthal 2004, 159; Bask et al. 2011, 308; Voordijk et al. 2006) and give more responsibilities to suppliers, for example in product development (Hsuan 1999, 198). Alternative work arrangements, according to Schilling and Steensma (2001, 1152), means, for example, the use of temporary agency workers. These workers can provide benefit for the organization in terms of flexible capabilities, which can be altered according to the market situation. Alliances are typically created in order to expand strategic competencies, promote organizational learning, and expedite access to new technology, markets, and customers, and to gain production efficiencies (Hsuan 1999, 198).

Modularity between organizations also refers to supply chain modularity. Supply chain modularity refers to how tasks are allocated among the companies involved and how the interactions between them are organized (Voordijk et al. 2006). Because design, manufacturing, and assembly are typically separated across the modular supply chain, coordination of interaction can be challenging. Coordination challenges can be alleviated through formalized information streams that should flow across the network of suppliers. Another possibility is to delegate the coordination and control to the experts (Voordijk et al. 2006), for example, to so-called system integrators (Gittell et al. 2009). In order to enable supply chain function effectively, the operations should be flexible enough to accommodate the changing demands with reconfigurable resources (Doran 2003, 325).

3.3 Taking advantage of modularity

The increasing competition for customers drives managers to take advantage of modularity (Starr 2010; Schilling 2000). In fact, the extant literature describes several advantages derived from the application of modularity. Modularity is said to benefit both customers as well as providers. Although empirical evidence concerning the benefits of modularity is scarce, the literature describes several theoretical benefits drawn from modularity (see Jacobs et al. 2007, 1046). However, the beneficial use of modularity requires certain environmental circumstances, and modularity might thus suit some contexts better than others (Schilling 2000). The typically mentioned benefits of modularity and those environmental circumstances that contribute to the attractiveness of modularity are described below.

Modularity can be considered as a strategy to effectively organize complex products, processes, and organizations (Baldwin & Clark 1997, 86). Complex systems of services also become more manageable if service entities are decomposed into smaller units (Baldwin & Clark 1997; Baldwin & Clark 2000; Bask et al 2010; Mikkola 2003, 441). When putting these two statements together, it can be argued that modularity enables the organizing of complex products, services, processes, and organizations in an efficient manner by decomposing tasks into smaller and simpler activities and managing them independently (Mikkola & Gassmann 2003, 204; De Blok et al. 2010a, 3).

It is argued that modularity improves operational and functional flexibility (Gershenson et al. 2003, 304; Schilling 2000; Baldwin & Clark 2000; Bask et al. 2010, 362; Mikkola & Gassmann 2003, 204; Mikkola 2003, 441). In addition, because modularity is said to facilitate economies of scale and scope, it has the potential to bring cost savings (Bask et al. 2010, 362; Jacobs et al. 2007, 1048; Mikkola 2003, 441). These benefits are enabled by components that can be used across product families (Voss & Hsuan 2011, 234; Mikkola 2003, 441; Rahikka et al. 2011, 359). The flexibility and large reusability of components is possible when product architecture is standard and interfaces are shared (Voss & Hsuan 2011, 234; Pekkarinen & Ulkuniemi 2008, 86).

One of the benefits of modularity is related to the design and the development of products, services, and processes in general and to innovation development in particular. Decomposability and independence across modules allow the simultaneous implementation of several development and design processes (Baldwin & Clark 2000; Sanchez & Mahoney 1996). Parallel development processes support the specialization of development teams. In addition, parallel development processes are likely to reduce the development time and testing time of new modules (Mikkola & Gassmann 2003, 204; Langlois & Robertson 1992, 301). Similarly, decomposability supports outsourcing, which then allows firms to

take advantage of a wide range of capabilities beyond their own organizational boundaries (Baldwin & Clark 1997, Schilling & Steensma 2001, 1152) and leave the independent development and design work to suppliers.

Advantages to customers are typically related to the increased variety in products and services and the increased choice options (Gershenson et al. 2003, 304; Schilling 2000, Pekkarinen & Ulkuniemi 2008; Baldwin & Clark 2000; Mikkola & Gassmann 2003, 204; Hsuan 1999, 199). Modularity enables providers to increase variety without increasing costs (Duray et al. 2000, 608; Sanchez 1995, 142), which also benefits the customer. Due to modularity, customers can take advantage of variety as they can update their service packages or devices part by part without having to change the whole package at the same time (Schilling 2000; Hsuan Mikkola 2000; Langlois & Robertson 1992, 297).

Although all the products, processes, services, and organizations are said to be modular to some extent, modularity might suit some contexts better than others (Schilling 2000; Schilling & Steensma 2001; Gampagnolo & Camuffo 2010). Sundbo (1994) lists several changes in market environments that, according to his study, drive organizations towards modularity: increased competition between companies, the price as the central factor in competition, demand for increased productivity, customers' demand for quality, the need for innovations and renewal in order to manage the competition, the increasing and rapid development of technology, market globalization, and mergers and acquisitions, as well as the development of strategies, such as concentration on a certain customer segment. Furthermore, it is said that modularity intrigues organizations when they have increasing pressure to rationalize their production and produce more variety with fewer costs (Gershenson et al. 2003, 295). Ethiraj and Levinthal (2004, 159) argue that modularity becomes attractive when systems become so large and interdependencies between the elements of the system become so numerous that integrated design becomes nearly impossible to manage.

Schilling (2000) and Schilling and Steensma (2001) describe factors that support or prevent the application of modularity. According to them, three factors – input heterogeneity, demand heterogeneity, and the urgency of the context entailing competitive intensity and technological change – essentially support the application of modularity in products (Schilling 2000). Further on, the heterogeneity of input and demand, the availability of standards, the speed of technological change, and competitive intensity act as catalysts towards modular organizations (Schilling & Steensma 2001).

Schilling (2000) argues that if demand is heterogeneous, it is likely to support heterogeneous inputs, and vice versa. Demand and input heterogeneity are therefore intertwined and together support modularity. Input heterogeneity is dependent on the availability of diverse technology and inter-firm capabilities. The more there is diverse technology and inter-firm capabilities, the more

heterogeneous inputs will be. In modular systems, providers can support diverse technology instead of supporting only one technology. This makes modularity attractive to suppliers. In addition, heterogeneous inter-firm capabilities encourage providers to specialize as the professionals are typically eager to deepen their core competencies. Specialization, on its behalf, can potentially increase the choice options for customers. According to Schilling (2000) and Schilling and Steensma (2001), the urgency of the context depends on the speed of technological change, the competitive intensity, and the availability of standards. If the context is considered urgent, providers are likely to find modularity attractive. In contrast, contextual inertia might steer providers away from modularity. Contextual inertia, such as weak competition, allows providers to protect their market power and architectural control, which is likely to make modularity less attractive (Schilling 2000). According to Schilling (2000), both customers and providers are typically eager to use new technology. The speed of technological development increases input diversity and thereby supports heterogeneous demand (ibid.). The availability of standards increases competitive intensity and promotes market penetration. However, they may also reduce providers' market power and architectural control.

3.4 Managerial concerns related to modularity

Greenwood and Miller (2010, 79-80) conclude that organizational design significantly affects managerial practices. Therefore, it can be argued that the way in which modular products, services, processes, and organizations are applied in practice is essentially a managerial question. Modularity is said to have managerial implications, for example, to new service development (Campagnolo & Camuffo 2010; Baldwin & Clark 1997, Novak & Eppinger 2001), standardization, outsourcing (Campagnolo & Camuffo 2010; Novak & Eppinger 2001; Eissens-van der Laan 2015), providers' coordination, and collaboration with them (Campagnolo & Camuffo 2010; Lau et al. 2010; Howard & Squire 2007; Eissens-van der Laan 2015).

Managerial implications of modularity are intertwined. New service development, for example, requires the standardization of interfaces whereas outsourcing requires network coordination. In addition, it would be artificial to separate products, services, processes, and organizations when discussing the managerial implications of modularity. For instance, standards agreed at the organizational level are implemented at the level of products, services, and processes. For these reasons, although this thesis discusses managerial concerns related to new service development, standardization and customization,

outsourcing, and network management in separate subsections, the discussion is intertwined.

3.4.1 New service development

Modularity is said to be particularly useful when flexibility and rapid innovations are considered important (Baldwin & Clark 2000). Modularity allows organizations to develop and update their production throughout the lifecycle of the product (Brusoni & Prencipe 2001; Schilling 2000; Langlois & Robertson 1992). It also allows reacting to customers' changing preferences as well as upgrading services, providing add-ons, and introducing technical improvements rapidly (Voss & Hsuan 2011, 235; Hsuan Mikkola 2000). This development work should be conducted according to the firm's strategy; managers are in a position to coordinate the development process and decide whether innovation should be implemented (Sundbo 1997, 445).

When products, services, or processes with a modular structure are developed, changes affect only the core idea of the product while leaving the relationships between the other products untouched (Henderson & Clark 1990). This can be considered the reason why modularity facilitates rapid product development (Bask et al. 2010, 362; Hsuan Mikkola 2000). In other words, independence across modules allows for the implementation of several internal design processes simultaneously without negatively affecting the whole system (Baldwin & Clark 2000; Sanchez & Mahoney 1996). Autonomously working design teams can focus on internal hidden design rules and pay less attention to the modifications made by other suppliers (Lau et al. 2010; Sanchez & Mahoney 1996; Jacobs et al. 2007). Parallel-working design teams are likely to reduce development time and testing can be done simultaneously (Mikkola & Gassmann 2003, 204). Parallel independent development also supports provider specialization (Hsuan Mikkola 2000) as providers are able to concentrate on improving their core competencies. Furthermore, autonomous development reduces the need for managers to interfere in the design process (Sanchez 1995, 146; Sanchez & Mahoney 1996).

Modularity allows design processes to happen parallel in autonomous teams only if interfaces are standardized and well defined (Gershenson et al. 2003, 304; Baldwin & Clark 2000). The definition process of the interfaces is said to require strong supplier involvement. Suppliers should be involved in the definition process early enough in order to work closely, co-develop, and share information with each other. (Lau et al. 2010; 2007.)

3.4.2 Standardization and customization

The concepts of modularity and standardization are closely related, even to the extent that modularity and standardization are said to be conceptually inseparable (Jacobs et al. 2007, 1048). In modularity, standards are related to the development of products, services, and processes themselves while also to interfaces between them. In addition, standardization is closely related to mass customization, which has become increasingly important in meeting the needs of customers. In fact, Sundbo (2002) argues that the potential benefits of standardization are increased customer satisfaction, as well as easier quality and cost management. From the managerial perspective, standardization has an essential role in developing innovations, developing standard interfaces, and applying standardization to respond to the requirement of customization. These three managerial practices related to standardization are discussed in this section.

Standardization has a significant effect on innovation development. As customers increasingly require high quality, managers are forced to pay attention to standardization. For example, in order to guarantee and concretize quality for customers, managers might apply standards, such as ISO standards (Sundbo 1997, 448). Standardization naturally guides the innovation process and it has, in fact, a dual role in the organization's performance and innovation process. On the one hand, standards are said to speed up competition and alleviate market penetration as they explicitly shape buyers' requirements for suppliers (Izsak & Edler 2011, 4). On the other hand, standardizing extensively might restrict innovation (Zhang & Gao 2010; Gadde & Jellbo 2002, 50).

Another important managerial task related to modularity is the standardization of interfaces. The independency of modules, as well as their compatibility, is based on standardization (Ulrich 1995). Therefore it is crucial that interfaces between modules are standardized in order to enable the flexible compatibility of modules (Hsuan 1999, 198). It has been suggested that standard interfaces should be developed in collaboration with providers (Lau et al. 2007; 2010). Once standard interfaces are agreed, it is not beneficial for providers to develop innovations that change the architecture of interfaces (Galvin & Morkel 2001). If changes are made in standards, innovation compatibility with other products or services will diminish. Unfortunately, there is a risk that standardizing interfaces extensively might even prohibit radical innovation.

Customer orientation, along with customization, has become increasingly important in service production as customer preferences are more divergent than ever (Bask et al. 2011, 307). In modularity, customers' needs can be met either by providing standard products or services in unique combinations (Sundbo 1994, 245) or by leaving room for customization inside the standard product or service. These two ways of customizing are discussed below.

In order to provide a wide range of end products to meet the specific needs of customers (Bask et al. 2010, 362), modules can be standardized and then provided for customers in unique combinations (Broekhuis 2009). In manufacturing, this kind of customization is typically related to mass customization, where modularity works as an important enabler of cost-efficient production (Bask et al. 2011). In fact, modularity is said to be strongly related to mass customization (Bask et al. 2011, 306), as mass customizers must utilize modular design in order to achieve the same efficiency available if mass production is utilized (Duray et al 2000, 606; Mikkola 2007, 57; Kumar 2004, 296). The aim of mass customization is to produce customized goods with low costs (Mikkola 2007, 57). Modularity supports this aim as it enables increasing the number of products available without increasing costs (Ulrich 1995, 428; Duray et al. 2000, 608). If a moderate number of components is produced and then combined in a unique manner, more choice options can be created with fewer costs. (Broekhuis 2009, 979.)

However, especially in the literature concerning service modularity, it is argued that services can be standardized only partly and some parts of the module can be left “open” for customization (Vähätalo 2012; see also De Blok et al. 2013, 17). If the goal of service delivery is to ensure customer satisfaction by using a demand-based and user-driven approach (CEC 2009), it is important to maximize the possibilities of creating services that respond to customers’ expectations. Customization can be done either early or late in the stages of the delivery process, depending on the nature of the service and depending on the time when the customers are involved in the process (Bask et al. 2011). Given the essential role of the customer in the service process, customization is closely related to co-creation (Pekkarinen & Ulkuniemi 2008).

3.4.3 Outsourcing

In production systems, managerial tasks are related to outsourcing (Campagnolo & Camuffo 2010). Firms are increasingly outsourcing and relying on full service providers (Gadde & Jellbo 2002; Howard & Squire 2007, 1193). Although Voss and Hsuan (2011, 234) argue that a modular product structure facilitates outsourcing, Campagnolo and Camuffo (2010, 269) state that the relationship between outsourcing and modularity is not clear. Based on their literature review, Campagnolo and Camuffo (2010) agree that the connection exists. However, they conclude that the direction of the effect is debated and needs to be further studied.

Sako (2002) describes three alternatives for managers to move towards the outsourcing of modular products. In the first alternative, the organization can adopt modular design and produce the first parts itself before outsourcing in order to maintain in-house knowledge. In the second alternative, non-modular components

can be outsourced and suppliers are then expected to develop the components towards modularity. While this triggers supplier capabilities both in design and in capacity, it might also jeopardize the control of architectural knowledge. In the third alternative, outsourcing and modularization can be implemented simultaneously. This, on the one hand, accelerates product innovation, while on the other hand, it entails a significant risk of loss of control of product architecture.

In order to outsource, services should be decomposable and should enable standardizing, and it should be possible to define interfaces (Mikkola 2007; Voss & Hsuan 2009, 547; Hsuan Mikola 2003, 440). Standardized modules are easily outsourced to suppliers (Ulrich 1995; Hsuan 1999) through the use of the loosely coupled approach in supply chains (Sanchez & Mahoney 1996; Sanchez 1995). Outsourcing non-core activities provides suppliers with the possibility of working and developing their products independently, as well as specializing and concentrating on their core competencies (Campagnolo & Camuffo 2010, 269; Pekkarinen & Ulkuniemi 2008, 84). In addition, in modular systems, organizations can combine outsourced processes and competencies from different providers and thereby add the customer value (Pekkarinen & Ulkuniemi 2008, 87).

Outsourcing supports flexibility in scale and scope as organizations can scale production according to demand without increasing their own labor or capital investment (Pekkarinen & Ulkuniemi 2008, 87). Furthermore, outsourcing modular processes can be beneficial as modular architecture diminishes the need for supply chain coordination (Sanchez & Manohey 1996; Sanchez 1995). However, Novak and Eppinger (2001, 202) argue that coordination costs can be low only in simple production, whereas in outsourcing complex products coordination costs might make in-house production more profitable.

3.4.4 Network management

At the organizational level, managers need to consider both the organization's internal modularity as well as it being a part of the larger modular system. This, according to Campagnolo and Camuffo (2010, 274), brings up the issues of coordination and collaboration within and across organizations. It seems that organizations are moving from vertically integrated structures to horizontal networks. Outsourcing raises the question of relationships in the supply network and whether suppliers should be kept at arm's length or whether strategic partnerships should be formed (Hsuan 1999, 203). This question related to relationships in the network is interesting as in the literature on modularity two conflicting strategies for network management prevail: loose coupling and tight integration (Lau et al. 2010; Howard & Squire 2007).

Loose coupling, or the so-called 'black box' strategy, is applied to give greater independence to suppliers and to reduce communication and coordination among suppliers. Loose coupling is said to bring benefits, particularly within new service development processes in the modular environment (Sanchez & Mahoney 1996; Baldwin & Clark 2000; Schilling 2000). High module independence and standard interfaces decrease the need for the coordination of the development process. Standard interfaces enable so-called embedded or concealed coordination, which significantly diminishes the need for conducting managerial authority in the coordination of the development process. (Sanchez & Mahoney 1996.) Instead of coordinating the development process, managers can monitor the output. Interfaces are kept to a minimum in order to reap cost benefits from the reduction of coordination. (Sanchez & Mahoney 1996.) Sanchez (1995) lists requirements for embedded coordination: component specifications should be understood by providers, the development process should be autonomous, and providers should be monitored by referring how the produced component conforms to interface specifications.

Loose coupling of the network also means that suppliers are kept at arm's length. Purchasers may provide only critical information to the suppliers in order to mitigate knowledge leakage (Lau et al. 2010). The black box strategy benefits the purchaser as it supports supplier independence and allows suppliers to use their maximum competence in design and production capacity. However, at the same time, the black box strategy involves the risk of losing technological understanding, negotiation power, and control of architectural knowledge. (Sako 2002.)

The other strategy for network management is tight network integration, which is applied to promote continuous communication and collaboration. Tight network integration is said to enhance co-development and reduce interface constraints. (Lau et al. 2010; Hsuan 1999.) Particularly, new service development is said to require intensive collaboration and coordination (Howard & Squire 2007; Lau et al. 2010).

According to Jacobs et al. (2007), outsourced modules require extensive supplier integration in order to help providers to develop innovations through collaboration. Lau et al. (2010) argue that extensive coordination, and therefore tight supply chain integration, is important, particularly in the knowledge-intensive new product development. In the development of knowledge-intensive services, knowledge sharing is necessary and cannot be left to the embedded coordination mechanisms of modularity. Instead, active knowledge sharing and systematic integration should play a significant role in the knowledge-intensive new service development. However, knowledge sharing has consequences related to knowledge leakage, and therefore requires a balance between information sharing and information protection. In the end, it is in managers' best interests to know

what knowledge is shared and how it is shared, as well as by whom the sharing is coordinated. (Lau et al. 2010.) According to Jacobs et al. (2007), knowledge leakage can be avoided in tight supply chain integration when the buyer and supplier can concentrate on communicating around the interfaces instead of the final product. Information sharing is particularly important, for example, when interfaces are agreed, when the process of product development is monitored, and when feedback from pilot projects is needed (Howard & Squire, 2007).

4 SUMMARIES OF THE ORIGINAL STUDIES

This chapter briefly describes the original studies, their main objectives, and results. In subsection 4.5, the research data and methods used in original studies are described.

Two of the studies (Study 1 and Study 2) have been published in peer reviewed international journals. Two of the studies (Study 3 and Study 4) have been presented in recognized international conferences. Study 1, a systematic literature review, was conducted first and its aim was to enhance the author's pre-understanding of the topic. Results and suggestions for future studies presented in Study 1 laid a foundation for the research questions in Studies 2, 3, and 4. Studies 2, 3, and 4 were written in parallel processes and do not have either an explicit chronological order or content-related dependencies; instead, they explore modularity in health and social services from different perspectives. The results of the studies are discussed in Chapter 5 in more detail.

4.1 Study 1: Modularity in health and social services – a systematic review

Study 1 was conducted as a systematic literature review in order to create a thorough picture of previously published academic studies concerning modularity in health and social services. Multidisciplinary databases were screened in order to find out how the concept of modularity is perceived and used in the context of health and social services. The focus of the article selection is in modular services, processes, and organizations. Articles concerning modular products, such as imaging devices, were excluded from the literature review. Information systems were also excluded if the focus of the article is in computer technology itself. If the focus of the article is in the service that the information technology supports, the article is included in the review. Nineteen articles in total were chosen for analysis. In Study 1, the classification and the analysis of the data is based on the theoretical literature on modularity.

The systematic literature review conducted in Study 1 clarifies the ways in which modular services, processes, and organizations are applied in health and social services. The results reveal that modularity is mainly used to describe the physical structure of the services, such as modular treatment protocols developed for patients. According to results, in only a few articles (De Blok et al. 2009;

2010a; 2010b; Chorpita et al. 2005) is the theoretical background based on modularity. In addition, the literature review reveals how the characteristics and essential elements of modularity appear in the context of health and social service. In the articles included in the review, the characteristics of modularity— the independency of components, decomposable architecture, and compatibility – are described to some extent, while the essential elements – hidden and visible design rules – are described implicitly in the main.

Study 1 also reveals some managerial concerns. The possibility of independent new service development, for example, is exploited in health and social services in order to increase the variety of services and to develop information systems that would support service delivery (Lim et al. 2009; Hu & Ahmed 1989). According to results, managerial concerns related to the standardization of health and social services processes are discussed particularly by Bohmer (2005). Bohmer describes modularity as one option to arrange unique service packages for patients effectively. In addition, the results in Study 1 reveal that the need for customization in health and social services is widely recognized and the ways in which services can be customized is discussed in several studies (e.g., De Blok et al. 2009; 2010a; Lim et al. 2009; Kolko et al. 2010). In relation to multiple providers, the literature review reveals challenges. Meyer et al. (2007), for example, argue that poor collaboration between providers causes problems in smooth processes, and De Blok et al. (2010a) concludes that poor collaboration between providers leaves service coordination to customers.

4.2 Study 2: Organizing health services through modularity

The purpose of Study 2 is to analyze the way in which the factors influencing a transformation towards or away from modularity, according to the general modular systems theory, appear in the context of health services, and the extent to which the special characteristics of health services might support or prevent its application. The study is theoretical in nature and it reflects the general modular systems theory presented by Schilling (2000) and Schilling and Steensma (2001) against the special characteristics of health services – the asymmetry of information, uncertainty, and externalities – identified in the context of health economics.

In her general modular systems theory Schilling (2000) proposes factors – heterogeneous inputs and demand and the urgency of the context – which have, as she argues, an effect on the attractiveness of modularity from the perspective of customers and providers. Together with Steensma, she adds the facilitating mechanisms – the speed of technological change, competitive intensity, and the availability of standards – to this list (Schilling & Steensma 2001).

Study 2 suggests eleven proposition pairs that direct health services both towards and away from modularity. The results of Study 2 reveal that, on the one hand, heterogeneous demand and inputs are in conflict with scarce resources, asymmetry of information, and negative externalities and thereby prevent modularity in health and social services. On the other hand, insurance-based systems related to context uncertainty and the subsidization of positive externalities support heterogeneous demand and input, and thus modularity in health service provision. With respect to facilitating mechanisms, the analysis reveals that modularity is supported through the standardization of health services. Standards protect the customer from problems related to information asymmetry. In addition, standard interfaces are one of the factors ensuring fluency of services. However, standardization could also prohibit modularity if it does not allow new technical and service innovation and competition.

The findings provide potentially important information for health service managers and providers, enabling them to understand how modularity would benefit health service provision and where contradictions are to be expected. In addition, the study contributes to the discourse on service modularity in general and complements the literature of modularity enhancing the understanding of how modularity appears in both public and private health services.

4.3 Study 3: Supply chain management in health and social services – tightly integrated or loosely coupled?

The extant literature of modularity suggests two contradicting strategies – loose coupling and tight integration – for conducting supply chain management (SCM) in health and social services. Study 3 analyses how, in what circumstances, and for what purposes managers apply these strategies in SCM in the context of health and social services.

Eighteen public sector health and social services supply chain managers from three different municipalities were interviewed. The data is analyzed from the perspective of coordination, collaboration, standardization, and shared information as these are prevalent perspectives in the academic literature concerning loose coupling and tight integration.

The analysis indicates that the two strategies of SCM – tight integration and loose coupling – do not exclude each other in health and social services. Instead, they are used in different situations and for different purposes. The analysis reveals four types of loose coupling. Loose coupling is applied in traditional formal contracting, outcome-oriented contracting, and third sector service provision. In addition, loose coupling is applied when service vouchers are used in purchasing. In traditional formal contracting, providers are kept arm's length, collaboration is

minimal, and coordination is conducted through official monitoring. In outcome-oriented contracting, collaboration is concentrated on the pre-procurement phase and room is provided for independent service development and production. This is possible because in outcome-oriented contracting, the purchaser's focus is on end results. Collaboration with a third sector is not always based on contracts; instead, it is informal and based on the provider's own initiative. Finally, the aim of service vouchers is to keep standards as minimal as possible and leave providers room to compete and attract customers with extra value. It can be concluded that the main purpose of applying loose coupling is to ensure the lawfulness of services.

The analysis also suggests three types of tight integration. According to results, the aim of the tight integration is to enhance collaboration within the supply chain. Tight integration is applied mainly in less formal development projects in order to promote the effectiveness of services and to add to customer value. Tight integration can be facilitated by the supplier or purchaser, depending on who has the responsibility for the development project. Tight integration can also be contract based. In this way, purchasers obligate suppliers to collaborate with each other and with the purchaser.

4.4 Study 4: Public procurement for innovations – Perspectives from health and social services

Study 4 concentrates on outsourcing, especially on public procurement, which is considered an essential instrument in promoting innovation and thereby enhancing public economy (COM 2011). Therefore public procurers are strongly encouraged to apply procurement practices that support innovation (Edler & Georghiou 2007; Uyerra et al. 2014). However, conducting public procurement for innovation is said to be challenging, and several barriers that prohibit public procurement for innovation have been reported. The study does not evaluate the current innovation policy in EU per se (see Ahonen & Virtanen 2008), instead the aim of Study 4 is to analyze whether innovation-supportive procurement practices are used in health and social services and what possible barriers to the public procurement for innovation exist in this context.

Public procurement for innovations, the focus of the Study 4, is linked to modularity through those procurement practices that are said to enhance innovations. It can be argued that innovation-supportive procurement practices, such as outcome-based procurement and early meetings with providers, to name a few, are very similar to managerial practices described in the literature of modularity. The aim of the outcome-based procurement, for example, is to support innovations by minimizing control of the production process. Purchasers aim to define the outcome and concentrate on it, instead of defining the production

process in great detail. Similarly, in modularity, the aim is to define the interfaces instead of regulating the entire process. It is suggested in the literature of modularity that tight integration is particularly useful in the early state of new service development (Mikkola 2003). In that way, suppliers have the ability to affect the interfaces and to agree on other important issues. However, after that, suppliers should have autonomy to develop innovations, and coordination can be kept at a minimum. These supply chain management practices are in line with the literature concerning innovation-supportive procurement practices. Early meetings, before procurement, are said to provide an opportunity to discuss the aims of the procured services and to agree on the communication practices, for example (Edler et al. 2011; Uyarra et al. 2014). To conclude, it can be argued that, by applying innovation-supportive procurement practices, health and social service managers have the ability to support modularity, as well.

Eighteen public sector representatives participating in procurement processes, from three different municipalities, were interviewed. Results reveal that innovation-supportive purchasing practices are used in health and social services. However, several barriers are reported, some of which are similar to those mentioned in the earlier studies. In addition, results reveal that some of the barriers are related to the health and social services context in particular. For example, uncertainty of demand, challenges in outcome definition and measurement, rigid regulation of the context, multiple suppliers, and complex environments, as well as ethical sensitivity of the context, creates barriers to using innovation-supportive practices in public procurement. One of the main barriers is over-avoiding risks that might occur in relation to innovation-supportive procurement practices. The results have significance when evaluating the applicability of public procurement for innovation in the health and social services context. With regard to managerial issues related to modularity and public procurement for innovations, Study 4 reveals concerns related to new service development, standardization, and coordination of the supply network. According to the results, detailed standardization and monitoring of the contracts (coordinating the suppliers) is used in order to avoid conflicts with providers and to protect customers from asymmetry of information. However, rigid regulation narrowed the providers' possibilities of developing innovation.

4.5 Research data and methods of original studies

This thesis includes four original studies. Various data and research methods were applied in these original studies. In Study 1, a systematic literature review was conducted in order to draw attention to the research gap and indicate the research questions for the other studies. Study 2 evaluates theoretically the applicability of

modularity in health and social services. In Studies 3 and 4, qualitative interviews were used as the main method in order to describe health and social services managers' experiences related to network management strategies and to procurement practices that they apply. Methods used in the original studies are described below in more detail, and their approaches, objectives, and data are summarized in the Table 2.

Table 2 Approaches, objectives, and data of the original studies

	<i>Approach of the study</i>	<i>Objective of the study</i>	<i>Data of the study</i>
Study 1	Systematic literature review	To analyze the existing literature concerning modularity in health and social services; to describe how modularity is perceived and used in the context of health and social services	Articles (n = 19) that concern modularity in health and social services and are published in international journals
Study 2	Theoretical reasoning	To evaluate the General modular systems theory from the perspective of special characteristics of health and social services; to analyze the way in which the factors influencing the transformation towards or away from modularity, according to the general modular systems theory (Schilling 2000), appear in the context of health and social services, and the extent to which the special characteristics of health and services	Propositions provided by Schilling (2000) and Schilling and Steensma (2001) and the literature concerning health economics (e.g., Arrow 1963; Mooney 1992)

		might support or prevent its application	
Study 3	Interpretative qualitative research	Managers' experiences concerning network management in health and social services	Interviews of 18 health and social services managers, from 3 different municipalities
Study 4	Interpretative qualitative research	Managers' experiences concerning public procurement for innovation in health and social services	Interviews of 18 health and social services managers (participating in public procurement processes), from 3 different municipalities

4.5.1 Systematic literature review

The aim of a literature review is to review something that has already been published (Jesson et al. 2011, 9). A systematic literature review helps to clarify the research gap, provide rationale for future research, or it might work as an introduction to new research (Jesson et al. 2011, 18; Torgerson 2003, 8; Petticrew & Roberts 2006, 21; Tranfield et al. 2003, 208). Although the pre-understanding at the beginning of this thesis was that the literature concerning modularity in health and social services is not extensive, it was found important to appraise the literature systematically. The aim was to find out how modularity is perceived and used in the context of health and social services, and in addition, to provide insights for future research.

A systematic literature review should be a neutral and technical, as well as a rational and standardized process. It should reflect the objectivity and the transparency of the process (Jesson et al. 2011, 15; Torgerson 2003, 6; Tranfield et al. 2003, 209). According to Needleman (2002), a systematic literature review should entail a clear purpose and a research question as well as a clear definition of inclusion and exclusion criteria. In addition, screening should be conducted according to the research strategy, and inclusion and exclusion criteria should be applied to identify potential studies. A systematic literature review should include pooling the data and producing the conclusions.

Needleman's (2002, 7) systematic review process was followed in Study 1. First, research questions were decided and inclusion criteria were identified. The main inclusion criteria was that the article's focus should be on modularity and should have a connection to health or/and social services. Articles concerning devices and information systems were excluded if there was no clear description

of the modular services that the device or the system was supporting. Additional limitations and keywords are described more closely in Study 1.

Second, the literature was screened from the following electronic databases: Medline (Ovid), Cinahl, Cochrane library, SocIndex, ProQuest/ABI INFORM, Business Source complete, Science Direct (Elsevier), and Emerald. The screening was conducted according to inclusion and exclusion criteria, and Primas' screening process was used (see Moher et al. 2009). This screening provided sixteen articles. In addition, the references of the accepted articles were screened manually and three more articles were accepted. The theoretical literature of modularity was used as the pooling criteria for the data. The conclusion was drawn related to modular structure and essential elements of modularity in health and social services. In addition, some managerial concerns were presented.

4.5.2 *Theoretical reasoning*

Study 2 was theoretical and thus did not include any firsthand empirical data. Instead, it applied deductive reasoning in order to create propositions that would answer the research questions and shed light on the theoretical possibilities of applying modularity in health and social services.

Deductive reasoning moves from general assumption to more specific situation (Burns & Grove 2009, 7). It aims to draw conclusions through logical thinking (Ghaudri & Grønhaug 2010, 15). According to Hyde (2000, 82), deductive reasoning is a process that tests theory; the process starts from existing theory and aims to appraise whether the theory can be applied to specific instances. Accordingly, Study 2 aimed to evaluate whether the theory of modularity could be applied to the context of health and social services and whether the context-related characteristics would promote or prevent the application. Study 2 combined the general modular systems theory (Schilling 2000; Schilling & Steensma 2001) and the characteristics of the health service context that are acknowledged in the literature on health economics (e.g., Arrow 1963; Mooney 1992; Santerre & Neun 1996; Van der Gaag & Perlman 1981). Combining these two perspectives created propositions which illustrated the context-related reasons either promoting or preventing the application of modularity to health and social services.

Deductive reasoning can be divided into two phases: building of propositions based on extant theories, and the empirical testing of the propositions (Hyde 2000). Only the first phase was conducted in Study 2, with the second phase being left for future research.

4.5.3 Interpretative qualitative research

The objectives of Studies 3 and 4 were to explore the experiences of health and social services managers concerning supply chain management strategies (Study 3) and public procurement for innovation (Study 4). Studies 3 and 4 were both qualitative and exploratory in nature. They were exploratory in a sense that both applied theories and literature from other discipline to a new context, namely to health and social services (see Ghaudri & Grønhaug 2010, 56). It has been argued that qualitative research methods are the most useful for exploratory research as they enable explanations (Ghaudri & Grønhaug 2010, 106). Given that it was important to discover how the interviewees understood supply chain management and public procurement for innovation, qualitative interviews seemed appropriate method for data collection (Eriksson & Kovalainen 2008).

The empirical data was collected during the spring of 2013. Interviewees were chosen from three municipalities, representing, in Finnish terms, large- and mid-sized municipalities ranging from approximately 80,000 to 20,000 inhabitants. The particular municipalities were chosen as they all applied different ways of organizing and managing supply chains and different procurement practices (see Gummesson 2000, 95). The first of the municipalities applied a purchaser-provider split, the second applied the agreement control model, while the third had some of their service production under traditional hierarchical budgeting and some outsourced production. According to Ghaudri and Grønhaug (2010, 140), this could be called the 'quota sample' as the selection of participants was discretionary. Choosing municipalities discretionally was justified because the aim was not to compare the individual municipalities, rather the purpose was to gain diverse perspectives on management in health and social services.

The interviewees included public purchasers and public providers working as health and social services managers. They were all either responsible for participating or conducting supply chain management and purchasing in the area of social and health services, particularly in the area of services for the elderly. This particular service area was chosen because services for the elderly can be considered rather modular in their nature (Study 2). The participants represented managers from mid-level to top management. Written permission for interviews were requested from each of three the municipalities. Interviewees were selected based on the municipalities' information available on the Internet. The mid-level and top managers who were responsible for arranging home services for the elderly were asked to volunteer for interviews. In total, twenty people were contacted and eighteen volunteered (nine interviewees from the first municipality, five from the second, and four from the third). The number of interviewees corresponds to the size of the municipalities as well as the municipalities' way of organizing services. If purchasing and providing were separated, as was in the case in the first

municipality, there were more people to interview. The two selected interviewees who did not participate were from the second and the third municipalities. Consequently, eighteen public sector supply chain managers from three different municipalities were interviewed.

All interviewees were contacted either by phone or e-mail and the time and the place for the interviews were decided according to interviewees' preferences. In addition, interviewees were informed about the topic of the interviews. Open-ended interviews were chosen for the data collection method as the aim was to inspire the interviewees to share their experiences easily. Since there is no operationalization concerning the concept of modularity in the health and social services context, interviewing as a research method aimed at avoiding misinterpretation of the concepts and confusion with related concepts (such as confusing tight integration with the rather similar concepts of care paths or pathways which are typically used in health sciences).

At the time of the interviews, the aims and the purpose of the study were repeated and the interviewees were reminded of the anonymity of the reporting. The interviews lasted from 53 to 147 minutes. All the interviews were recorded and transcribed with the approval of the interviewees.

The data analysis in both studies, 3 and 4, was abductive. According to Gummesson (2000, 64), after starting from either deductive or inductive bases, most studies are iterating both logics, and are thus abductive, at least to some extent. For example, it has been argued that in exploratory research it might be useful to start deductively as long as the existing theory only guides but does not dictate the analysis (Ghauri & Grønhaug 2010, 206). Similarly in Studies 3 and 4, the analysis started from deductive bases. In Study 3, the background of the study consisted of two contradicting supply chain management strategies described in the extant literature. Thereby these two strategies – loose coupling and tight integration – were used as the bases of classification of the data. However, four different types of loose coupling and three types of tight integration emerged from the data and were not based on previous literature. In Study 4, the extant literature concerning practices supporting or preventing public procurement for innovation was applied as the basic classification scheme for the data analysis. However, in the early state of analysis it became clear that classification could be applied only in upper categories, while the content of lower categories was somewhat different from the extant literature. Consequently, it can be argued that in both studies the analysis started deductively while being inductively open to the nuances of the data.

5 MODULARITY IN HEALTH AND SOCIAL SERVICES

This chapter discusses the results of the thesis. The chapter is organized according to the research questions so that subsection 5.1 answers the research question number 1, as it analyses how modular structures manifest in the health and social services context. Subsection 5.2 answers the research question number 2 and thus analyses the characteristics of the health and social services context and how they support or prevent modularity. In addition, subsection 5.3 answers the research question number 3 and explores the managerial concerns if modularity is applied to the health and social services context.

5.1 Modular characteristics and structures in health and social services

The aim of the first research question was to analyze how the structure of modularity appears in the context of health and social services. The structural categories of modularity described in subsection 3.2 – modularity in products, production, services, processes, and organizations – are discussed in this subsection from the perspective of health and social services. The discussion is based on Study 1, which contained the structural categories of services, processes, and organizations. The category of product modularity is described according to Study 2 and supplemented with the existing literature. Production modularity is excluded from this section for the reasons mentioned in subsection 1.3.

The systematic literature review conducted in Study 1 revealed that modularity has not been studied widely in the context of health and social services. There are only very few studies that explicitly discuss service, process, or organizational modularity in the health and social services context (see e.g., De Blok et al. 2009; 2010a, 2010b; 2013; 2014; Chorpita et al. 2005; Eissens-van der Laan 2015). There are few more studies that describe modular applications, such as information technology solutions in the context of health and social services (see e.g., Wohlrab et al. 2007; Shukla 1983; Ried et al. 2001). Most of the studies analyzed in the systematic literature review, however, made a pre-assumption that the structure of product, service, process, or organization is modular, although they did not apply the theoretical literature of modularity as a background for the study. Findings are in line with Eissens-van der Laan's (2015, 143) results. Her systematic review of

service modularity revealed that only a few studies have paid explicit attention to the characteristics of modularity. This subsection evaluates how modular structures, as described in the theoretical literature of modularity, appear in the health and social services context.

According to Schilling (2000), all systems are modular to some extent. Modularity can be understood as a continuum, where one end represents modularity and the other end represents specificity. In this respect, it is reasonable to argue that also within the health and social services context, services, products, processes, and organizations are modular at least to some extent. The context of health and social services is extremely heterogeneous, consisting of numerous services, products, processes, and organizations, some being more modular than the others. The degree of modularity and the way in which modular structures manifest in products, services, processes, and organizations can be evaluated from the perspective of modular characteristics (see Lau et al. 2007, 1040; Baldwin & Clark 2000; Schilling 2000; Ulrich 1995). In other words, the degree of modularity can be evaluated by analyzing how decomposable, separable, and compatible the structures in health and social services are. Next, products, services, and organizations of health and social services are discussed from the perspective of modular characteristics. Processes are extensively intertwined with services and therefore are not discussed here separately. Instead, in this section, service delivery processes are discussed together with services.

5.1.1 Modular products in health and social services

The health and social services environment is full of products. For example, medical devices are numerous, and during past decades there has been an increasing interest in investing in devices related to information technology (Borycki 2013). It can be argued that, in many parts, the medical industry is decomposable by nature. Study 2 proposed an example where the pharmaceutical industry and industry developing medicine dispensers support each other. However, collaboration across manufacturers is not self-evident. For example, surgical endoscopic instruments, which are numerous, are rather small units, consisting of camera heads, cables, and different instrument heads etc., which all can be mixed and matched according to patient needs and surgeons' preferences. The units are standardized within the manufacturer; they fit into the same endoscopy screen, but do not fit into other manufacturers' screens. Large operation units typically have devices from several manufacturers (Gobbi & Hsuan 2015, 442). In this age of rapid technology development it would support both managerial and operational arrangements if devices from different manufacturers are compatible across manufacturers. However, so far, compatibility across

manufacturers has not been in the interests of large technology firms nor systematically required by purchasers.

Another example of challenges related to compatibility of products in health and social services is the increasing field of information technology. Over the past decades, the amount of different software in health and social services has increased extensively (Borycki 2013). Unfortunately, software provided by different manufacturers has not been very compatible across suppliers (Study 4). In fact, many problems in using separate software have been reported in health and social services (see also Borycki 2013). Information technologies that are not configured are likely to prevent service development, production, and delivery (Pekkarinen & Ulkuniemi 2008, 93). In health and social services, incompatible information systems are even said to increase the possibility for adverse events (Borycki 2013). These reasons have encouraged purchasers to set requirements for providers and call for open interfaces and the possibility of combining new information technology systems with old ones (Study 4).

It can be concluded that the possibility of modularizing products is not fully utilized. Application of open-source or free software would enhance modularity. Increased compatibility would especially benefit professionals and managers in health and social services, as they have to consider the restrictions of compatibility while organizing their daily work. Inpatients and outpatients would benefit, too. Inpatients would benefit from more fluent and flexible work processes in the hospital units. Outpatients would benefit when buying and updating their medical devices.

5.1.2 Modular services and delivery processes in health and social services

Despite numerous technical devices and their significance in value production, services can be considered as the most important element in value creation for customers in the health and social services context. Health and social services typically have a strong process nature. In this sense, health and social services do not differ from services in general (see Sundbo 1994; Pekkarinen & Ulkuniemi 2008). For example, in health and social services it is common that treatment of illness constitutes several services produced by several providers over a long period of time. This indicates that services are rather modular; they can be separated temporally and production can be divided out to multiple providers, and yet they can constitute a fluent entity. However, some services can be more modular than others. Different types of modular health and social services are discussed below. In addition, the role of interfaces in service processes is briefly described at the end of this subsection as the interfaces are essentially related to service modularity.

The treatment of hypertension could work as an example of service provided by multiple providers over a long period of time (Wilmot 2007; Bohmer 2005). Wilmot (2007) argues that in hypertension treatment, customers should be able to choose between different combinations of medication, different lifestyles, different diets, different exercise regimes, psychological support etc. according to his/her personal preferences. All these essential parts of hypertension treatment are typically provided by different suppliers. Based on this example, the treatment of hypertension can be decomposed into separate modules and the modules are rather loosely connected to each other. However, some connection exists, such as dietary and medication choices, which might have an effect on exercise regimes.

Another example of modular structures in health and social services and service delivery are those of supporting the independent living of the elderly (De Blok et al. 2009; 2010a; Study 2). Support for independent living typically consists of several services provided by multiple providers. Services are somewhat independent while they might have, for example, sequential requirements. For example, nutrition and medication might have a sequential order, or the need to shower might precede wound care.

However, in health and social services there are also processes with less of a modular nature. They might be decomposable and separable while not entailing the possibility of mixing and matching. Processes such as emergency protocols for stroke treatment have little variety across patients (Study 2). Due to the fact that modularity is a continuum, there are also services between highly modular and less modular services. An example of this might be the processes for elective surgery. In elective surgery, parts of the process are separable and provided by multiple providers, while they are also rather fixed entailing few possibilities for variation (Feyrer et al. 2005; see also Gittel et al. 2009). Yet the customer might be able to choose, for example, between the hospitals or surgeons. Inside the modules there might also be choice options, such as physical exercises in postoperative physiotherapy or different surgery techniques in the intraoperative phase (see also Bohmer 2005).

Consequently, it could be argued that services and their delivery processes in health and social services are rather modular; services act independently and have a decomposable architecture. However, there are challenges in the compatibility of services. In fact, health and social services have been accused of being fragmented (Teperi et al. 2009: 17; Lloyd & Wait 2006: 7; Nolte et al. 2012: 126). In modularity, compatibility is an essential characteristic, which, with the help of standard interfaces, enables the mixing and matching of modules (Langlois & Robertson 1992, 299, Ulrich 1995). Interfaces in services are said to entail a strong human aspect (Voss & Hsuan 2009; De Blok et al. 2014), which means, for example, information transfer between providers. Unfortunately, the information

transfer in processes has been regarded as frail, entailing various problems (De Blok et al 2010a; Gloudberg & Mintzberg 2001b; see also JCAHO 2015).

The literature review conducted in Study 1 did not reveal studies concentrating on interfaces in health and social services. In fact, the only study concentrating on interfaces in health and social services is recently published by De Blok and others (2014). Their work creates a typology for interfaces in health and social services. According to them, some interfaces aim at supporting coherence among services, and information transfer plays an important role in this. Similarly, results from Study 1 indicate that fluent information transfer and free access to information are crucial factors to a well-functioning processes. The important role of fluent information transfer in service processes was also recognized by health and social services managers in Study 4.

5.1.3 Modular organizations in health and social services

When it comes to organizational structures, modularity can prevail inside the organization or between organizations (Study 1; Schilling & Steensma 2001). Organizations' internal modularity was described by, for example, Rainey and Rainey (1986), who presented an empirical example where the organization aimed to enhance the enrichment and participation of employees by structuring the organization by modules. In their example, modules entailed most of the organization' functions, which encouraged employees to take responsibility for the entire process instead of concentrating on small details in the process. Although the process structure is becoming more common in health and social services organizations, they are still typically organized in a rather functional manner (Tevameri 2014, Fättholm & Jansson 2008). The functional structure originates from the tradition of separating medical specialties into their own "functions" (see e.g., Tevameri 2014; Virtanen 2010; Glouberman & Mintzberg 2001a; Study 2). If these functional units are evaluated from the perspective of modular characteristics, it can be argued that they do work independently and they have a tendency to concentrate on their own interests. These functional units have even been criticized for a lack of collaboration with other functional units. Unfortunately, interfaces between functional units are not well developed, partly due to the poor information transfers systems and partly due to the old professional traditions (see e.g. Kallio 2015). This kind of functional structure has a risk of sub-optimization, as pointed out in Study 3. The results revealed that unit-based budgeting inside health and social services organizations prevents collaboration and causes sub-optimization inside the organizations.

Modularity in organizations can also prevail between organizations. For example, De Blok et al. (2010a) described the organizational structures where

services for the elderly are provided in a modular manner. One essential reason why modular structures between health and social services organizations have increased is the trend for outsourcing. When health and social services are outsourced, services are consequently provided by multiple providers from private, public, and non-profit sectors.

The relationships between providers in outsourced services have been rather formal, and mutual collaboration has not been self-evident (Study 3; Study 4). In fact, health and social services organizations that have conducted outsourcing have typically applied loose coupling as a supply chain management strategy. Loose coupling as a supply chain management strategy might support the independence of organizations, but it is also likely to prevent collaboration between them (Study 3). However, if the organizations are lacking standard interfaces, loose coupling increases the risks of fragmentation.

Additional challenges to organization modularity in health and social services are brought by a wide network of stakeholders who have no contractual relationships with purchasers. This network consists of multiple providers from public, private, and third sectors. In addition, those stakeholders do not represent only health and social services; instead, they provide services and products from all possible fields needed when health and social service entities are constructed. All of them are related to each other, at least to some extent. Therefore, it can be concluded that, although the structure of health and social services organizations is modular, the interfaces guaranteeing the compatibility have been somewhat undeveloped (Study 3; see also de Blok et al. 2010a, 287).

Some of the providers in the process are suppliers, some are competitors, and some are complements. In this respect, health and social service organizations as well as the services and products they provide can be considered as ecosystems (see Adner & Kapoor 2010, 309). From the ecosystem perspective, the relationships of the partners and their coordination becomes important. Adner and Kapoor (2010) report challenges in innovation ecosystems, such as compatibility challenges. Innovation ecosystems enhance collaborative learning among providers and thereby create a performance that is unique and difficult to imitate (2010, 311-312). They, however, remind readers that the degree to which performance advantages are achieved is related to the degree of modularity of products and providers. If the interfaces are open, the uniqueness is more difficult to create, and if the suppliers are modular, the learning is distributed in the supply chain and might not benefit the providers as a group.

5.2 Context-related challenges in applying modularity in health and social services

The aim of the second research question was to analyze how the context-related special characteristics of health and social services support or prevent the application of modularity in the health and social services context. Study 2 describes the characteristics related to the health and social services context from the perspective of health economics and analyzes how the asymmetry of information, uncertainty, and externalities affect the application of modularity. Study 4 evaluates how the context-related characteristics affect public procurement for innovation. This subsection analyses how the special characteristics of the health and social services context – asymmetry of information, uncertainty, externalities, unclear outcomes, and complex environments – support or prevent the application of modularity. In subsection 2.4, strong regulation is described as a special characteristic of its own. Here it is, however, discussed together with asymmetry of information, uncertainty, and external factors.

5.2.1 Asymmetry of information and modularity

Asymmetry of information is strongly related to health and social services (Mooney 1992) in at least two ways. First, it affects standardization; second, it affects heterogeneous demand. Standardization and heterogeneous demand both affect the attractiveness of modularity.

Asymmetry of information in health and social services has spawned several national and international standards and recommendations in order to protect the customer from e.g., poor-quality services (Van der Gaag & Perlman 1981). Although standardizing is important in health and social services and although standard interfaces do support modularity, standardizing design rules or interfaces too extensively prohibit the attractiveness of modularity (Schilling 2000). For example, too extensive standardization restricts suppliers' ability to provide heterogeneous products or services or to conduct new service development (Study 2).

Heterogeneous demand is one of the factors enhancing the attractiveness of modularity (Schilling 2000). A demand-based policy – currently a topical issue in Western countries – encourages suppliers to produce products and services as per demand. A demand-based policy also emphasizes customers' ability and willingness to make rational choices concerning their health and social services (Wilmot 2007, Lako & Rosenau 2008, De Blok et al. 2009). A demand-based policy is likely to support modularity if customers are encouraged to ask for

heterogeneous services or use multiple suppliers (Study 2). Heterogeneous demand also encourages providers to specialize in order to meet customers' versatile needs with a wide variety of services or products. However, there is a risk that, due to information asymmetry, customers are not willing to appreciate versatility (Mikkola 2007; Schilling 2000). Customers may not have enough information or capabilities to decide on the service or the provider (Lako & Rosenau 2008). In addition, customers might be unwilling to assemble or coordinate the service packages themselves (Schilling 2000). In fact, there are many customer groups that are unable, for one reason or another, to coordinate their health and social services (Lako & Rosenau 2008; Study 2).

5.2.2 Uncertainty and modularity

Strong uncertainty at the customer level, and to some extent also at the system level (Study 2), prevails in health and social services. Uncertainty at the customer level means that people have little possibility of predicting their need for services (Arrow 1963; Shortell & Kaluzny 2006). Nevertheless, providers should be prepared to meet the changing needs of customers. At the system level, uncertainty is related to the urgency of the context. For example, unpredictable or rapid changes in regulations and political discourse can create uncertainty. The extant literature describes how the urgency of the context – especially rapid changes in demand and input – would support modularity (Schilling 2000; Schilling & Steensma 2001). However, barriers also exist.

Uncertainty related to customers' rapidly changing needs requires from providers an ability to react to these changes with flexible service production. This can be conducted in two ways. The first option would require from the provider a vast repertoire of standard services. In this way it would be possible to combine unique service packages for customers from standard service modules. The second option would be separating those parts that must be standardized from the parts that can be customized. Customized parts could be then adjusted according the unique needs of the customer. (Study 1.) Both options are possible to conduct in modular structures, and for this reason it could be argued that modularity might help providers to respond to uncertainty of demand at the customer level (Study 2).

Uncertainty of the demand in health and social services makes both public and private insurance attractive (Santerre & Neun 1996). Insurance, however, creates a moral hazard and expose customers and professionals to higher consumption of more heterogeneous services (Santerre & Neun 1996; Arrow 1963). While heterogeneous demand would support modular structures (Schilling 2000), both public authorities as well as insurance companies regulate the demand in order to

prevent increasing costs. Consequently, if there is no heterogeneous demand, there is no need for heterogeneous inputs either and modularity becomes less attractive (Study 2). However, health and social services are not only financed by public authorities or by insurance companies. People are increasingly willing to invest in their health and social well-being from their own pocket. If customers are buying health and social services at their own expense (i.e., without expecting compensation from public authorities or from private insurance companies) it might be profitable for suppliers to provide more heterogeneous services.

Uncertainty at the customer level also affects the contracting between purchasers and suppliers. Uncertainty concerning customer needs constitutes a risk if contracts are long and inflexible. Providers might not have the possibility of reacting to the changing needs of customers by customizing services or providing entirely new innovations that might even better suit customers' changed needs than previous innovations (Study 4; Gobbi & Hsuan 2015, 442). Instead, providers have to produce what has been ordered in the contract. This is likely to prohibit the attractiveness of modularity, particularity from the perspective of flexible customization and new service development (Study 4).

Uncertainty at the system level creates the same type of challenges in contracting as mentioned above. Although health and social services have been argued to express inertia at the political level (Study 2), changes in national legislation and in recommendations might cause problems if contracts are long. If changes are made during the contract period, providers are obligated to adapt their production to these changes. Changes in the content of a valid contract might be expensive for purchasers (Study 4), and therefore uncertainty related to existing legislation and standards encourages purchasers to make short contracts with providers. In order to tackle the uncertainty at the system level and support modularity, contracts should be either short and inflexible or long and flexible. In this way, contracts would support innovation and providers' ability to respond to customers' changing needs.

5.2.3 External factors and modularity

External factors referred in this thesis constitute externalities described in the literature on health economics and other external factors related to the complex and intertwined nature of health and social services processes. These external factors have an effect on the attractiveness of modularity at least in two ways.

First, externalities described in the literature on health economics give authorities a good reason to interfere both in customers' consumption and in suppliers' production (Mooney 1992). On the one hand, production and consumption that promote negative externalities, such as smoking or drinking

alcohol, are prohibited with restrictions or sanctions. Consequently, suppliers are unwilling to produce such services. Heterogeneous production becomes unattractive and does not encourage modular structures. On the other hand, services producing positive externalities are subsidized and they are likely to seem attractive to both providers and customers. (Study 2.) If the variety of subsidized services is narrow, it will not encourage heterogeneous production. However, if the variability of these subsidized services is wide enough, it will support heterogeneous production of services and thereby enhance the attractiveness of modular structures.

Second, in health and social services, production processes are complex and constitute multiple providers. As processes are intertwined and linked with each other in many ways (Tevameri & Kallio 2009; Shortell & Kalyzny 2006), purchasers' ability to measure the effect or effectiveness of a single provider becomes challenging (Voss & Hsuan 2009; Study 4). This is particularly problematic if purchasers should reward providers for excellent results. Purchasers' ability to track the results received from one particular service might be limited. In addition, due to the complicated and intertwined processes other providers', ineffective practices might vitiate the results of other providers' benefits. Furthermore, it might be difficult to separate provider input from other external inputs of the service processes, such as help from family members. Thus, rewarding providers for good results, such as new, effective innovations, becomes difficult and might reduce providers' willingness to develop or apply innovations. Consequently, complex and intertwined service processes might make modularity less attractive.

5.2.4 Unclear outcomes and modularity

Autonomous new service development can be considered as one of the benefits of modularity. Autonomous development turns the attention to the outcome, whereas the way in which the outcome is achieved is left to the hands of providers. In fact, the way in which the services or products are produced should not be in the interest of purchasers or other suppliers (Baldwin & Clark 2000; Sanchez & Mahoney 1996). Unfortunately, in health and social services the outcome is difficult to define. Unclear outcomes prohibit the possibility of concentrating on end results and measure them. Measurement is instead typically focused on the processes. If the process is extensively defined and monitored there will be room for new service development. This might reduce the attractiveness of modularity. (Study 4.)

Unclear outcomes is one reason why national recommendations related to health and social services provision are so detailed and cover the whole production process. The aim of these regulations is to guarantee the quality of services and

protect customers from problems caused by asymmetry of information. If outcomes are clear and easy to define, the quality of services can be evaluated by outcomes. This would encourage providers towards independent, new service development and would make modular structures more attractive. (Study 4.)

5.2.5 Complex environment and modularity

Health and social services organizations operate in complex environments (Shortell & Kalunzy 2006; Glouberman & Mintzberg 2001a). In addition, the health and social services context is said to be a high (Stepanovich & Ulrich 1999) and conflicted velocity environment where the rate and the direction of change might vary (see McCarthy et al. 2010). Related to modularity, Schilling (2000) argues that the urgency of the context supports modularity. This is due to the speed of technological change and to competitive intensity (Schilling 2000). In this respect, the complex and conflicted environments of health and social services support modularity.

In addition, multiple stakeholders and complicated networks increase the complexity of environments. Due to the rapid development of modern medicine and due to the increasing requirements for effectiveness, organizations and professionals providing health and social services are specialized (Shortell & Kalunzy 2006). While the traditional functional structure of medical subspecialties supports specialization, it might not support collaboration (see Glouberman & Mintzberg 2001b). Modularity enables specialization, and allows both organizations and providers to concentrate on development of their own capabilities. Collaboration in modularity is said to be important, particularly at early stages of new service development processes (Lau et al. 2010). For instance, early agreement of standard interfaces is crucial. After that, collaboration can be conducted via standard interfaces. Moreover, the independence across modules makes tight collaboration eventually unnecessary. This could be considered as appropriate for medical professionals (and organizations) that have no tradition of close collaboration across subspecialties or across disciplines.

5.3 Managerial concerns related to modularity in health and social services

The aim of the third research question was to analyze how managerial concerns related to modularity appear in the health and social services context. As described in Chapter 3, managerial concerns are explored from the perspective of new service

development, standardization and customization, outsourcing, and network management.

5.3.1 New service development in health and social services

The ability to enable and simulate innovation with independent new service development processes is considered to be one of the benefits of modularity (Mikkola & Gassmann 2003). At first glance, it seems that new and more cost-effective innovations are also attractive from the perspective of health and social services, as the costs for producing services are increasing while public recourses are decreasing. However, Studies 3 and 4 revealed the context-related challenges and managerial practices that affect new service development. These challenges and practices are discussed below. In addition, Studies 3 and 4 revealed the ways in which visible design rules are agreed. Visible design rules are related to new service development; however, as they are also strongly related to standardization, the topic is elaborated in the next subsection.

A modular structure supports independent new service development processes (Sanchez & Mahoney 1996). Only visible design rules should be defined and standardized, whereas hidden design rules should be left for the provider to decide. Hidden design rules should not affect other suppliers' production or the development of other products or services. This logic is similar to outcome-based procurement discussed in Study 4. Outcome-based procurement is one of the innovation-supportive practices recommended for those public procurers who wish to encourage public procurement for innovation (Uyarra et al. 2014; Edler et al. 2011). The aim of the outcome-based procurement is to define the desired outcome and concentrate on it instead of controlling the entire production process (Eissens-van der Laan 2015). In outcome-based procurement, room is left for suppliers to decide how services should be delivered and how to develop them independently.

Based on the description above, it could be argued that outcome-based procurement and modular new service development support each other. However, outcome-based procurement seems to be rather challenging to conduct in the health and social services context. Outcomes of health and social services are difficult to define (Williams 2004, Shortell & Kalunzy 2006), and therefore managerial monitoring typically concentrates on the process (Study 3; Study 4). However, if the process is defined in detail, no room for innovation is left. Similarly, if hidden design rules are extensively defined by purchasers, no room is left for providers' independent development work.

There are also other context-related characteristics than difficulties in defining the outcome that make outcome orientation challenging for managers in health and

social services. In order to protect customers from asymmetry of information, managers tend to concentrate on measuring the process instead of the outcome. In addition, national and international regulations, which are exceptionally strict in health and social services, cause challenges to outcome orientation. National and international regulations aim at guaranteeing the minimum quality for health and social services. International regulation typically concerns the way in which services should be provided and contain recommendations for evidence-based practices. National regulation entails many legislative issues, for example licensing, and defines by whom the service can be provided (see e.g., Laki terveydenhuollon ammattihenkilöistä 28.6.1994/559). Both care protocol recommendations and legislation inevitably lead to concentrating on the processes instead of the outcome, and no room for innovation is left for providers (Study 4). Consequently, it can be argued, managers in health and social services are forced to monitor the process, and therefore it is not possible for providers to conduct independent modular new service development to a large extent (Study 4).

New service development is linked to outsourcing more widely than only in relation to outcome-based procurement. Procurement for innovation has been a topical issue in the EU during the recent years (COM 2011). The aim of procurement for innovation is to encourage suppliers to develop innovations and provide them to purchasers. Innovation development is said to be supported with certain types of procurement practices. In addition to outcome-based procurement, these practices include, for example, signaling future needs, being aware of emerging innovations, and long-term contracting (Edler & Georghiou 2007; Caldwell et al. 2005; Pelkonen & Valovirta 2014; Georghiou et al. 2014; Uyarra et al. 2014). Although it is argued in the existing literature that these practices enhance innovations and encourage providers to new service development, they are challenging to apply in health and social services procurement (Study 4).

Study 4 reveals that barriers to conduct public procurement for innovation were related to the lack of future orientation and the over-avoiding of risks. A lack of future orientation included for example, difficulties in signaling future needs. This was due to political instability and a lack of long-term purchasing strategies. With regard to risk avoidance, innovation supportive practices – such as outcome based-procurement, practices providing incentives, long-term contracting, and emphasizing quality in tender evaluation criteria – were considered to entail many financial and ethical risks and were therefore avoided by the health and social services managers.

All these above mentioned reasons – difficulties in defining and measuring the outcome, extensive process regulation, and challenges in procurement for innovation – diminish providers' ability and willingness to concentrate on innovation development. For these reasons, managers in health and social services

are not able to provide a free rein to suppliers to conduct new service development as would be possible in more modular contexts.

5.3.2 Standardization and customization in health and social services

In subsection 3.4.2, standardization was described from three perspectives: innovation development, standard interface development, and standardization in order to respond to the requirement of customization. This subsection discusses the benefits and challenges related to standard interface development and standardization in order to respond to the requirement of customization in health and social services. Standardization related to innovation development and the ways in which national standards guide production and prohibit innovation is not discussed here; the question was brought up in the previous subsection.

Standard interfaces are an essential element in modularity and part of the visible design rules as described in subsection 3.1. Interfaces were not elaborated explicitly in any of the original studies. Yet, the original studies touched upon interfaces from two perspectives. First, purchasers and providers were planning the interfaces together. Second, purchasers were paying increasing attention to interfaces between people and interfaces between products.

According to the literature, it is important to decide and agree about standard interfaces early enough and involve a wide range of providers in the decision process (Lau et al. 2007; 2010). Study 4 reveals that purchasers and providers were increasingly planning the interfaces together. Arranging early meetings with providers and purchasers before procurement is an emerging practice in health and social services. The aim of the meetings is to prepare the forthcoming procurement. The meetings are arranged in order to discuss the conditions of the contract and practicalities of the service production, for example procedures for customers' need assessment and communication practices. In their typology for interfaces in health and social services De Blok et al. (2014, 183) classed these practices as interfaces between people. Although the early meetings were not exposed thoroughly in Studies 3 and 4, the analysis provided an impression that early meetings are potentially fruitful platforms for interface-related discussion.

According to Studies 3 and 4, purchasers are paying increasing attention to interfaces between people and interfaces between products. Thus far, health and social services have been accused of being fragmented (see e.g., Teperi et al. 2009). The conclusion might be that adequate attention is not given to the interfaces. Indeed, according to previous studies, health and social services have suffered from poor information transfer due to both deficiency in communication between people (Taylor 2015; Staggers & Blaz 2013; Virtanen & Stenvall 2014, 94) and poor interfaces between information technologies (Borycki 2013).

However, health and social services managers are increasingly paying attention to these problems and aiming to resolve them by means of new procurement practices (Study 3; Study 4).

Managers, as well as personnel, in health and social services are aware of the problems that poorly functioning information technology might cause (Borycki 2013). As reported in Study 4, managers are particularly concerned about the lack of interfaces between information technologies, for example communication between different manufacturer's software (see also Gobbi & Hsuan 2015, 443). Managers traced the problem to the traditionally used procurement practices, as, so far, it has not been typical to require open interfaces for technical devices. Only recently have some purchasers started to require open interfaces from technology providers (Study 4).

The communication between providers works also as an important interface in health and social services (De Blok et al. 2014), while not always being fluent in this context (De Blok et al. 2010a). In order to enhance communication, purchasers have started to require collaboration from providers and have written the requirement for it in contracts (Study 3). The main aim for enhancing the communication and collaboration between providers was to promote new service development and ensure the smooth flow for customers from one service to another (Study 3).

The other perspective regarding standardization in this subsection is the standardization in order to respond to the requirement of customization. Knowledge-intensive business services are known for their customized service production (Cabigiosu et al. 2012). However, there is a need to balance giving professionals room to customize the service and yet ensuring commercial viability (Greenwood & Miller 2010, 82). Health and social services can be considered as a highly knowledge-intensive context where services are produced by professionals with long discipline traditions (Glouberman & Mintzberg 2001a; Kallio 2015; Virtanen 2010). It has been suggested that it is difficult to standardize the production process of knowledge-intensive services as this would destroy the unique and individual solution to customers' problems (Sundbo 1994, 254). However, in the health and social services context, professionals' work has already been standardized to some extent due to global clinical guidelines, so-called evidence-based practices (see e.g., Cochrane collaboration databases). In addition, within operations management literature it has been suggested, that in order to improve efficiency, health and social services and their production can and should be standardized in many parts (Lillrank et al. 2004; Bohmer 2005). For example, process standardization should be conducted either by selecting homogeneous inputs (such as in highly specialized units) or by separating the standard processes from those requiring customization inside the organization or unit (Bohmer 2005, 324).

Although standardization would increase efficiency, unconditional standardization in health and social services is not possible (Bohmer 2005, 324; Lillrank et al. 2004). There are, at least, two reasons for this. First, customers' needs are so heterogeneous that they are impossible to standardize entirely and second, uncertainty of demand complicates standardization. Therefore, in order to respond to the unique needs of customers, it is important to retain the possibility of customization. As mentioned in subsection 3.4.2, customization can be conducted in two ways, both of which are also valid in the context of health and social services.

The first option for customization is to combine unique entities from standard products or services (see Bohmer 2005). This practice follows the idea of mass customization (see Duray et al. 2000, 607-608). However, this would require an extensive number of standard service modules, and whether preparing to produce such an extensive number is profitable can be questioned (Study 1). The second option is to define the standardized part of the service and enable the customization for the remainder (Study 1; De Blok et al. 2013). De Blok et al. (2010a) describe the customization process of long-term care services for the elderly and states that customer involvement increases towards the actual delivery phase. In the preparatory phase, customer involvement can be thin, while in the actual on-the-job phase, the service is customized together with the customer according to his/her needs and preferences. However, results in Study 4 suggest that some of the contracts made with providers are so detailed that they might not enable or provide enough incentives for suppliers to conduct customization.

5.3.3 Outsourcing in health and social services

Subsection 3.4.3 described the advantages and disadvantages of outsourcing in relation to modularity. Outsourcing has been an increasing trend both in public and private organizations in general, as well as in health and social services organizations. In this subsection, the possible benefits of outsourcing related to specialization, resource flexibility, and low coordination effort, as well as disadvantages related to losing architectural power in health and social services are discussed. In addition, some general challenges related to outsourcing in health and social services are pointed out.

Organizations typically want to specialize and develop their core competences (Campagnolo & Camuffo 2010, 269; Pekkarinen & Ulkuniemi 2008, 84), which then, hopefully, will increase the quality of products and services. Specialization is strongly present and widely applied among health and social services professions. To begin with, specialties and subspecialties form an old tradition, particularly in medicine (Glouberman & Mintzberg 2001b; Virtanen 2010). In

addition, the rapid development of science and advancements in medical technology support this specialization. Furthermore, the growing expectation for high quality encourages professionals to focus on increasingly narrow subspecialties (Casalino 2003). Based on arguments presented above, outsourcing, which increases modularity in organization structures (Schilling & Steensma 2011), can be considered useful in health and social services. Studies 3 and 4 described the outsourcing of services provided for the elderly. Additional services, such as, food delivery services, cultural services, and physical activities are bought from different providers. This does support specialization, though it might also create challenges in cases of possible problems in information transfer between providers.

Outsourcing might also appear attractive if organizations are unwilling to make permanent investments in physical facilities or human resources. Fixed capital might cause inflexibility in reacting to changes in operational environment or changes in demand (Pekkarinen & Ulkuniemi 2008), both of which have been reported as being high in health and social services (Stepanovich & Ulrich 1999; Van der Gaag & Perlman 1981). Inflexibility has been considered problematic, for example, in Finland, where the public sector has had an extensive amount of fixed capital due to the sector's significant role in service production. Consequently, one of the reasons for outsourcing has been to reduce the amount of fixed capital, such as real estate. However, outsourcing fixed costs might not be as easy as expected. Private health and social services providers are also unwilling to invest in real estate, particularly if they consider the political environment at the local level too unpredictable, as was the case in Study 4.

Outsourcing of loosely coupled activities is said to diminish the need for managerial coordination (Sanchez & Mahoney 1996). In the context of health and social services, this argument is not self-evident. As mentioned previously in this thesis and in Study 3, asymmetry of information forces managers to conduct rather detailed coordination, such as monitoring production processes, in health and social services. Although found to be challenging and resource consuming, (Study 3; Study 4) there are limited possibilities to reduce coordination. However, results in the Studies 3 and 4 indicate that managers are increasingly aiming towards less detailed coordination, for example by using outcome-based purchasing practices.

Although outsourcing has been reported as bringing advantages, it might also bring disadvantages. Outsourcing always affects firms' capabilities in the long term (Novak & Eppinger 2001, 194) and might diminish purchasers' comprehensive understanding of purchased products or services. In addition, it might jeopardize purchasers' architectural control and reduce their negotiation power in the procurement process (Sako 2002). These problems were also recognized by the interviewees in Study 4. Health and social services purchasers

hesitated to outsource the entire production and considered it important to keep some production in house.

5.3.4 Network management in health and social services

Modularity has been widely related to supply chain management (e.g., Doran et al. 2007; Sako 2002; Salvador et al. 2002; Howard & Squire 2007; Lau et al. 2010). In this thesis, modularity is considered to be related not only to supply chains but also networks. Networks consists of providers contributing health promotion by producing products or services regardless of whether they have formal contractual relationships or not. The literature of modularity contains two perspectives on the coordination of suppliers (Howard & Squire 2007; Lau et al. 2010; Hsuan 1999). On the one hand, tight supply chain integration is applied to encourage continuous communication and collaboration among suppliers and is said to improve co-development and reduce interface constraints (e.g., Lau et al. 2010; Hsuan 1999). On the other hand, loose coupling is applied to provide better independence to suppliers and to reduce the need for communication. Loose coupling is said to bring benefits particularly in new service development processes in a modular environment (Sanchez & Mahoney 1996; Baldwin & Clark 2000; Schilling 2000). Based on Study 3 it can be argued that both supply chain management strategies – loose coupling and tight integration – are applied in health and social services. However, they are used in different situations and for different purposes.

According to the results of Study 3, loose coupling is mainly used in order to ensure the lawfulness of services. Loose coupling is manifested in traditional, formal, and detailed contracting, in outcome-oriented contracting, third sector service provision, and in services purchased with service vouchers. In traditional contracting, collaboration was scant and coordination was based on contract monitoring. In outcome-oriented contracting, collaboration took place particularly before contracting and was related to contract planning. Coordination was aimed at measuring the outcome of the services and the intention was not to interfere in the service production process. Information sharing between organizations was scant in both above-mentioned management strategies and was conducted according to contract requirements. In the case of third sector service provision the coordination, collaboration, and information sharing was not systematic and was mainly based on providers' initiative. According to the results, purchasing with service vouchers was the fourth form of loose coupling. The aim of it was somewhat similar to outcome-oriented contracting; the purpose was to leave room for providers' specialization (Study 3).

Tight integration of providers' network was mainly applied in development projects when the aim was to promote the effectiveness of the networks' service

processes. In tightly integrated networks, the collaboration was either voluntary or obligatory. Collaboration was voluntary particularly between separate units inside public organizations. Compulsory collaboration was required in contracts made between purchasers and providers. The aim was to stimulate particularly the collaboration between private providers as well as collaboration between public and private providers. The aim of tight integration in general was to standardize the processes in order to guarantee a smooth customer flow.

Applied strategies – loose coupling and tight integration – greatly impact network management. Concentrating on detailed monitoring and facilitating collaboration with formal contracts might raise issues related to trust. Although collaboration between suppliers and purchasers in health and social services is wide in informal occasions, such as in development projects, it is not typically emphasized in supply chain strategies (Study 3). Early involvement of suppliers, particularly in new service development (Mikkola 2003, 450) but also in outsourcing (Edler et al. 2011; Uyarra et al. 2014; Study 4), increases. Collaboration is likely to enhance joint discussion, mutual understanding, and fluent information flows. Collaboration in development projects could promote the use of those network management strategies that require trust, such as outcome-based procurement. In addition, it could be beneficial to integrate suppliers to municipalities strategy work in order to promote collaboration, communication, and trust. It is, however, understandable that health and social services managers feel challenged to balance loose coupling (e.g., formal contracts) and tight integration (e.g., collaboration). Risks related to financial issues as well as to sensitive service areas of health and well-being create pressures to “play it safe” and lean towards detailed contracting.

6 CONCLUSIONS

The purpose of this thesis has been to increase understanding concerning modularity and the possibilities applying modularity in the health and social services context. In addition, the purpose has been to shed light on the viewpoints worth taking into account when considering the application of modularity in health and social services.

The thesis has aimed to analyze, on the one hand, (I) the way in which modular structures are applied in the health and social services context and, on the other hand, (II) what advantages and possible barriers, as well as (III) managerial concerns might occur if modularity is applied in the health and social services context.

The first subsection of this chapter summarizes the results and the answers to the research questions. The way in which the results contribute to theory and practice is discussed in the second and third subsections. The validity of the thesis is evaluated in the fifth subsection, and the last subsection presents the paths future for research.

6.1 Summarizing the results

The aim of this thesis was to analyze the way in which modular structures are applied in the health and social services context and what advantages and possible barriers, as well as managerial concerns, might occur if modularity is applied. The thesis answered three research questions, which are discussed thoroughly in Chapter 5. The results for each research question are briefly summarized below.

The aim of the first research question was to *analyze how modular structures appear in the context of health and social services*. It can be argued that physical structures in products, services, processes, and organizations are rather modular in health and social services. They can be decomposed in rather small independent units, while the challenge seems to occur in compatibility. According to the literature, standard interfaces play a key role in the compatibility of modules (Balwin & Clark 1997). However, compatibility of products and information systems across providers has been the focus of attention only in recent years (Study 4). In addition, compatibility problems also occur in services. In fact, health and social services and service processes have been accused of fragmentation (see e.g., Teperi et al. 2009). Regardless of attempts to create smooth care paths, the joint

delivery of services has been a challenge in health and social services (De Blok et al. 2010a; Study 3; Study 4). However, in order to guarantee smooth processes for customers, managers are increasingly emphasizing the importance of collaboration and the mutual creation of interfaces that support coherence of services (Study 3; De Blok et al. 2014, 186-187). The current trend of outsourcing moves health and social services organizations towards modular organization structures. However, although the structures might be modular, there are many challenges in managerial practices related to organizational fragmentation e.g. guaranteeing the collaboration between providers in health and social services network (Study 3).

The aim of the second research question was to *analyze how the context-related special characteristics of health and social services support or prevent the application of modularity in the health and social services context*. Based on the extant literature, it could be argued that modularity should be beneficial in the context of health and social services. The benefits of modularity, described in subsection 3.3 of this thesis, would potentially be very useful to fight against the current challenges prevailing in health and social services. Due to scarce resources, cost saving resulting from flexibility and economies of scale and scope would be beneficial in health and social services. Moreover, enhancing innovations with a modular new service development might be useful in order to meet the heterogeneous needs of customers with cost-effective services. In addition, when considering the environment where modularity is said to work at its best (see Schilling 2000), it is appropriate to argue that modularity suits health and social services rather well. Demand in health and social services is heterogeneous and even enhanced by the moral hazard customers and professionals place on it. Inputs are also heterogeneous, particularly in fast-developing medical technology and in medicine. In addition, the context of health and social services can be considered as urgent, especially at the customer level. Furthermore, products, services, and processes in health and social services are well standardized. These considerations provide a good reason to assume that modularity would be advantageous in health and social services. However, when the special characteristics of the health and social services context are taken into consideration, the challenges in applying modularity become obvious. Asymmetry of information, negative externalities, as well as scarce resources, are the characteristics behind the reasons why heterogeneous inputs are restrained. In addition, extensive standardization, i.e., regulation in health and social services, restricts heterogeneous inputs as well as possibilities of conducting independent new services development.

The aim of the third research question was to *analyze how managerial concerns related to modularity appear in the health and social services context*. Managerial concerns were explored from four perspectives: new service development, standardization and customization, outsourcing, and network management.

It seems difficult for managers to apply practices that would fully support new service development in health and social services. The context-related characteristics prevent managers from fully concentrating on the outcome and from leaving room for providers for independent development work. To be precise, due to the characteristics of the health and social services context – mainly strong regulation, asymmetry of information, and unclear outcome – managers think that they are forced to control the service delivery process extensively.

Standardization is an indispensable part of modularity and has multiple roles related to health and social services. Standard interfaces are considered essential elements in modularity (Baldwin & Clark 1997). However, in services generally and in health and social services particularly, standard interfaces are more difficult to define than for example in manufacturing (Voss & Hsuan 2007; see also De Blok et al. 2014). Furthermore, hidden design rules in modularity are said to be mainly a matter of suppliers and should not be standardized by outsiders (see e.g., Baldwin & Clark 1997). However, in health and social services design rules are also standardized extensively by regulations. This unfortunately diminishes the independence of suppliers.

Outsourcing has been a current trend in health and social services (see e.g., de Gooijer 2007). However, outsourcing has both positive as well as negative implications in health and social services. On the one hand, outsourcing brings advantages in health and social services as it supports specialization and the flexible management of resources. In addition, modularity seems to support the currently recommended practices for public procurement for innovation, such as outcome-based procurement. With regard to these arguments, modularity seems to be beneficial in outsourcing health and social services. On the other hand, outsourcing extensively reduces the purchaser's understanding concerning outsourced services and reduces their negotiation power. Furthermore, there are context-related characteristics – such as uncertainty of demand, challenges in outcome definition and measurement, rigid regulation of the context, the complex environment – that make outsourcing complicated and even prohibit the public procurement of innovations.

The health and social services environment is considered highly complicated (Shortell & Kalunzy 2006; Stepanovich & Ulrich 1999; Glouberman & Mintzberg 2001a; Study 2). One of the reasons for this complexity is a large number of providers, as well as a wide variety of heterogeneous services. Managers coordinate large networks and aim to ensure the quality and the safety of service processes. The extant literature on modularity raises the question of whether network management strategies should be loose coupling or tight integration. Based on the results of Study 3, it can be argued that both strategies can be applied in health and social services. However, they should be applied for different

purposes. Loose coupling is typically applied mainly to ensure the lawfulness of the services, whereas tight integration is applied to ensure collaboration.

Greenwood and Miller (2010, 79-81) argued that different organizations confront different challenges which can be responded to with particular structures and designs. This thesis has evaluated whether the challenges confronted by the health and social services context can be alleviated with modular structures. It can be concluded that from the theoretical perspective modularity fits well in health and social services. The current challenges in health and social services are those that, according to the literature, can be alleviated with the help of modularity. In addition, the empirical studies (Studies 3 and 4) concerning modularity in health and social services also indicate that modularity might be beneficial to this context. However, the special characteristics of the health and social services context prevent some of the benefits of modularity and complicate its application of modularity.

6.2 Theoretical contributions

This thesis contributes to three areas in the academic literature. Firstly, it contributes to the literature of organizational structures and their management. Secondly, it contributes to the theoretical literature of modularity and expands it to health and modular services. Thirdly, the thesis provides an alternative perspective to health science-related discourse on health and social services management. Contributions to these three areas are discussed below.

This thesis provides a contribution to the literature of organizational structures and their management. According to Greenwood and Miller (2010, 80) theoretical literature classifying organizational structures tends to concentrate on traditional design, such as process and matrix structures. Therefore, only little is known about the more complex organizational arrangements such as modular organizations. Greenwood and Miller also point out that organizational structures essentially affect managerial practices. Based on this thesis, it can be argued that not only the organizational structures but also the structures in products, services, and processes have managerial implications. As a consequence, this thesis increases the understanding of modularity as a structure in health and social services organizations and explores managerial implications of modularity.

In the health and social services context, service production is not only a matter of structures inside the organizations; instead, service production is spread over large networks and multiple providers. This thesis expands the extant discourse of product, service, process, and organization modularity to network modularity and describes how it appears in the context of health and social services. Though not typically discussed per se, network modularity is implicitly present in many

studies. Those few studies that do concentrate on network modularity (e.g., Langlois & Robertson 1992; Hoogeweegen et al. 1999; Hsuan Mikkola 2002) have basic markets as their context, whereas this thesis sheds light on networks that operate in the health and social service market. Network modularity is an interesting structure in the health and social services context, as the network participants form a very heterogeneous group of providers (e.g., organizations with different sizes and different revenue logics) with very heterogeneous network relations (e.g., a large number of different types of contracts or non-contractual relationships). Although this thesis only scratches the surface of network modularity in health and social services, it manages to reveal some challenges. For example, standardizing interfaces in networks, where some suppliers are subcontractors and some suppliers provide services on a voluntary basis without formal contracts, is particularly challenging.

The literature of modularity originates from operations management, while it has also been applied in several other disciplines. Thus far, the literature concerning modularity in health and social services has been scarce. As mentioned in Study 1, only very few studies have explored modularity in health and social services from a theoretical perspective. In this thesis, the starting point was in the literature of modularity. For example, the characteristics and essential elements of modularity described in the literature were reflected in health and social services. In addition, the theoretical framework of Schilling (2000) and Schilling and Steensma (2001) provided an important background to evaluate the context of health and social services from the perspective of factors that enhance modularity. Consequently, by starting from a theoretical basis it was possible to evaluate how the arguments and premises used in the literature of modularity fit in the context of health and social services.

It is obvious that not all the viewpoints related to modularity are discussed in this thesis. However, if different perspectives presented in previous studies are combined, the picture concerning modularity in health and social services starts to emerge. Previous studies mainly explore the topic from rather an operational level. De Blok et al. (2010a, 2010b, 2013) and Chorpita et al. (2005) provide perspectives of service package design and customization. De Blok et al.'s study related to interfaces (2014) provides operational, but also some managerial, aspects to service package construction, while their earlier work (2009) has more general, macro-level orientation as the study is related to service policy. It can be argued that Eissens-van der Laan's (2015) study brings the discourse of modularity in the health and social services context to the managerial and institutional levels, although also she has somewhat operationally oriented perspectives in her study. This thesis concentrates particularly on the middle- or macro-level of organizing and managing modular services. It can be thus argued that together with the above-

mentioned studies it forms a reasonable understanding of modularity in health and social services.

This thesis also contributes to the health sciences-oriented discourse of organizing and managing health and social services. The thesis takes into account the special characteristics of the health and social services context and explores how they affect managing and organizing services. It brings forward the health economic-oriented arguments and describes their implications, particularly on managerial practices.

In addition, this thesis provides an alternative to traditional health sciences-oriented discourse related to fluent services, which typically concentrates on fluent care paths and pathways. In spite of years of hard work to promote fluency, health and social services are still considered as rather fragmented (see e.g., Nolte et al. 2012). This thesis argues that modular structures have the potential to enhance the fluency of services. It might, therefore, be worth absorbing the concept of modularity into health and social sciences. Thus far, studies concerning health and social services modularity have been conducted from the interests of operations management researchers or economics and business researchers.

6.3 Practical contributions

This thesis has important practical contributions to managers operating in health and social services. First of all, it provides knowledge concerning advantages and disadvantages of modularity in health and social services. This information is crucial if managers are considering applying modularity in health and social services. The thesis also brings out different network management strategies and their usefulness in different situations. It also provides tools to support new service development with innovation-supportive procurement practices. In addition, the results enhance managers' understanding concerning the role of standardization and customization of health and social services.

Due to the changes affecting health and social services organizations, managers are under the pressure to conduct large reforms in order to adapt to the changes. It is typical that organizations are applying new structural and managerial practices from other disciplines in order to adapt to changes. However, too often new structures and managerial practices are applied without a thorough pre-evaluation of possible advantages or disadvantages. It is taken for granted that if the structures and practices work in one context they will also work in other contexts. It is, however, extremely important to evaluate the pros and cons of new practices before application. This might save managers from the most obvious failures or unpleasant surprises. This thesis provides at least some of the most obvious pros

and cons that should be taken into account if the application of modularity is considered.

The health and social services context is a complex entity where multiple providers form an extensive network (Virtanen & Stenvall 2014, 102). Managers are in challenging positions to manage the network of multiple stakeholders with multiple incentives. This thesis explores the managerial strategies – loose coupling and tight integration – and describes how they are used and in what circumstances. This might help health and social services managers to understand and evaluate their current network management strategies and practices. In addition, they may perhaps more consciously apply different strategies for different purposes.

Scarce resources force health and social services managers to search for new and more cost-effective practices. Providing room for suppliers to develop innovations has not been extensive. In fact, it seems that practices aimed at increased effectiveness have been launched with a rather top-down orientation instead of providing room for workers to develop effective innovations themselves (see also Virtanen & Stenvall 2014, 95). Outcome-based procurement is one of the practices that aims to provide room for innovations. Outcome-based procurement is an emerging trend in public procurement, and this thesis describes how it provides possibilities for enhancing innovation in health and social services, too. In addition, it is important to evaluate current procurement practices and consider new practices other than outcome-based procurement that enhance innovations and collaboration among stakeholders. Although it is argued that modularity supports outsourcing, as decomposed and compatible units are easy to procure, it is important to recognize and understand how the special characteristics of the health and social services context affect new procurement practices.

Standardization, particularity in the form of regulation, has multiple roles in health and social services. Standards, for example, protect customers from low-quality services or unqualified providers, Standards, for example evidence-based protocols, also support professionals in their work. Unfortunately standards may also prohibit necessary or useful new services.

Managers are in positions to ensure the quality of services and to monitor whether providers adhere to standards. It is important that managers understand both the possibilities that standards bring in the form of compatibility, but also understand the disadvantages they bring in the form of inflexibility. Managers could be encouraged to concentrate on standardization that supports compatibility instead of standardizing design rules extensively. Requiring standard and open interfaces, particularly in products such as software, might not only support compatibility but also encourage new innovations and enhance the fluency of services.

Based on the findings of this thesis, or of any individual study, for that matter, it is impossible to say whether modularity should or should not be applied in health

and social services. Nor is it impossible to provide any clear pragmatic advice how to apply modularity. It is hoped that this thesis broadens managers' and politicians' perspectives with regard to organization and management of health and social services. This thesis potentially increases managers' and politicians' abilities to see health and social services as a large entity and enhances their understanding of the effects of their managerial practices in complex environments. It should be established practice to consider all the potential effects of decision making. This thesis brings to the forefront some consequences of managerial practices applied in health and social services. For example, it describes how standardization has implications both in terms of quality of services as well as in innovation possibilities. Similarly, different network management strategies have different implications in collaborative relationships in outsourcing. This thesis is intended to increase the awareness of consequences of managerial practices both on practical and on strategic levels.

6.4 Evaluation of the thesis

Although the question of validity and reliability is important to all research orientations (Silverman 2001), the content of the criteria might vary depending on the orientation (see Eriksson & Kovalainen 2008, 290-296). This thesis does not rely on any research orientation purely. Studies 1 and 2 somewhat represent a realist approach and objectivism whereas the studies 3 and 4 are more close relativistic approach and subjectivism. Thereby, in this present subsection the thesis is evaluated by using multiple-evaluation criteria, some of them being more appropriate to Studies 1 and 2 and some of them to Studies 3 and 4. This subsection evaluates the thesis by using the concepts of triangulation, generalization, credibility, transferability, dependability, and confirmability (see Eriksson & Kovalainen 2008, 292-294).

Triangulation is a way to increase the credibility of a study. There are multiple forms of triangulation to be used either separately or in combination (see Eriksson & Kovalainen 2008, 292-293). This thesis applied methodological triangulation, method triangulation, data triangulation and theory triangulation. Methodological triangulation was applied as the methodological choices in this thesis, varying from a rather positivistic orientation of the systematic literature review (Study 1) and propositions building (Study 2) to more interpretative orientation of qualitative interviews (Studies 3 and 4). Combining different orientations to the same thesis was not considered problematic. Instead, different orientations supported the versatile scrutiny of the topic. Method triangulation was also applied across the original studies. The analysis of the data in the systematic literature review was rather descriptive, whereas the content analysis of qualitative interviews was more

interpretive. In Study 2, deductive reasoning was used as an independent method to analyze the data and to create propositions. The qualitative studies (Study 3 and 4) applied data triangulation as there were three municipalities from where the data was collected. The aim of the data triangulation was not essentially to cross-validate the data, instead the aim was to capture diverse dimensions of the same phenomenon. Selected municipalities applied different ways of organizing health and social services. Therefore they provided wider range of perspectives to the research questions.

In addition, this thesis applied theoretical triangulation. The main theoretical approach in this thesis was the theory of modularity. However, the theory of health economics was also applied (Study 2) as well as the literature of supply chain management (Study 3) and literature concerning public procurement (Study 4).

Generalizability in the qualitative approach refers to analytic generalizations where the results are compared with previous research results (Eriksson & Kovalainen 2008, 294). As the literature review revealed, only a few studies concerning modularity in health and social services have been conducted, most of which have been published by De Blok and her author colleagues. Their conclusions concerning modularity in health and social services seemed to be in accordance with the results of this thesis, and therefore their studies were often used as a reference.

Transferability is close to generalizability discussed above. In addition to comparing results with the extant literature, other concerns also related to transferability were recognized. Studies 1 and 2 recognized that health and social services entail extremely heterogeneous services. In this respect, it is questionable whether the results can be transferrable within health and social services. However, Study 2 provides examples from different areas of health and social services in order to illustrate the appearance of modularity in different areas of health and social services. In relation to national transferability, it can be argued that the organization and management of health and social services differs from country to country. This might be the case, for example, in the procurement of health and social services. The practices that are so far only emerging in Finland might be more established elsewhere. However, according to Mooney (1992), the differences between the health services market and the basic market are rather similar in every country. For this reason, no explicit difference was made in this thesis between production for the public sector or the private sector, nor between countries.

In order to ensure the *dependability* of the research, the research process should be logical, traceable and well documented (Eriksson & Kovalainen 2008, 294). In the original studies, the research process was carefully conducted and described within the length of a journal article. In Studies 1 and 2, the research process was described in a way that makes the study repeatable. In Studies 3 and 4, the research

protocol was described and good scientific practice was applied. These protocols are also described in subsection 4.5.3. In qualitative studies, the researcher always affects the results. The effect, however, can and must be recognized and evaluated (Saunders et al. 2011, 383; see also Burns & Grove 2009, 392). In case of this thesis, the researcher has a background in health sciences, and thus has a pre-understanding concerning the issues at hand. Although the aim was to stay neutral, the author's background might have affected the interviews and the analysis of the data.

Credibility describes how the findings are supported by the data (Silverman 2010, 293; Gummesson 2000, 186) and that other researchers should, on the basis of the research material, come to rather similar conclusions (Eriksson & Kovalainen 2008, 294). In the case of the Studies 1 and 2, everyone had access to the data and therefore the credibility can be evaluated by anyone. In the case of Studies 3 and 4, the path from the data to interpretations and further on to the conclusion was confirmed with analysis trees and tables, as well as with authentic quotations from the data. If a researcher has pre-knowledge concerning the topic s/he is able to evaluate the credibility of the results (Eriksson & Kovalainen 2008, 294). In this thesis, the researcher has a background in health sciences, and thus has the ability to appraise the results and evaluate whether they match her previous clinical experiences. Using a peer researcher in the data analysis would have verified the results; however, there were no resources for this; instead the analysis was discussed with the co-author of Studies 3 and 4.

Confirmability of the study means that the results and interpretations are real and not imagined (Eriksson & Kovalainen 2008, 294). In the original studies, the methods of the studies were carefully described. The original data was kept in mind during the analysis of these studies as well as during the interpretations made in this thesis. In the systematic literature review (Study 1) the research process was carefully described in order to enable repeatability. Also in the theoretical reasoning (Study 2), all the literature used in creating the hypothesis is freely available for evaluation. In the qualitative studies (Studies 3 and 4), the data was illustrated with quotations in order to clarify the path from original data to conclusions.

6.5 Suggestions for future research

This final subsection briefly discusses the ideas for future studies that have appeared along this dissertation process. This thesis covers mainly the perspective of public health and social services managers who conducted purchasing as a part of their managerial tasks. Some of the managers worked in dual roles and represented both purchasers and providers. Regardless of this, their status was

somewhat different from the private sector managers. It would therefore be interesting to study how private sector managers experience modular structures and what kind of managerial concerns they have in relation to modularity. For example, providers' experiences of standardization and how it supports or prevents new service development would supplement the perspective of this thesis.

Heterogeneity of the services was considered as one of the limitations in the transferability of the results of this thesis. This thesis, as well as the studies of De Blok and others (2010a; 2010b), mainly concentrates on services for the elderly. In the future, it would be important to more systematically analyze where in the trajectory of modularity different health and social services could be located. Understanding the way in which services are modular and the degree of modularity might help managers to evaluate their possibilities to apply and draw benefits out of modularity.

The results of the thesis indicate consistency between modular new service development and currently recommended procurement practices, such as outcome-based procurement. As public procurement in health and social services has significant financial implications for the public economy, it would be worth exploring more thoroughly how outsourcing of services in general, and public procurement in particular, would benefit from modular service structures.

REFERENCES

- Adner, R. – Kapoor, R. (2010) Value creation in innovations ecosystems: How the structure of technological interdependence affects firm performance in new technology generations. *Strategic management journal*, Vol. 31 (3), 306–333.
- Ahonen, P. – Virtanen P. (2008) Understanding evaluation in the social sector: Two reflexive metaevaluation case studies inspired by Pierre Bourdieu. *International Journal of Public Administration*, Vol. 31 (10-11), 1146–1166.
- Andrews, J. H. (1998) Bacteria as modular organisms. *Annual review of microbiology*, Vol. 52 (1), 105–126.
- Aronsson, H. – Abrahamsson, M. – Spens, K. (2011) Developing lean and agile health care supply chains. *Supply Chain Management: An International Journal*, Vol. 16 (3), 176–183.
- Arrow, K. J. (1963) Uncertainty and the welfare economics of medical care. *The American economic review*, Vol. 53 (5), 931–973.
- Baldwin, C. Y. – Clark, K. B. (1997) Managing in an age of modularity. *Harvard Business Journal*, Vol. 75 (5), 84–93.
- Baldwin, C. Y. – Clark, K. B. (2000) *Design rules: The power of Modularity*. MIT Press, Cambridge, MA, USA.,
- Bask, A. H. – Lipponen, M. – Rajahonka, M. – Tinnilä, M. (2010) The concept of modularity: diffusion from manufacturing to service production. *Journal of Manufacturing Technology Management*, Vol. 21 (3), 355–375.
- Bask, A. H. – Lipponen, M. – Rajahonka, M. – Tinnilä, M. (2011) Framework for modularity and customization: service perspective. *Journal of business & Industrial marketing*, Vol. 26 (5), 306–319.
- Bask, A. – Merisalo-Rantanen, H. – Tuunanen, T. (2014) Developing a modular service architecture for E-store supply chains: The small- and medium-sized enterprise perspective. *Service science*, Vol. 6 (4), 251–273.
- Bohmer, R. M. J. (2005) Medicine's service challenge: Blending custom and standard care. *Health care management review*, Vol. 30 (4), 322–330.
- Bolker, J. A. (2000) Modularity in development and why it matters to evo-devo. *American zoologist*, Vol. 40 (5), 770–776.
- Borycki, E. (2013) Trends in health information technology safety: From technology-induced errors to current approaches for ensuring technology safety. *Healthcare Information Research*, Vol. 19 (2), 69–78.

- Broekhuis, M. – De Blok, C. – Meijboom, B. (2009) Improving client-centred care and service: the role of front/back-office configurations. *Journal of advanced nursing*, Vol. 65 (5), 971–980.
- Brusoni S. – Prencipe, A. (2001) Managing knowledge in loosely coupled networks: Exploring the links between product and knowledge dynamics. *Journal of management studies*, Vol. 38 (7), 1219–1035.
- Burns, N. – Grove, S. K. (2009) *The practice of nursing research*. 6th edition. Saunders, Elsevier, Missouri, US.
- Cabigiosu, A. – Campagnolo, D. – Furlan, A. – Costa, G. (2012) *Balancing customization and standardization in knowledge intensive business services: the use of modular service architectures*. Department of Management at Università Ca' Foscari Venezia. Working Paper n. 11/2012.
- Caldwell, N. – Walker, H. – Harland, C. – Knight, L. – Zheng, J. – Wakeley, T. (2005). Promoting competitive markets: The role of public procurement. *Journal of purchasing & supply management*, Vol. 11, 242–251.
- Campagnolo, D. – Camuffo, A. 2010. The concept of modularity in management studies: a literature review. *International journal of management reviews*, Vol. 12 (3), 259–283.
- Casalino, L. – Devers, K. – Brewster, L. (2003) Focused factories? Physician – owned specialty facilities, *Health affairs*, Vol. 22 (6), 56–67.
- CEC (2009) *Design as a driver of user-centered innovation*. Commission of the European Communities. SEC (2009) 501 final. Available at: http://ec.europa.eu/enterprise/policies/innovation/files/design_swd_sec501_en.pdf (accessed 5 June 2013).
- Chorpita, B. F. – Daleiden, E. L. – Weisz, J. R. (2005) Modularity in the design and application of therapeutic interventions. *Applied and Preventive Psychology*, Vol. 11 (3), 141–156.
- COM (2011) 896 Final Brussels, European Commission (2011), Proposal for a directive of the European Parliament and of the council of public procurement. <<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0896:FIN:EN:PDF>>, retrieved Dec 9, 2014
- De Blok, C. – Meijboom, B. – Luijkx, K. – Schols, J. (2009) Demand-based provision of housing, welfare and care services to elderly clients: from policy to daily practice through operations management. *Health Care Analysis*, Vol. 17 (1), 68–84.
- De Blok, C. – Luijkx, K. – Meijboom, B. – Schols, J. (2010a) Improving long-term care provision: towards demand-based care by means of modularity. *BMC Health Services Research*, Vol. 10:278. doi:10.1186/1472-6963-10-278.
- De Blok, C. – Luijkx, K. – Meijboom, B. – Schols, J. (2010b) Modular care and service packages for independently living elderly. *International Journal of Operations and Production Management*, Vol. 30 (1), 75–97.

- De Blok, C. – Meijboom, B. – Luijckx, K. – Schols, J. (2013) The human dimension of modular care provision: Opportunities for personalization and customization. *International journal of production economics*, Vol. 142 (1), 16–26.
- De Blok, C. – Meijboom, B. – Luijckx, K. – Schols, J. – Schroeder, R. (2014) Interfaces in service modularity: A typology developed in modular health care provision. *Journal of operations Management*, Vol. 32 (4), 175–189.
- De Gooijer, W. (2007) *Trends in EU Health Care Systems*. Springer, Amsterdam, Netherlands.
- Duray, R. – Ward, P. T. – Milligan, G. W. – Berry, W. L. (2000) Approaches to mass customization: configurations and empirical validation. *Journal of operations management*, Vol 18 (69), 605–626.
- Doran, D. (2003) Supply chain implications of modularization. *International journal of operations and production management*, Vol. 23 (3), 316–326.
- Doran, D. – Hill, A. – Hwang, K. S. – Jacob, G. – Operations Research Group (2007) Supply chain modularisation: Cases from the French automobile industry. *International Journal Production Economics*, Vol. 106 (1), 2–11.
- Edler, J. – Georghiou, L. (2007). Public procurement and innovation – resurrecting the demand side. *Research policy*, Vol. 36 (7), 949–963.
- Edler, J. – Georghiou, L. – Uyarra, E. – Yeow, J. (2011) *Procurement and innovation: Underpinning the debate*. Background paper. Forum organized within the UNDERPINN project, Manchester, UK. <<https://www.escholar.manchester.ac.uk/api/datastream?publicationPid=uk-ac-man-scw:145283&datastreamId=FULL-TEXT.PDF>> retrieved Nov 17, 2013.
- Edwards, H. M. (2007) Composition of binary quadratic forms and the foundations of mathematics. In: *The shaping of arithmetic. C.F Gauss's disquisitiones arithmeticae*, eds. Golstein C. – Schappeacher N. – Schwermer J., Springer, 129–144. <<http://math.nyu.edu/faculty/edwardsd/shaping.pdf>> retrieved Jan 22, 2014).
- Eissens-van der Laan, M. (2015) *The feasibility of modularity in professional service design. Towards low cost person-centred care*. Doctoral thesis, University of Groningen, Groningen.
- Eissens-van der Laan, M. – Broekhuis, M. – van Offenbeek, M. – Ahaus K. (2016) Service decomposition: a conceptual analysis of modularizing services. *International journal of operations and production management*, Vol. 36 (3), 308–331.
- Eriksson, P. – Kovalainen, A. (2008) *Qualitative methods in business research*. Sage publications Ltd., London.
- Ethiraj, S. .K. – Levinthal, D. (2004) Modularity and innovation in complex systems. *Management Sciences*, Vol. 50 (2), 159–173.

- Feyrer, R. – Rösch, J. – Weyand, M. – Kunzmann, U. (2005) Cost unit accounting based on a clinical pathway: a practical tool for a DRG implementation. *Thoracic & Cardiovascular Surgeon*, Vol. 53 (5), 261–266.
- Fodor, J. A. (1983) *The modularity of mind*. MIT Press, Cambridge.
- Fältholm, Y. – Jansson, A. (2008) The implementation of process orientation at a Swedish hospital. *International journal of health planning and management*, Vol 23 (3), 219–233.
- Gadde, L-E. – Jellbo, O. (2002) System sourcing—opportunities and problems. *European Journal of Purchasing & Supply Management*, Vol. 8 (1), 43–51.
- Galvin, P. – Morkel, A. (2001) The effect of product modularity on industry structure: The case of the world bicycle industry. *Industry and Innovation*, Vol. 8 (1), 31–47.
- Georghiou, L. – Edler, J. – Uyarra, E. – Yeow, J. (2014) Policy instrument for public procurement of innovation: Choice, design and assessment. *Technological Forecasting & Social Change*, Vol. 86, 1-12.
- Gershenson, J. K. – Prasad, G. J. – Zhang, Y. (2003) Product modularity: definitions and benefits. *Journal of engineering design*, Vol. 14 (3), 295–313.
- Ghauri, P. – Grønhaug, K. (2010) *Research Methods in Business Studies*. Prentice Hall.
- Gittell, J. – Hagigi, F. – Weinberg, D. (2009) Modularity and the coordination of complex work: The case of post-surgical patient care. Working paper. <content/uploads/sites/60/2014/07/Gittell.etal_.Modularity.pdf> retrieved Jan 15, 2013.
- Glouberman, S. – Mintzberg, H. (2001a) Managing the care health and of the cure of disease – Part I: Differentiation. *Health care management review*, Vol. 26 (1), 56–69.
- Glouberman, S. – Mintzberg, H. (2001b) Managing the care health and of the cure of disease – Part II: Integration. *Health care management review*, Vol. 26 (1), 70–84.
- Gobbi, C. – Hsuan, J. (2015) Collaborative purchasing of complex technologies in healthcare. Implications for alignment strategies. *International Journal of Operations & Production management*, Vol. 35 (3), 430–455.
- Goll, M. (2010) *Ageing in the European Union: where exactly? Rural areas are losing the young generation quicker than urban areas*. Eurostat 26/2010 Available at: <http://ec.europa.eu/eurostat/documents/3433488/5565060/KS-SF-10-026-EN.PDF/310f80f5-2c48-469f-8094-cc59c3e6d0af>
- Greenwood, R. – Miller, D. (2010) Tackling Design Anew: Getting Back to the Heart of Organizational Theory. *Academy of Management Perspectives*, Vol. 24 (4), 78–88.
- Gummesson, E. (2000) *Qualitative methods in management research*. 2nd edition, Sage Publications, Thousand Oaks California US.

- Henderson, R. M. – Clark, K. B. (1990) Architectural innovation: The reconfiguration of existing. *Administrative science quarterly*, Vol. 35 (1), 9–30.
- Hoetker, G. (2006) Do modular products lead to modular organizations? *Strategic Management Journal*, Vol. 27 (6), 501–518.
- Hoogeweegen, M. R. (1999) Modular Network Design: Using Information and Communication Technology to Allocate Production Tasks in a Virtual Organization. *Decision Sciences*, Vol. 30 (4), 1073–1103.
- Howard, M. – Squire, B. (2007) Modularization and the impact on supply relationships. *International journal of Operations and Production Management*, Vol. 27 (11), 1192–1212.
- Hsuan, J. (1999) Impacts of supplier-buyer relationship on modularization in new product development. *European journal of purchasing and supply management*, Vol. 5 (3-4), 197-209.
- Hsuan, J. (2000) Modularization assessment of product architecture. *Paper presented in DRUID Winter conference January 7.-8. 2000. Denmark.*
- Hsuan Mikkola, J. (2002) Industry structure and modular predict architectures: An interpretation of the bicycle industry. Paper presented in The 9th International Annual EurOMA Conference. April 10, 2002.
- Hu, P-W. – Ahmed, M. M. (1989) COMOL: Computer-aided operations and management of the lift. *Computers & Industrial Engineering*, Vol. 17 (1-4), 565–569.
- Hyde, K. F. (2000) Recognising deductive processes in qualitative research. *Qualitative Market Research: An International Journal*, Vol. 3 (2), 82–90.
- Izsak, K. – Edler, J. (2011) *Trends and Challenges in Demand-Side Innovation Policies in Europe: Thematic report 2011 under specific contract for the integration of INNO policy trend chart with ERAWATCH (2011-2012)*. Brussels.
- Jaakkola, E. – Halinen, A. (2006) Problem solving within professional services: evidence from the medical field. *International journal of service industry management*, Vol. 17 (5), 409–429.
- Jacobs, M. – Vickery, S. K. – Droge, C. (2007) The effects of product modularity on competitive performance. Do integrations strategies mediate the relationship? *International journal of operations and production management*, Vol. 27 (10) 1046–1068.
- JCAHO (2015) *Sentinel Event Data - Root Causes by Event Type (2004-2014)*. The Joint Commission. April 24, 2015. http://www.jointcommission.org/assets/1/18/Root_Causes_by_Event_Type_2004-2014.pdf> retrieved Jun 6, 2015.
- Jesson, J. K. – Matheson L. – Lacey F. M. (2011) *Doing your literature review. Traditional and systematic techniques*. Sage publications Ltd. CPI Group, Croydon, UK
- Kallio, T. J. (2015) *Professional Bureaucracies at the Efficiency Era – Balancing Between Professional Ethos and Efficiency Pressures*. Doctoral Thesis, University of Tampere, Tampere.

- Kolko, D. J. – Campo, J. V. – Kelleher, K. – Cheng, Y. (2010) Improving access to care and clinical outcome for pediatric behavioral problems: A randomized trial of a nurse –administrated intervention in primary care. *Journal of Developmental & Behavioral Pediatrics*, Vol. 31 (5), 393–404.
- Kumar, A. (2004) Mass Customization: Metrics and Modularity. *The International Journal of Flexible Manufacturing Systems*, Vol. 16 (4), 287–311.
- Kupota, F. – Miguel P. – Hsuan J. (2015) Analysis of the theoretical relationships between product and production modularity and their implications in the automotive industry. *Paper presented in EurOMA Conference July 28 – July 1 Neuchatel, Switzerland*.
- Laki terveydenhuollon ammattihenkilöistä 28.6.1994/559. <<https://www.finlex.fi/fi/laki/ajantasa/1994/19940559>>
- Lako, C. J. – Rosenau, R. (2009) Demand-driven care and hospital choice. Dutch health policy toward demand-driven care: results from a survey into hospital choice. *Health Care Analysis*, Vol. 17 (1), 20–35.
- Langlois, R. N. – Robertson, P. L. (1992) Networks and innovation in a modular system: Lessons from the microcomputer and stereo component industries. *Research policy*, Vol. 21 (4), 297–313.
- Langlois, R. N. – Savage, D. A. (2001) Standards, modularity and innovation: the case of medical practice. In: *Path dependence and creation*, eds. Garud, R. – Karnøe, P. Lawrence Erlbaum Associates, Mahwah, 150–168.
- Larsen, L. S. – Larsen, A. (1984) Pogotowie Ratunkowe: The emergency medical system of Poland. *Annals of Emergency Medicine*, Vol. 13 (11), 1052–1055.
- Lau A. K. W. – Yam, R. C. M. – Tang E. P. Y. (2007) Supply chain product co-development, product modularity and product performance. Empirical evidence from Hong Kong manufacturers. *Industrial management & Data systems*, Vol. 107 (7), 1036–1065.
- Lau, A. – Yam, R. – Tang, E. – Sun, H. Y. (2010) Factors influencing the relationship between product modularity and supply chain integration. *International journal of Operation and Production Management*, Vol. 30 (9), 951–977.
- Lillrank, P. – Kujala, J. – Parvinen, P. (2004) *Keskeneräinen potilas*. Talentum, Helsinki.
- Lim, J. L. – Yih, Y. – Gichunge, C. – Tierney, W. M. – Le, T. H. – Zhang, J. – Lawley, M. A. – Petersen, T. J. – Mamlin, J. J. (2009) The AMPATH Nutritional Information System: designing a food. *Journal of the American Medical Informatics Association*, Vol. 16 (6) 882–888.
- Lloyd, J. – Wait, S. (2006) *Integrated care. A guide for policymakers*. Alliance for Health and the Future, London.
- McCarthy, I. P. – Lawrence, T. B. – Wixted, B. – Gordon, B. R. (2010) A multidimensional conceptualization of environmental velocity. *Academy of management review*, Vol. 35 (4), 604–626.

- Machado Guimarães, C. – Crespo de Carvalho, J. (2013) Strategic out-sourcing: a lean tool of healthcare supply chain management. *Strategic Outsourcing: An International Journal*, Vol. 6 (2), 138–166
- Meyer, M. H. – Jekowsky, E. – Crane, F. G. (2007) Applying platform design to improve the integration of patient services across the continuum of care. *Managing Service Quality*, Vol. 17 (1), 23–40.
- Mikkola, J. (2003) Modularity, component outsourcing, and inter-firm learning. *R & D Management*, Vol. 33 (3), 439–454.
- Mikkola, J. H. – Grassmann, O. (2003) Managing modularity of product architectures: toward an integrated theory. *IEEE Transactions on Engineering Management*, Vol. 50 (2), 204–218.
- Mikkola, J. H. (2007) Management of product architecture modularity for mass customization: modeling and theoretical considerations. *IEEE Transactions on Engineering Management*, Vol. 54 (1), 57–69.
- Moher, D. – Liberati, A. – Tetzlaff, J. – Altman, D. G. – The PRISMA Group (2009) Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *Public Library of Science: Medicine*, Vol. 6 (7): e1000097. doi:10.1371/journal.pmed.1000097
- Mooney, G. (1992) *Economics, medicine and health care*. 2nd edition. Pearson Education, UK.
- Needleman, I. G. (2002) A guide to systematic reviews. *Journal of clinical periodontology*, Vol. 29 (3), 6–9.
- Nolte, E. – Knai, C. – Hofmarcher, M. – Conklin, A. – Erler, A. – Elissen, A. – Flamm, M. – Fullerton, B. – Sönnichsen, A. – Vrijhoef, H. J. M. (2012) Overcoming fragmentation in health care: chronic care in Austria, Germany and the Netherlands. *Health Economics Policy and Law*, Vol. 7 (1), 125–146.
- Novak, S. – Eppinger, S. D. (2001) Sourcing By Design: Product Complexity and the Supply Chain. *Management Science*, Vol. 47 (1), 189–204
- OECD (2015) *Elderly population (indicator)*. doi: 10.1787/8d805ea1-en <<https://data.oecd.org/pop/elderly-population.htm>> retrieved Jun11, 2015.
- Orton, J. D. – Weick, K. E. (1990) Loosely coupled systems: a reconceptualization. *Academy of management review*, Vol. 15 (2), 203–223.
- Parvinen, P. – Lillrank, P. – Ilvonen, K. (2005) *Johtaminen terveydenhuollossa*. Talentum, Helsinki.
- Pekkarinen, S. – Ulkuniemi, P. (2007) Modularization of customer interface - a key for low cost strategy in services. *Paper presented in XVII International RESER Conference, Tampere, Finland, 2007*.
- Pekkarinen, S. – Ulkuniemi, P. (2008) Modularity in developing business services by platform approach. *International Journal of Logistics Management*, Vol. 18 (1), 84–103.
- Pelkonen, A. – Valovirta, V. (2015) Can service innovation be procured? An analysis of impacts and challenges in the procurement of innovation in social services. *Innovation: The European journal of social science research*, Vol. 28 (3), 384–402.

- Petticrew, M. – Roberts, H. (2006) *Systematic reviews in social sciences. A practical guide*. Blackwell publishing Ltd. Malden, USA
- Rahikka, E. – Ulkuniemi, P. – Pekkarinen, S. (2011) Developing the value perception of the business customer through service modularity. *Journal of Business & Industrial Marketing*, Vol. 26 (5), 357–367.
- Rainey, G. W. – Rainey, H. G. (1986) Structural Overhaul in a Government Agency: Implications of social security claims modularization for central OD principles and techniques. *Public Administration Quarterly*, Vol. 10 (2), 206–228.
- Ried, S. – Specht, U. – Thorbecke, R. – Goecke, K. – Wohlfarth, R. (2001) MOSES: An educational program for patient with epilepsy and their relatives. *Epilepsia*, Vol. 42 (3), 76–80.
- Saarni, S. (2010) *Effectiveness in Health Care Decision-making. An Ethical Analysis*. National Institute for Health and Welfare (THL), Research 40. <<http://www.thl.fi/thl-client/pdfs/015a5de8-8d7f-4a78-a5c5-64f7e40e1b5b>> retrieved May 19, 2014.
- Sade, R. M. (2013) Are surgeons ethically obligated to treat Medicare patients despite substantial reductions in reimbursement. *The Journal of Thoracic and Cardiovascular Surgery*, Vol. 145 (1), 37.
- Sako, M. (2002) Modularity and outsourcing: the nature of nature of co-evolution of product architecture and organization architecture in the global automotive industry. In: *The business of system integration*. eds. Prencipe, A. – Hobday, M. Oxford University Press, Oxford
- Sako, M. – Murray, F. (1999) Modules in design, production and use: Implications for the global automotive industry. *Paper presented in the International motor vehicle program annual sponsors meeting October 5–7 Cambridge Massachusetts, USA*.
- Salvador, F. – Forza, C. – Rungtusanatham, M. (2002) Modularity, product variety, production volume, and component sourcing: theorizing beyond generic prescriptions. *Journal of Operations Management*, Vol. 20 (5), 549–575.
- Salvador F. (2007) Toward a product system modularity construct: Literature review and reconceptualization. *IEEE Transactions on Engineering Management*, Vol. 54 (2), 219–240.
- Sanchez, R. (1995) Strategic flexibility in product competition. *Strategic management journal*, Vol. 16 (Special Issue), 135–159.
- Sanchez, R. – Mahoney, J. T. (1996) Modularity, flexibility, and knowledge management in product and organization design. *Strategic management journal*, Vol. 17 (S2), 63–76.
- Santerre, R. – Neun, S. (1996) *Health economics: Theories, insights and industry studies*. IrwinBook Team, USA.
- Saunders, M. – Lewis, P. – Thornhill, A. (2011) *Research methods for business students*. 6th edition, Pearson Education Limited, Essex, UK.
- Schilling, M. A. (2000) Toward a general modular systems theory and its application to interfirm product modularity. *Academy of management review*, Vol. 25 (2), 312–334.

- Schilling, M.A. (2002) Modularity in multiple disciplines. In: *Managing in the Modular Age: Architectures, Networks and Organizations*. eds. R. Garud, R. Langlois, and A. Kumaraswamy Blackwell Publishers, Oxford, England, 203–214.
- Schilling, M. A. – Steensma, H. K. (2001) The use of modular organizational forms: an industry-level analysis. *Academy of management journal*, Vol. 44 (6), 1149–1168.
- Shortell, S. M. – Kaluzny, A. D. (2006) Organization theory and health services management. In: *Health Care Management: Organization Design and Behavior*. eds. Shortell, S. M. – Kaluzny, A. D. 5th, Thompson, delmar Learning, New York, USA
- Shukla, R. K. (1983) All-RN model of nursing care delivery: A cost benefit evaluation. *Inquiry*, Vol. 20 (2), 173–84.
- Silverman, D. (2001) *Interpreting qualitative data. Methods for analyzing talk, text and interaction*. 2nd edition. Sage publications, London.
- Silverman, D. (2010) *Doing qualitative research*. 3rd edition, Sage publications, London.
- Simon, H. A. (1962) The architecture of complexity. *Proceedings in the American Philosophical society*, Vol. 106 (6), 467–482.
- Sintonen, H. – Pekurinen, M. (2006) *Terveystaloustiede*. WSOY, Porvoo.
- Staggers, N. – Blaz, J. W. (2013) Research on nursing handoffs for medical and surgical settings: an integrative review. *Journal of Advanced Nursing*, Vol. 69 (2), 247–262.
- Starr, M. K. (2010) Modular production – a 45-year-old concept. *International journal of operation and production management*, Vol. 30 (1), 7–19.
- Stepanovich, P. L. – Uhrig, J. D. (1999) Decision making in high-velocity environments: Implications for healthcare. *Journal of healthcare management*, Vol. 44 (3), 197–205.
- Sundbo, J. (1994) Modularization of service production and a thesis of convergence between service and manufacturing organizations. *Scandinavian Journal of Management*, Vol. 10 (3), 245–266.
- Sundbo, J. (1997) Management on innovations in services. *The service industries journal*, Vol. 17 (3), 432–455.
- Sundbo, J. (2002) The service economy: Standardization or customization? *The service industries journal*, Vol. 22 (4), 93–116.
- Taylor, J. S. (2015) Improving Patient Safety and Satisfaction With Standardized Bedside Handoff and Walking Rounds Quality Measurement and Improvement Staffing Program Development and Evaluation. *Clinical Journal of Oncology Nursing*, Vol. 19 (4), 414–416
- Teperi, J. – Porter, M. E. – Vuorenkoski, L. – Baron, J. F. (2009) *The Finnish Health Care System: A Value-Based Perspective*. Sitra reports 82. <http://www.isc.hbs.edu/pdf/Finnish_Health_Care_System_SITRA2009.pdf> retrieved May 3, 2013.
- Tevameri, T. (2014) *Matriisirakenteen omaksuminen sairaalaorganisaatiossa – rakenteeseen päätyminen, organisaatiosuunnittelu ja toimintalogiikan hyväksyminen*. Turun kauppakorkeakoulun julkaisuja, Sarja A-3:2014. Turun kauppakorkeakoulu, Turku.

- Tevameri, T. & Kallio, T. J. (2010) Matriisi- ja prosessimainen toimintatapa sairaalaorganisaatioiden uudelleenkehittämisessä. *Hallinnon tutkimus*, Vol. 28 (1), 15–32.
- Tuomala, M. (2009) *Julkistalous*. Gaudeamus, Helsinki.
- Torgerson, C. (2003) *Systematic reviews*. Continuum, International Publishing Group. New York. US.
- Tranfield, D. – Denyer, D. – Smart, P. (2003) Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British journal of management*, Vol. 14 (3), 207–222.
- Ulrich, K. (1994) Fundamentals of product modularity. In: *Management of design. Engineering an management perspectives*. eds. Dasu S. and Eastman C. Kluwer Academic publishers, Massachusetts 219–231.
- Ulrich, K. (1995) The role of product architecture in the manufacturing firm. *Research Policy*, Vol. 24 (3), 419–440.
- Uyarra, E. – Edler, J. – Garcia-Estevez, J. – Georghiou, L. – Yeow, J. (2014) Barriers to innovation though public procurement: A Supplier perspective. *Technovation*, Vol. 34 (10), 631–645.
- Van der Gaag, J. – Perlman, M. (1981) *Health, economics and health economics*. North-Holland Publishing company, Netherlands.
- Virtanen J. (2010) *Johtajana sairaalassa. Johtajan toimintakenttä julkisessa erikoissairaanhoidossa keskijohtoon ja ylimpään johtoon kuuluvien lääkäri- ja hoitajataustaisten johtajien näkökulmasta*. Turun kauppakorkeakoulun julkaisuja, Sarja A-2:2010. Turun kauppakorkeakoulu, Turku
- Virtanen, P. – Stenvall, J. (2014) The evolution of public services from co-production to co-creation and beyond. New public management's unfinished trajectory? *The International Journal of Leadership in Public Services*, Vol. 10 (2), 91-107.
- Voordijk, H. – Meijboom, B. – de Haan, J. (2006) Modularity in supply chains: a multiple case study in the construction industry. *International journal of operations and production management*, Vol. 26 (6), 600–618.
- Voss, C., – Hsuan, J. (2009) Service architecture and modularity. *Decision Sciences*, Vol. 40 (3), 541–569.
- Voss, C., – Hsuan, J. (2011) The opportunity to re-think what we know about service design. In: *The science of service systems*. eds. Demirkan, H., Spohrer, J. C. and Krishna, V. Springer, New York, 231–244.
- Vähätalo, M. (2012) Modularity in health and social services – a systematic review. *International Journal of Public and Private healthcare management and economics*, Vol. 2 (1), 7–21.
- Vähätalo, M. – Kallio, T. J. (2015) Organizing health services through modularity. *International Journal of Operations and Production Management*, Vol. 35 (6), 925–945.
- Weick, K. (1976) Educational organizations as loosely coupled systems. *Administrative Science Quarterly*, Vol. 21, 1–19.
- Williams, A. (2004) Health and health care. In: *Measuring outcome in the public sector*. eds. Smith, P., Taylor & Francis, London, 20–33.

- Wilmot, S. (2007) A fair range of choice: Justifying maximum patient choice in the British national health service. *Health Care Analysis*, Vol. 15 (2), 59–72.
- Wohlrab, G. C. – Rinnert, S. – Bettendorf, U. – Fischbach, H. – Heinen, G. – Klein, P. – Kluger, G. – Jacob, G. – Rahn, D. – Winter, R. – Pfäfflin, M. (2007) Famoses: A modular educational program for children with epilepsy and their parents. *Epilepsy & Behavior*, Vol. 10 (1), 44–48.
- Zhang, G. – Gao, R. (2010) Modularity and incremental innovations: the roles of design rules and organizational communication. *Computer Mathematic Organization Theory*, Vol. 16 (2), 171–200.

APPENDIX 1: THE AUTHOR'S ROLE AND HER CONTRIBUTION TO THE ORIGINAL STUDIES

Study 1 was conducted alone by Vähätalo. In general level the topic was discussed with professor Ismo Räihä and professor Timo Sneck, while they did not contribute to the actual study.

Studies 2, 3 and 4 were co-authored by Vähätalo and Kallio. The work was distributed similarly in all three studies. Vähätalo came up with the research idea for all three studies. She familiarized herself with the theoretical literature, collected the data, carried out the data analysis and reported the results. Kallio's role in all three studies was to develop and construct the argumentation. He revised the manuscripts several times and made comprehensive adjustments. He also improved the structure of manuscripts extensively. In addition, he clarified significantly the interpretation of the results and the expressions used in manuscripts as well as pointed out the additional literature.