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Service Development in Public Private Partnerships in the Military Domain

Requirements Management as a Service Performance Development and Measurement System

Markus Häyhtiö

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Service Development in Public Private Partnerships in the Military Domain: Requirements Management as a Service Performance Development and Measurement System

ACADEMIC DISSERTATION

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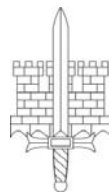

NATIONAL DEFENCE UNIVERSITY
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ABSTRACT

In this dissertation, the subject of Requirement Management (RM) as a performance measurement and development system is discussed. Public Private Partnerships (PPPs) in the educational environment and catering operations in the Finnish Defence Forces (FDF) are used as case examples. In addition, due to their relevance to the FDF, the author's research describes New Service Development (NSD), sustainability and Critical Infrastructure Protection (CIP).

The dissertation contributes to current studies in the areas of RM, PPP and service science. The main objectives of this study are to research, analyse and assess how RM could be used as an NSD technique in PPPs. The results of this research establish a proposed development model for services in the PPP context.

The work contributes to the scientific discussion on the discipline of service science and NSD, introducing a cross-disciplinary study that combines currently separate areas in the field of service science. This research contributes scientific evidence showing that RM offers benefits as a managerial approach, and it shows how RM could be used as a technique in NSD during all lifecycle stages of a service. The results indicate that RM increases the opportunity to find, use and utilise key performance indicators in the search for efficiency and effectiveness in services.

Keywords: Requirements Management, Public–Private Partnership, New Service Development, Finnish Defence Forces, Critical Infrastructure Protection

TIIVISTELMÄ

Tässä väitöskirjassa käsitellään vaatimustenhallintaa suorituksen johtamisen välineenä. Tapaustutkimuksina on tutkittu julkisen- ja yksityisen toimijan yhteistyötä Suomen Puolustusvoimissa ja korkeakouluympäristössä. Uuden palvelun kehittäminen, vastuullisuus liiketoiminnassa ja kriittisen infrastruktuurin suojelu ovat myös osa tutkimusta. Jokainen tutkimuksen yksittäinen osa-alue koskettaa Puolustusvoimien ruokahuollon kehittämistä ja johtamista.

Tutkimus tuottaa uutta ja hyödyllistä tietoa niin vaatimustenhallinnan, yksityisen ja julkisen toimijan välisen yhteistyön ja palvelutieteen aloille. Työn päätavoitteena on tutkia, analysoida ja arvioida kuinka vaatimustenhallintaa voidaan hyödyntää palvelun kehittämisen välineenä yksityisen ja julkisen toimijan välisessä yhteistyössä. Työn tuloksena kirjoittaja esittää kehittämismallin, jota voidaan hyödyntää yksityisen ja julkisen toimijan välisessä palvelunkehityksessä.

Väitös tuo tieteelliseen keskusteluun uusia näkökulmia ja tutkimustuloksia niin palvelutieteen kuin uuden palvelun kehittämisen osa-alueille ja esittää poikkitieteellisen tutkimuksen, joka yhdistää aiemmin erilliset tutkimusalueet palvelutieteen alalla. Työ antaa tieteellisen todisteen sille, että vaatimustenhallinta tarjoaa hyötyä suorituksen johtamiseen. Tutkimuksen lopputulokset osoittavat, kuinka vaatimustenhallintaa voidaan hyödyntää uuden palvelun kehittämisessä kehitettävän palvelun eri elinkaaren vaiheissa.

Työssä todistetaan, kuinka vaatimustenhallinta lisää mahdollisuuksia löytää, käyttää ja hyödyntää suorituskyvyn mittareita palvelun tehokkuuden ja vaikuttavuuden hallinnassa ja määrittelyssä.

Avainsanat: vaatimusmäärittely, yksityisen ja julkisen tahon yhteistyö, suorituksen johtaminen, uuden palvelun kehitys, kriittisen infrastruktuurin suojelu, Suomen Puolustusvoimat

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Helsinki 7.5.2018

Markus Häyhtiö

PUBLICATIONS OF THE DISSERTATION

This doctoral dissertation by Markus Häyhtiö consists of a summary and the following five publications (papers):

[1] New Service Development: Structured model and development management in hospitality industry, publication date Jul 19, 2014 publication description Euro-CHRIE 2014

[2] Requirements management and PBC: how can requirements management help in purchasing public services through performance based contracts? Publication date Dec 2, 2014 Presented in IPSERA 2015, ISBN: 978-90-823707-0-6

[3] Häyhtiö M, Harjanne A., Rajakangas-Tolsa J., (2017) Sustainable New Service Development: Insights of Food Wastage Data – Case: University Catering, "Consilience: The Journal of Sustainable Development", Volume 17, Issue 1, January 2017

[4] Häyhtiö, M. (2016), Requirements as operational metrics –Case: Finnish Defence Forces, "Management and Production Engineering Review", volume 7, Number 3, September 2016

[5] Häyhtiö, M. and Zaerens, K. (2017), A Comprehensive Assessment Model for Critical Infrastructure Protection, "Management and Production Engineering Review", Volume 8, Number 4, December 2017

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CONTRIBUTIONS OF THE AUTHOR

The author was the sole author in the publications [1] and [4] and primary author in the publications [2, 3 and 5]. Professor Juha-Matti Lehtonen gave his valuable insights on the area of PPP in the publication [2]. Ph.D. candidate Atte Harjanne and Ph.D. Johanna Rajakangas-Tolsa were both co-authors in the publication [3]. Ph.D. candidate Klaus Zaerens was the co-author in the publication [5]. Author's roles are described in more detail in the table 1.

Publication	Conceptualization and research design	Collecting data	Interpretation and conclusions	Paper writing	Overall role
1	X	X	X	X	S
2	X	X	X	X	Pr
3	X	X	X	X	Pr
4	X	X	X	X	S
5	X	X	X	X	Pr

Table 1 - Contribution of the author in the publications of the dissertation
Legend: S=sole author, Pr=primary author

LIST OF ABBREVIATIONS

ASTM	American Society for Testing Materials
B-to-B	Business to business
CIP	Critical Infrastructure Protection
CMMI	Capability Maturity Model Integration
CSR	Corporate Social Responsibility
ERP	Enterprise Resource System
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FDF	Finnish Defence Forces
FIC	Fundamental Inputs to Capability
FP	Foundational Premise
GD-logic	Goods-Dominant logic
INCOSE	International Council on Systems Engineering
ISO	International Organization for Standardization
KPI	Key Performance Indicator
LEED	Leadership in Energy and Environmental Design
MOD	Ministry of Defence
NASA	National Aeronautics and Space Administration
NSD	New Service Development
OECD	Organisation for Economic Co-operation and Development
PBC	Performance Based Contracting
PBL	Performance Based Logistics
PMBOK	Project Management Body of Knowledge
PMC	Private Military Company
PPP	Public Private Partnership
R2P	Responsibility to Protect
RM	Requirements Management
RO	Research Objective
SD-Logic	Service-Dominant Logic
SB	Service Blueprinting
SNSD	Sustainable New Service Development
UN	United Nations

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1

INTRODUCTION

The Finnish Ministry of Defence (MOD) has stated in its strategy that one of the development areas it controls is material capability. *Material capability* includes all the systems in which capability is utilised for the Finnish Defence Forces (FDF) to fulfil their statutory mission. In its strategy, the MOD stated that there is an increasing need to create networked cooperation in all the areas linked to the security of supply under all the conditions in Finnish society. One security of supply area under development is the FDF's catering operations (Puolustusministeriö, 2011).

To establish a more cost-effective way of securing mandatory tasks, the FDF have engaged in a significant organisational reconstruction. A decision was made to create a management structure in which the FDF formed strategic partnerships with their most important partners. These partners produce the service, and the FDF act as a commercial client (Puolustusministeriö, 2013a). The FDF's catering operations are part of this reconstruction.

One of the main principles in the strategic partnership is the transparency of the operations in all situations, at all levels of the operations and throughout the whole lifecycle of the service. The FDF's operational environment requires that operations are tested, developed and managed in such a way that abnormalities will not affect them. These operations must be defined unambiguously during peacetime, in a manner wherein the description enables operational planning and development for crisis situations (Puolustusministeriö, 2013b). The proposed outcome of the development work is an operational concept for New Service Development (NSD).

Enhancement of the FDF's obligations requires an international viewpoint on the subject. The legal aspects of the international operations need to be discussed, and variables affecting partnerships outside national borders must be researched. The creation of an operational concept demands a requirements elicitation, which considers the desired capabilities, costs, known and emergent risks and time. This elicitation should cover all the stakeholders, several possible impacts should be assessed, and most of all, it should be done in cooperation with the strategic partners (Pasivirta & Kosola, 2005).

One solution in operational concept development in the multi-stakeholder environment is using a managerial approach called Requirements Management (RM). This demands cross-disciplinary research covering the whole lifecycle of a service and the whole service supply chain system.

1.1 RESEARCH PURPOSE AND OBJECTIVES

The purpose of this research is to define how RM can be used in interdisciplinary subjects, such as service as a development and management technique in Public Private Partnerships (PPPs). This research shows the importance of the researched and assessed individual managerial areas for NSD. From a practical perspective, the objective of this dissertation is to explore the institutional catering operations and show how individual Key Performance Indicators (KPIs) can be used as metrics in the form of requirements in the development process of a service and service system. From a scientific perspective, the aim of this research is to propose a development model that considers the variables affecting the service outcome from multiple stakeholder perspectives in PPP.

There are three research objectives discussed in this dissertation, as follows:

1) Does RM create KPIs that enable cohesiveness between the strategic partners, supporting both the efficiency and effectiveness of PPP in catering operations?

2) Is it possible to use RM as a development technique in NSD?

3) What are the mechanisms that should be used to create sufficient KPIs in the contractual environment in which these operations are being run?

1.2 FRAMEWORK OF THE RESEARCH

While fulfilling its statutory mission, the FDF have undergone a massive organisation reconstructing process. By the end of 2015, 2200 employees were laid off, several large military units ware closed, material procurement was reduced and the administrative structure was changed. As a part of this reconstruction, FDF's catering operations were reorganised. The overall effects of these changes are illustrated in Table 2.

Changes in the mandatory obligations since June 2017 necessitate more attention to the international aspects of the tasks. Law regarding the FDF were enhanced, and international operations with and between the European Union (EU) member states were included as mandatory tasks of the FDF (Säädöstietopankki Finlex, 2017). The changes affected catering operations and future service capability development in the FDF.

2011	DEFENCE FORCES	2015
Ca. €2450 m	Annual appropriations	Ca. €2200 m
350 000	Wartime strength	Ca. 230 000
15 000*	Peacetime personnel	Ca. 12 300
27 000/y	Size of age group to be trained	25 000/y
25 000/y	Trained reservists	18 000/y
4	Number of command levels	3
51	Number of administrative units	Ca. 26
25	Brigade-level/equiv. units to be trained	16

Table 2 - Changes in the Finnish Defence Forces (Puolustusvoimauudistuksen ratkaisumalli, n.d.)

These organisational changes and changes in the mandatory tasks demand a new comprehensive approach to service capability development. These changes necessitate structured mechanisms and a concept that enables development work. There is a need for information based on the predetermined development goals in the total system under development. This approach must follow the pre-existing guidelines, which are used for material capability development in the FDF, introduced by Pasivirta and Kosola (2005). At the core of their approach are requirements that steer the development work in all the lifecycle stages.

In this dissertation, PPP in the military context is defined as a contractual agreement between a private company and public agent. The purpose of a PPP is the private delivery of activities traditionally performed by a public entity (Forrer, Kee, Newcomer, & Boyer, 2010).

1.3 DISSERTATION DESIGN

This dissertation comprises four theoretical parts, which are built around five publications. These papers are presented in their logical order according to the research objectives. The links between the papers and research objectives are illustrated in Table 3. The structure of the dissertation is presented in Table 4.

Research Objectives (RO)	Publication 1	Publication 2	Publication 3	Publication 4	Publication 5
RO 1	X	X		X	
RO 2			X	X	
RO 3				X	X

Table 3 - Links between the Research Publications and Research Objectives

The first part of the dissertation covers service and NSD as phenomena, and the discipline of service science is researched. In this part, a general framework of service development is researched and illustrated. The first publication relating to this part is a conceptual paper based on a comprehensive literature review, since the research area is rather incoherent. It was important to cover the areas in need of study to elucidate the research objectives.

In the second part, which is related to the publication 2, the concept of PPP is researched. Its importance and effects on NSD are illustrated. PPP in military organisations is studied and the operating domain – the FDF – is introduced. The second article, relating to this part of the dissertation, is a conceptual paper based on the comprehensive literature review, which introduces the concept of a PPP. The question of RM as a suitable method for managing PPP throughout the lifecycle of a service is discussed in the paper.

In the third part, which is related to publications 3 and 4, the core of the author's approach to the development work, RM, is introduced. This part discusses how the managerial process in RM is related to NSD. There are two case studies linked to this part of the dissertation. They cover the use of requirements to employ information from the operations as a source for NSD. In these case studies, the authors studied a university catering unit and Santahamina garrison catering services. The subject of Corporate Social Responsibility (CSR) is also discussed.

In the first case study, the authors defined two research issues to reach the research objectives. The questions on 'the amount of waste produced by a single managed catering business unit' and 'evaluation of the potentiality of using insights on food wastage data in NSD' were established to find necessary KPIs in the form of requirements. The assumption was that these two research areas affect the service provider's efficiency and service's effectiveness for the end user. The research aim was to assess and collect valuable requirements in this specific PPP environment.

The impetus for the questions was that as much as the one-third of the available food is being wasted globally. In the developed countries, most of the waste is created during the consumption phase (Gustavsson, Cederberg, Sonesson, Van Otterdijk, & Meybeck, 2011). In the current European Union (EU) legislation, the question of sustainability as a requirement needs to be evaluated for the whole lifecycle

of the service/product managed under the PPP framework. A new EU-wide purchasing directive will demand more transparent and precise traceability of goods and services, as well as consideration from a CSR, and especially, a climate impact point of view. This directive forces service providers to increase their overall transparency (EU, 2014).

The second case study, Santahamina garrison, was based on the results of the first case study. The first case showed that there is an opportunity to use individual requirements (or metrics) to manage service development in the individual domain.

The fourth part studies Critical Infrastructure Protection (CIP). In publication 5, relating to this part, the authors' research focussed on the service supply chain's resilience. The emphasis in this paper is on a comprehensive model, which is proposed to improve cyber-business resilience. The article addresses the issues related to the contractual environment and requirements in the cyber-domain, which need to be followed from the customer perspective in the PPP. The goal of the research was to find and assess capabilities that enable recognition of an attack against the critical infrastructure and reduce the attacker's ability to operate in the target component. This is important in the business domain of the FDF, since the organisation's operating environment demands protection throughout the service supply chain.

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Table 4 - Structure of the Dissertation (Numbers refer to dissertation chapters and sections)

1.4 AIM OF THE DISSERTATION, ASSUMPTIONS AND LIMITATIONS

The aim of the dissertation was to identify practical methods for developing new services while utilising information from the both micro- and macro-environment in the PPP context. The author assumed that NSD is conducted as a project and the service supply chain management is run and managed using automated systems. This is the rationale for researching CIP as a part of NSD.

While the systems may be automated, they are created by humans, whose approach to the system is connected to the social environment in which it is developed, as Carley and Behrens stated (as cited in Sage & Rouse, 2009). This approach, which is widely used in the social sciences, is interested in the relationships and communication between individuals and larger groups. The assumption demands a thorough understanding of the whole service supply chain, communication mechanisms and the form of information in it. This necessitates research in the competence/capability development area from the individual and organisational perspectives. Social networks are important for the success of service supply chain operations. Uncertainty is defined, managed and accepted in the boundaries of a specific social network. Therefore, every organisation can reduce uncertainty by obtaining possession of critical assets and forming ties with stakeholders who are more specialised in a specific operation in their social network. It is argued that efficient service supply chain operations are a chain of competence exchange processes that can fulfil the goals of each entity participating to the operations.

The limitations of the study appear in that not all the necessary information is publicly available due to the research subject – the FDF. In addition, the research framework is dispersed and undefined, which leaves room for interpretation. Despite thorough data triangulation, the use of the case-study method can also complicate the generalisation process of the research results. The lack of an unambiguous conceptual research framework on the use of RM as a development method for services can also be viewed as a limitation. However, this increases the value of the work due to its novelty in the field of service science.

2

THEORETICAL FOUNDATIONS

This chapter provides a conceptual analysis of the research areas and managerial subjects surrounding the research objectives. These subjects and their relationships to NSD are researched, explained and assessed. The existing research gaps specifically relating to the interrelationships of these subjects are brought to the reader's attention. The purpose of the chapter is to show why and how these different subjects are related to each other and NSD.

2.1 SERVICE

The role of services has increased significantly. It has been predicted that services will create more than half of the economic growth during the 21st century and become the largest employing industry in the developed countries (Maglio & Spohrer, 2010; Chesbrough & Spohre, 2006; Menor, Tatikonda, & Sampson, 2002). Even so, the research area of service science is rather dispersed. For example, as a study conducted by Brax (2013) indicated, there is no comprehensive definition of the term *service*. Relevant definitions of a service for this research are given in Table 5.

Researcher(s)	Definition
Organisation for Economic Co-operation and Development (OECD, 2015, p. 68)	A service is 'a result of a production activity that changes the conditions of the consuming units, or facilitates the exchange of products or financial assets. Among the former, service providers can affect changes in the condition of the consumer's goods, in the physical and mental conditions of persons (e.g. through health or transportation, as well as through the provision of information, education, etc.)'.
Crawford (2013, p. 66)	'An act of meeting the needs of another and/or physical labor that does not reveal a palpable product'.
Maglio and Spohrer (2008, p.3)	'[We define] service as *value-cocreation*, value as change that people prefer, and value-cocreation as a change or set of related changes that people prefer and realize as a result of their communication, planning, or other purposeful and knowledge-intensive interactions'.
Fitzsimmons and Fitzsimmons (2006, p.426)	'A time-perishable, intangible experience performed for a customer acting in the role of a co-producer'.

Kotler (2007, p.248)	'A service is any activity or benefit that one party offer to another that is essentially intangible and does not result in the ownership of anything'.
Lusch and Vargo (2006, p. 283)	'The application of specialized competences (knowledge and skills), through deeds, processes, and performances for the benefit of another entity or the entity itself'.
Grönroos (2006, p. 2)	'The consumer influence on the service offering is twofold. The consumer himself takes part in the production process and, consequently, has an impact on what he gets in return. On the other hand, the other customers simultaneously buying or consuming a service also influence the service offering'.

Table 5 - Definitions of a Service

These definitions emphasise different approaches. Issues like the end result of a production, service activity, customer activity in the production process, communication and competences are highlighted. This creates a need to define an approach to the service as a phenomenon.

Based on a need to define service, the author chose to follow the principles of Service Dominant Logic (SD-logic) introduced by Vargo and Lusch (2004), Nordic School of Marketing by Grönroos (2006) and Service Science by Maglio and Spohrer (2008). All these approaches emphasise the processual nature of the service, simultaneous production and consumption of the service product and communication between the actors in the service process.

The philosophical view on the theoretical foundation of this dissertation relies heavily on the ideas of the SD-Logic and its 11 conceptual foundations. SD-Logic, which was introduced for the first time 2004 by Vargo and Lusch, has significantly changed research and practices in the area of service science (Grönroos & Ravald, 2011).

At the core of SD-Logic is the shift from an emphasis on the traditional goods-based, tangible resources to dynamic resources, which act together with other resources. Vargo and Lusch (2004) referred to these resources as operand and operant resources, respectively:

> *'Operant resources are the fundamental source of competitive advantage' is the foundational premise, which emphasises the use of competences for the benefit of another. There is an obvious need to define the necessary competences and the outcomes of these competences in a unambiguous manner.* (Vargo, Maglio, & Akaka, 2008)

The foundational premises (FPs) of SD-Logic and their development from 2004 to 2016 are introduced in Table 6.

Foundational Premise	Rationale	Latest Updates
FP 1	Service is the fundamental basis of exchange.	No change
FP 2	Indirect exchange masks the fundamental basis of exchange.	No change
FP 3	Goods are a distribution mechanism for service provision.	No change
FP 4	Operant resources are the fundamental source of competitive advantage	Operant resources are the fundamental source of strategic benefit.
FP 5	All economies are service economies.	No change
FP 6	The customer is always a co-creator of value.	Value is co-created by multiple actors, always including the beneficiary.
FP 7	The enterprise cannot deliver value, but only offer value propositions.	Actors cannot deliver value, but they can participate in the creation and offering of value propositions.
FP 8	A service-centred view is inherently customer oriented and relational.	A service-centred view is inherently beneficiary oriented and relational.
FP 9	All social and economic actors are resource integrators.	No change
F 10	Value is always uniquely and phenomenologically determined by the beneficiary.	No change
FP 11		**New** Value co-creation is coordinated through actor-generated institutions and institutional arrangements.

Table 6 - SD-Logic, Foundational Premises
Source: FP 1–8, Vargo and Lusch (2004); FP 9, Lusch and Vargo (2006); FP 10, Chandler and Vargo (2011); FP 11, Vargo and Lusch, (2016)

After the initial research phases, the author focussed on FPs 4, 6 and 11 from an SD-Logic point of view. FP 4 underlines the importance of a predetermined outcome definition, FP 6 highlights inter-functionality in the service process and FP 11 considers institutional arrangements throughout the service lifecycle.

The second important marketing approach the author followed was that of the Nordic School of Marketing. This approach focuses on service marketing, especially the business-to-business (B-to-B) marketing, use of case studies as a research meth-

od and links to service science. For these reasons it could not be neglected (Grönroos, 2009).

The Nordic School of Marketing's approach is holistic and exploratory, emphasising customer–firm interaction. It was already formed at the beginning of the 1970s, but its importance grew in the 1980s and 1990s, when marketing management of mass-produced consumer goods was challenged. It is one of the three major 'schools' of marketing, together with the French and North American ones (Grönroos, 2006; Gummesson, 1987). According to the Nordic School, the marketing function is not a separate function in a company. Rather, marketing is seen as a management function, which steers the whole company toward a more customer-centric approach in all the business operations. The Nordic School of Marketing is not a single list of principles, but instead, an attitude toward research in the area of marketing (Gummesson & Grönroos, 2012). The main difference from the North American approach is the shift from goods-based marketing to service-oriented marketing.

In their approach, Spohrer and Maglio (2008) emphasised interactions between the entities while creating win–win outcomes or mutual benefits. These authors used the term *value co-creation* to describe the core idea of their approach.

Due to their relevance as a philosophical foundation for the NSD, none of these approaches can be neglected. According to these approaches, the value of a good is created while a good is used, not while the ownership of a good is exchanged. Based on the research, the author defines NSD as the study of individual and organisational capability/competence and equipment. NSD is development work in an inter-functional environment through co-creation processes with a customer (Vargo & Lusch, 2016; Brax, 2013; Grönroos & Ravald, 2011; Maglio & Spohrer, 2008).

2.2 NEW SERVICE DEVELOPMENT (NSD)

Despite the service industry's importance, there is no clear agreement on the question of what NSD is. Service development can be seen as an enhancement of service experience (Pine & Gilmore, 2011), development and design process (De Jong & Vermeulen, 2003) or service process (Grönroos, 2000). The traditional business development and managerial processes have their roots in the goods-dominant logic (GD-Logic; (Grönroos & Ravald, 2011). NSD methods and approaches have followed the legacy of new *product* development (NPD), but there is continuous need to develop research on this area and combine cross-disciplinary methods in NSD (Vargo & Akaka, 2009).

In the NSD process, the whole service system needs to be analysed, developed and managed. As Normann (2001) stated,

> *Every service system is both a provider and client of service that is connected by value propositions in value chains, value networks or value-creating systems.*

Thus, the author defines NSD as a study of individual and organisational capacity combined with equipment and organisational capability/competence.

2.2.1 Existing service development methods

There are several methods that have been studied and used in NSD. They have their roots on the quality management, physical product development or process development (Zeithaml, Parasuraman, & Berry, 1990). The current state reflecting the use different methods was well described by Tukker and Tischner (2006), who recognised 13 different service/service system development methods in their research.

As Clayton, Backhouse and Dani (2012) study indicated, research in the area of NSD has not thoroughly covered inputs to the service process for desired outcomes. Market scanning research by Veflen Olsen and Sallis (2006) emphasised customers' role in NSD. Authors like Johnston (1999) and Shostack (1987) emphasised the interactive nature between the elements needed in the service production process, while Menor et al. (2002) highlighted the newness of the product and service delivery mechanisms. Melton (2007) and Crawford (2013) emphasised front-line employees' participation in the development process.

Verhoef et al. (2009) argued for the importance of customer participation and strategic decisions, but they offered little guidance for implementing them in service development. In the service design literature, Morelli (2012) described several techniques for clarifying the context of the service. Sangiorgi (2009) also identified the need for new tools for mapping out the potential actors in the system. However, these papers tend to neglect the difficulties inherit in understanding or modelling the context.

The author studied service development *methods*, such as service blueprinting (SB;Bitner, Ostrom, & Morgan, 2008), service system design/engineering (Wemmerlöv, 1990), incremental service development (Clayton et al. 2012) and Capability Maturity Model Integration (CMMI; Curtis, Hefley, & Miller, 2009). The purpose was to assess their usability for NSD in PPP in the military domain. The assessed approaches describe the service production process or development of the existing service system.

2.2.1.1 Service Blueprinting

SB is a method that was developed and introduced by Shostack (1982). The basic purpose of SB is to visualise the service process and link the customers' goals and physical elements needed for the service production from the customer perspective. SB underlines the actual service production process during the service encounters in so-called touch points (Spraragen & Chan, 2008). The method emphasises the end-user perspective rather than the organisation or system providing the service. Therefore, SB requires flexibility on the part of an organisation/service system from an individual customer perspective (Spraragen & Chan, 2008). As Kostopoulus, Gounaris and Boukis state,

> *[The] SB process is successful only if it results in a blueprint that helps the necessary flexibility that will enable front line employees to offer effective response to individual needs.* (Kostopoulus, Gounaris & Boukis, 2012., p.582)

As Milton and Johnson (2012) concluded in their research, there is an obvious need to combine both customer and organisational needs while conducting NSD. The size and complexity of the operations and large number of stakeholders participating in the service process do not support the use of SB in the FDF domain (Lings, 1999). There is a need to combine elements from both the viewpoints of the end user and organisation(s). The multi-actor environment the FDF operates in does not support the use of SB as the only development method. Another significant shortfall concerning the use of SB compared with RM is the need to make assumptions regarding the service process, which is not possible in the operational concept development in the FDF's operating environment.

2.2.1.2 Service system design/engineering

Service engineering is a systematic development process for services. According to Bullinger, Fähnrich and Meiren (2003), it differs from NSD by not being strictly marketing oriented. In their research, Bullinger et al. (2003) divided service components in to three dimensions, namely the outcome, process and structure dimensions. One of the main characteristics which need to be considered in this method is the phenomenon called 'service intensity' (Fähnrich & Meiren, 1999). Service intensity refers to the level of personalisation of a service encounter and the variety, reflecting intensity. The type of service – low or high intensity – defines the appropriate development method. The level of modification differs between high- and low-intensity services and demands different development approaches and methods. In their research, Sakao and Shimomura (2007) include service channels, adding a crucial component to the service development.

Service system design does not follow the principles and lifecycle phases used in the FDF in the material capability development (Pasivirta & Kosola, 2005). This creates an obstacle compared with RM for using this development method in the FDF domain.

2.2.1.3 Incremental service development

Incremental service development was introduced by Clayton et al. (2012). Incremental development focusses on the development of existing products or services (Brentani, 2001). Its transformation to the strategic partnership model and simultaneous organisational reconstruction does not support the use of this method in the development of the FDF's catering operations. In addition, the organisational structure and necessity of preplanning in the security of supply operations demands a predefined structure for development work. Therefore, this approach is not suitable for the operational concept development in the FDF domain. At the same time, this method is not excluded if it is based on the previously defined requirements in the already existing operations.

2.2.1.4 Discontinuous development

At the core of discontinuous development is a so-called fuzzy front-end development (Reid & De Brentani, 2004). This refers to the process, time and activity *before* the development process takes place (Johne & Storey, 1998). The development process is steered from bottom to top, as in RM. It considers the corporate environment, process, people involved, analysis of opportunities, development and implementation, but it does not specify requirements as a main source for the development work. This method is excluded from the research due to our viewpoint that abstract, co-created services need to have specific, detailed, and most importantly, common outcome– or common goal–focussed requirements.

2.2.1.5 Capability Maturity Model Integration for development

CMMI for development is a method used to measure organisational and process maturity in the organisational development. The approach focuses on process development. There are 22 individual process areas, which are defined by their maturity or capability into five levels according to the organisation's capability in the specific process area (Team, 2006).

The principle assumption behind the method is that capable processes secure the desired outcome. The method is used as a development platform for a company (Chrissis, Konrad, & Shrum, 2003). CMMI is used when answers to the following questions are needed:

1. What are our strengths?
2. Are our operations developing?
3. How do we know our processes are functioning in the desired manner?
4. How do we know our requirements for the possible processes changes are useful?
5. Are our products as good as they should be? (Chrissis et al., 2003)

Some research results have indicated up to a 61% median production improvement when CMMI is used (Gibson, Goldenson, & Kost, 2006; Goldenson & Gibson, 2003). However, CMMI should not be viewed as a contradictory method to RM; rather, RM is an essential part of CMMI. The development goals and measurement indicators in CMMI process development should be drawn from the requirements.

Despite its positive results, there has been criticism of this method. In their research Margarido, Faria, Vieira and Vidal (2013) recognised three main areas that can create development difficulties. The first was inadequate metrics deployment, while the second related to CMMI management issues, such as a lack of managerial involvement. The final issue was related to the understanding of the model, as misunderstandings can lead to misinterpretations in the result measurement and development project monitoring.

CMMI has advantages, but its utilisation would require process improvement across all the operations among the FDF and its strategic partners; this reduces its usability as a development technique in the FDF domain. Another restricting feature for this

development method is time. According to Nuseibeh and Easterbrook (2000), the median transition time from one maturity level another is 12–24 months.

2.3 ORGANIZATIONAL CAPABILITY DEVELOPMENT AS A PART OF NSD

The material capability includes all the systems where the capability is utilised as the FDF fulfil their statutory mission. This includes individual and organisational capabilities. By the service definition the author followed, service is a use of competences for a benefit of another, as stated in FP 4 in the SD-Logic (Vargo & Lusch, 2016). All the reasons described above and the importance of competences in project management highlighted organisational capability development as a part of NSD.

In this dissertation, a competence is referred to as a standard or quality of an outcome (Hoffmann, 1999). The term *competence* is used concurrently with *capability*. The role of competences in the project work is highlighted in the UK-based Institution of Civil Engineers competency framework, which contains 12 key management roles and roughly 140 competences related to these roles (Crawford, 2000).

At the core of organisational competence development is the ability to create those individual capabilities and competences that enable the organisational capabilities and competences to be managed, operated and developed further. As Helfat and Peteraf (2003) stated, an organisational capability is an 'ability of an organization to perform a coordinated task, utilizing organizational resources for the purpose of achieving a particular end result' (p.999). Organisational capability is meant to develop inter-functional effort, which includes collective action to generate an outcome that the individual actors are not capable of generating (Cohen & Levinthal, 1990; Nelson & Sidney, 1982). Organisational capabilities are a combination of both the operational and dynamic capabilities of a company or an organisation. These capabilities can be divided further as routine-based (dynamic) capabilities, as stated by Helfat and Winter, (2011), Nelson and Winter, (1982), and knowledge-based capabilities, as stated by Grant (1996) and Kogut and Zander (1993).

The division between dynamic capabilities and knowledge-based capabilities is relatively straightforward. A dynamic capability refers to an organisation's ability to adapt to the changing environmental factors, while a knowledge-based capability is a capability used to modify the resources an organisation has in its use. Knowledge-based capabilities affect and constrain an organisation's pace in reacting to emerging changes. During the development process, the influential elements include both internal and external factors (Pitelis & Teece, 2010; Winter, 2003).

To address the research questions, the author followed the definitions of military capability by the Australian fundamental inputs to capability (FIC). This approach views capability as a system of interlocking (inter-functional) and interdependent components (Director, 2006). This approach makes it possible to utilise systems wide approach and RM as a research method in the research domain. The role of organisational capability as a part of NSD in illustrated in Figure 1.

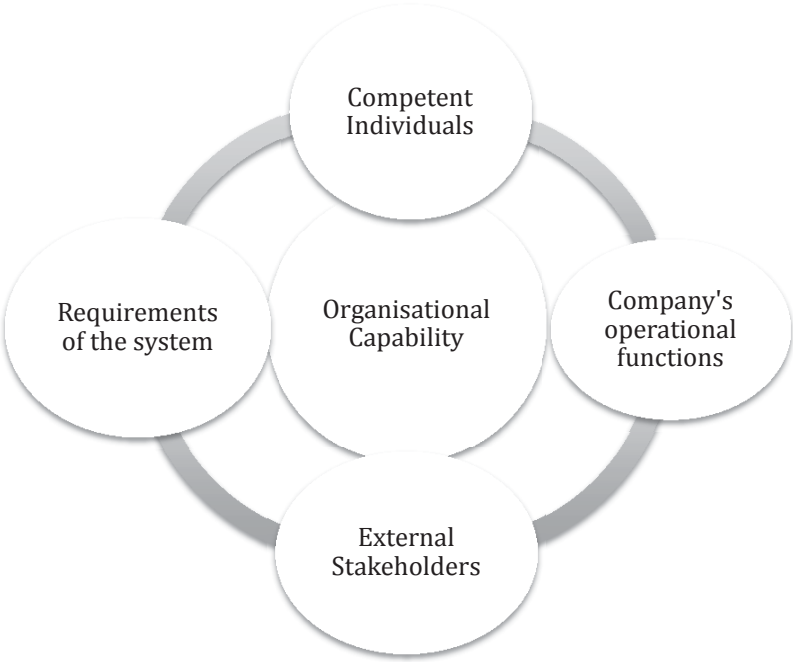

Figure 1 - Organisational capability as a part of NSD, Adapted from: Trott (2008)

Following the principles of SD-logic this ability is a value creation, which is coordinated through actor-generated institutions and institutional arrangements which are linked to larger system and their sub-systems that create an ecosystem of activities. (Vargo & Lusch, 2016; Cantwell, Dunning, & Lundan, 2010; Westney, 2009; Dunning & Lundan, 2008). Organizational capability, which needs are described in a form of requirements is a mean to reach the pre-determined NSD goals. These goals are communicated in a form of service promises. In the proposed model, these promises are developed, measured and assessed using Key Performance Indicators (KPIs) in a form of requirements throughout the service life cycle.

2.4 SUSTAINABILITY AS A PART OF NSD

In 2007, the MOD established a committee to research climate change and its effects on the FDF. This work was part of Finland's efforts to follow the Kyoto Protocol. In their report, Puolustusministeriö (2008) listed concrete actions in the FDF catering domain related to the treaty. In this report, they stated at least 5% of the offerings should be produced in the sustainable way (once a month) by 2010, and by 2015, this should reach at least 15% (once a week). In addition, the report stated that the public sector, including the FDF, should consider the whole lifecycle of the product (from field to fork) when sustainability is being assessed. Special attention should be paid to energy and water consumption, bio-waste should be minimised and the overall environmental impact of food should be minimised (Puolustusministeriö, 2008).

As part of business development, sustainability has been studied for decades, but the increasing effects of climate change and negative effects of globalisation have brought the issue from academia and the media into boardrooms (Moir, 2001). Sustainability is a part of the managerial approach called Corporate Social Responsibility (CSR). CSR is a term describing actions with the purpose of promote positive outcomes for the surrounding community and society (Schubert, Kandampully, Solnet, & Kralj, 2010).

There is no single definition of CSR, but a definition by Commission of the European Communities states that:, 'to measure their overall performance as well as their performance on specific CSR issues, companies use input, output, outcome and process indicators' (Commission of the European Communities, 2000, p.3).

In the CSR framework, sustainability is often defined as meeting the needs of the present, without compromising the ability of future generations to meet their needs (Brundtland, 1987). In the business domains, sustainable development is often connected to the so-called triple bottom line thinking. The triple bottom line approach emphasises that companies should measure their success not only in economic, but also, in environmental and social terms (Elkington, 1997).

Discussion about companies' initial motivation for implementing CSR practices and sustainability as a part of this is on-going, but typically, two types of CSR drivers are identified, namely internal and external drivers (Bonilla Priego, Najera, & Font, 2011; Masurel, 2007). The former is connected to goals like increasing profitability or developing competitive resources, whereas the latter is driven by legal regulations or explicit stakeholder expectations.

Shareholder and stakeholder value perspectives have been clear dividers of the discussion surrounding CSR, but one can ask whether it is even possible to separate the two (Johnson, Scholes, & Whittington, 2008). Several studies have shown that poorly managed sustainability requirements have a drastic effect on the development process, and most of all, the end result of service development (Barney, Aurum, & Wohlin, 2008; Almefelt, Berglund, Nilsson, & Malmqvist, 2006; Aurum & Wohlin, 2005; Barney, 1991).

In his widely cited research Carrol (1991) pointed out that economic responsibility creates a base for CSR. Without the fulfilment of their economic responsibilities, commercially operating entities are unable to exist. At the same time, economic growth should be a mean increasing quality of life, not decreasing it (Knox, Maklan, & French, 2005).

Opportunities to enhance operative savings and increase firm value in the industry from socially responsible operations serve shareholder and stakeholder approaches (Kang, Stein, Heo, & Lee, 2012). This requires a thorough contingent analysis of the whole business environment. Excellent examples of this are the Leadership in Energy and Environmental Design (LEED)-certified and LEED-qualified building projects in the US hotel industry, as illustrated by Butler (2008). In his study, Butler showed the positive financial effects and stakeholder attitudes of green policies. In

addition, reference points like LEED offer an opportunity to describe the need for resources in the form of requirements (Butler, 2008).

Sustainability as a part of NSD is a consequence of the internationalisation of businesses (Jamali & Mirshak, 2007). Globalisation has had local, national and multinational effects, which have not always been constructive or positive (Balbinot & Borim De Souza, 2012). Difficulties in CSR arise from both the national and multinational relations among the stakeholders. As Jamali and Mirshak's (2007) research indicated, national policies have a significant effect on the means and resources different stakeholders can utilise in the CSR activities.

Despite the alleged benefits of CSR, several studies have questioned these advantages (Knox et al., 2005). One can argue that, because their benefits are not clear, CSR activities are 'not worth of the money'. Despite the criticism, however, the role of sustainability in NSD is significant for several reasons. First, public organisations and other organisations with more than 500 employees must constantly follow and report their activities from the following areas:

1. Environmental protection;
2. Social responsibility and appropriate treatment of employees;
3. Respect for human rights;
4. Anti-corruption and bribery;
5. Diversity on company boards (in terms of age, gender, educational and professional background;

(Commission of European Communities, 2014).

Each area creates a set of requirements during the lifecycle of the product/service system. These areas are also interdependent, and they are affected by the whole service supply chain. According to the research conducted by Albareda et al. (2007), this multi-stakeholder view has been a development phase in CSR, and it has been adopted and supported by organisations like the United Nations (UN) Global Compact, Global Reporting Initiative and European Multi-Stakeholder Forum on CSR.

The author has concentrated on the environmental factors of CSR in this dissertation, despite the challenges involved in assessing environmental effects for the whole food supply lifecycle (Parfitt, Barthel, & Macnaughton, 2010). While there are overall difficulties in such an assessment, according to the Food and Agriculture Organisation of the United Nations (FAO), yearly as much as one-third of the produced food ends up as waste. The amount equals 1.3 billion kilogrammes of eatable food, which would cover 1.4 billion hectares of land. This is approximately 28% of the surface area of the world. This waste is divided into different categories and presented in Table 7 (Kuluttaja, 2017). Food waste is also a major source of CO^2 emissions. Annually, the CO^2 emissions from food waste in Finland is approximately equal to that created by 100 000 cars (Motiva, 2017).

Product	Wastage %
Grain	30
Milk and egg products	20
Fish and seafood	35
Fruits and vegetables	45
Meat	20
Oil plants and legumes	20
Beets and tubers	45

Table 7 - Global Food Waste by Ingredients

Finland is committed to following international treaties. This has affected all public-sector entities, including the FDF. Intensions to lower CO^2 emissions have direct effects on the ingredient choices, supply chain choices and menu management. Issues related to sustainability management create a need for both manageable requirements and preconditions, which must be considered in the NSD process.

2.5 NSD in PPP

PPP forms another main framework with RM for this research. Assumptions drawn from this discipline and its multi-stakeholder nature allowed the author to use RM, as Parviainen and Tihinen (2007) suggested. Challenges concerning the contract design, unrealistic expectations and possible environmental effects need to be considered as a part of the development work (Sharma & Bindal, 2014).

A PPP is a contractual agreement between a public agency (federal, state sector) and a private entity. Through this agreement, the skills and assets of each sector (public or local) are shared in delivering a service or facility for the public's use. In addition to the sharing resources, each party shares in the potential risks and rewards in the delivery of the service and/or facility (Halls, 2010).

PPP is not a new phenomenon. According to Forrer et al. (2010), it has existed since Roman times. Over the centuries, the state functions were limited to functions like defence, interior affairs and the judiciary. Since these create the basis for a state's survival as an independent entity, the state adopted the exclusive right to perform these activities and ensure the necessary resources via the development of a tax system and taxation (Krtalic & Kelebuda, 2010). Despite its long history, the role of PPPs has increased only recently; as research by Jacobson and Choi (2008) and Krtalic and Kelebuda, (2010) showed, the discussion surrounding the topic has become more active. PPPs as a mechanism for either funding or operate public services have increased in significance. According to Iossa and Martimort (2015), in 1990–2009, the financial value of the PPPs in EU reached € 250 billion.

Public procurement and contracting are often a necessity for public–private service management, and a mix of commercial and non-commercial operations requires studying contracting needs thoroughly. Only then is it possible to identify and prioritise the often politically contradictory stakeholder preferences at each stage of the

contracting process. Research disciplines surrounding PPP have varied from policy to management studies, healthcare management, sociology and military studies, reflecting the multidisciplinary nature of PPPs. Research has covered areas as polarised as abuse treatment to the role of multinational construction projects, and it has been funded by international public entities like the EU. Industries, from human services to the defence industry, are used as case examples in research to broaden the topic even more (Halls, 2010; Budina, Brixi, & Irwin, 2007; Petersen, Woodard, Urech, Daw, & Sookanan, 2006; Martin, 2002).

PPPs were defined more specifically by Linder (1999). There are at least six different uses of the term; in his view, these uses are closely related to political uses as a technique to achieve political goals. The six uses are as follows:

1. PPP as a management reform;
2. PPP as a problem conversion;
3. PPP as a moral regeneration;
4. PPP as risk shifting;
5. PPP as restructuring public services; and
6. PPP as power sharing (Linder, 1999, pp. 42–47)

Authors like Keating and Keating (2013), Demirag, Khadroo, Stepleton and Stevenson (2012), Forrer et al., (2010), Halls, (2010), Moulton and Wise (2010) and Wang (2009) have studied the subject from several non-political angles. These authors have shown six specific definitions, which have similarities with each other and Linder's (1999) work, but at the same time, exhibit significant differences.

To address the research objectives, the author combined the six different politically influenced uses in Linder's (1999) definitions 1 and 5 with more precise definitions in Table 8. This approach made it possible to create a framework, while forming research questions and interpreting the research results.

Researcher(s)	Definition
Forrer, Kee, Newcomer, & Boyer, (2010, p. 476)	'Public–private partnerships are on-going agreements between government and private sector organizations in which the private organization participates in the decision-making and production of a public good or service that has traditionally been provided by the public sector and in which the private sector shares the risk of that production'.
Halls, (2010, p. 22)	'Contractual agreement between a public agency (federal, state sector) entity. Through this agreement, the skills and assets of each sector (public A or local) and a private) are shared in delivering a service or facility for the use of the general public'.
Keating & Keating, (2013, p. 178)	'A long-term relationship between the state and a private non-profit or profit-seeking firm for designing, constructing, maintaining, and delivering infrastructure or social services'.

Wang & Jing, (2009 p. 779)	Partnerships involve 'a far more intensive interaction (or synergy), which requires strategic collaboration and intertangled action between the public and private parties from the very beginning of a project. ln a partnership, two parties conduct joint decision making and specify the problem, solution, and product in the joint process'.
Moulton & Wise, (2010, p. 350)	'Public–private configurations exist wherever government authority is extended to private firms for the production of outcomes that achieve public (as well as private) objectives'.
Demirag, Khadaroo, Stapleton, & Stevenson, (2012, p. 1318)	'Involves the public and private sectors sharing the risks and rewards on clearly defined projects financed by the private sector'.

Table 8 - Definitions of Public Private Partnership

Limiting the research topics the areas and/or definitions would not give an accurate and comprehensive picture of PPPs. According to Subbiah (2009), PPPs can and must be divided according to the lifecycle stages of the partnership, due to both micro- and macro-economic changes in the operating environment.

In his doctoral dissertation, Subbiah (2009) stated that factors like the organisational culture, work-related systems, differences in reporting procedures and differences in human resource management create obstacles that cannot neglected while researching PPP. This mosaic nature of PPP is clear, as several variables affect each other; as a result, a common ground is missing from the PPP research. This also explains why PPP research is flourishing and covers such a wide range of topics.

2.5.1 Evaluation of PPP success

Industries like human service industries, health care and abuse treatment have used a method called Performance-based Contracting (PBC) to help service suppliers and buyers in negotiating and agreeing on outcome-based contracts. As a part of PPP, PBC is an area of management that focuses on the outputs, quality, and mostly, outcomes of service provisions. Ultimately, PBC should be used to measure vital and important metrics for the buyer of the service (Berkowitz et al., 2003).

Monetary rewards are often tied to the contractor's achievement when it comes to contract extensions or renewals (Martin, 2002). Examples like that described by Brucker and Stewart (2011) show that PBC was initially implemented as a performance measurement technique to enhance data-driven decision-making capabilities. Francois (2000) described how the goal of the new system was to foster efficiency and quality of service by tying performance to the payment level.

In the military context, PBC is called performance-based logistics (PBL). As in PBC, in PBL, the responsibility for the product/service system management is held by the system supplier, unlike in the traditional end user–supplier relationship (Randall et al., 2010). In PBL, a customer buys predetermined outcomes, which depend on and are simultaneously vulnerable to the subsystems' outcomes. In PBL the whole lifecycle of the product is considered.

PBL can be defined as

> *an integrated acquisition and sustainment strategy for enhancing weapon system capability and readiness, where the contractual mechanisms will include long-term relationships and appropriately structured incentives with service providers, both organic and non-organic, to support the end user's (warfighter's) objectives.* (Barkowitz et al., 2003, p. 5)

PBL is a combination of several logistics functions, and each function and the whole system require measurable outcomes (Gansler & Lucyshyn, 2006). Management and development of a PBC/PBL system requires a goal given in the form of requirements and an embedded network, as Sinha, Kaplan, Paradkar and Williams (2008) and Abednego and Ogunlana (2006) show. If the requirements are not unambiguously expressed and managed, there are several risks that can materialise as a failure in the service production process. Research on PBC or PBL as a part of PPP by Berkowitz et al., (2003), Gansler & Lucyshyn, (2006), Gruneberg, Hughes and Ancell (2007), Kadish et al., (2006) Koerr, Lewis and Eaton (2005) has shown the necessity for results-based metrics.

Based on the definition given above, the author concludes that the PBL framework must fulfil the following criteria in managing organisational activity:

1. It must address how the user, buyer or developer reaches his or her goals while utilising PBL;
2. It must be related to change, since the purpose of PBL is to enhance existing systems;
3. It must be a system-wide approach to contracts/agreements; and
4. It is a time-bound relationship.

2.5.2 PPP in military organisations

Before discussing PPPs in the military context, it must be clarified whether the military industry is a regular business area or an expression of one of society's fundamental responsibilities. At the core of the discussion of PPP in the military context is the following question: What defines a so-called Private Military Company (PMC)? To discuss PPPs and military organisations, it is necessary to define society's role in supporting industry sectors closely cooperating with military and vice versa. Therefore, one can quite rightly ask, how can a PMC be distinguished from a civilian supplier?

Hired armed forces have played a significant role in conflicts throughout human history (Singer, 2011). There is a clear link between hired armed forces and the loss of sovereignty in so-called failed states. These failed states have no capacity to control their sovereignty during crises, when humanitarian or political.

On the public side of PPPs in military organisations are sovereign states or entities that are part of sovereign states. The idea of sovereign states, which have control over their autonomy under all conditions, dates to end of the 18th century. The Swiss international jurist Emmerich de Vettel described the principles of sovereign

state, with focus on control over territory (Krasner, 2001). These principles were refined in the Charter of the UN and Statute of the International Court of Justice, and they form the basis of international law (Higgins, 1963).

Questions about democratic control mechanisms and military governance can be traced back further than the principles of sovereignty. The rise of nation states in the 16th and 17th centuries enabled the formation of national armies. This period marked the imminent decline of local rulers, feudal aristocracies and non-permanent armed forces (Glete, 2002). A need to finance state-operated militaries was a driving force behind the birth of so-called fiscal-military states (Storrs, 2016).

Today, the definition of a sovereign state has altered from a control of sovereignty to the responsibility to protect (R2P) members of the sovereign state. This idea has been studied and introduced by a Commission of Intervention and State's Sovereignty in their 2001 report (Evan et al., 2001). Control over a state's autonomy and protection of its members have traditionally been the responsibility of the sovereign state's military. However, there are nations, such as Iceland, where the sovereignty is backed up by an agreement with another sovereign state (Thorhallsson & Vignisson, 2004). States' rights and abilities to control their domestic sovereignty and protect their citizen vary a great deal. Without an existing public entity with a capability to control a nation's sovereignty and protect its citizens, there is no possibility for discussing PPP in the military context.

On the private side of the equation, it was not until 1977, by a Nigerian initiative, that a term 'mercenary' was defined in UN Article 47 (Scheimer, 2008). However, this definition did not end unambiguity surrounding the issue, and crises in so-called failed states, such as Papua New Guinea, Angola and Sierra Leone, led to the rise of PMCs in the late 1980s and early 1990s. Companies that caught the attention of international community were Executive Outcomes and Sandline International (Spicer, 1999). These service providers took the role of legitimate companies, although they were actively participating to armed conflicts in Sierra Leone and Angola (Krahmann, 2011). According to Ghebali (2006), a brief period of uncertainty from 1977 regarding the definitions of PMCs ended 2004. Based on the work by two UN special rapporteurs from 1987 to 2003, a legal definition of PMCs was formed. This gave an PMCs and their supporting functions the opportunity to offer their services to commercial ventures, governmental organisations and nongovernmental organisations (NGOs; (Scheimer, 2008).

The revenues generated by PMCs in 2010 exceeded an estimated $200 billion, but the role of the actors varies a great deal and is extremely diversified. The main activities conducted by PMCs, according to the UK Foreign and Commonwealth Office, are illustrated in Table 9 (Bures, 2005; Hutton, 2004).

Activities, examples and users of private military and security companies		
Activities and services provided	**Examples of Companies**	**Main Users of Services**
Combat and Operational Support	Executive Outcomes, Sandline International, Gurkha Security Guards	Governments
Military Advice and Training	DSL, MPRI, Silver Shadow, Levdan, Vinnel, BDM	Governments
Arms Procurement	Executive Outcomes, Sandline International, Levdan	Governments
Intelligence gathering	Control Risk Group, Kroll, Saladin, DynCorp	Governments, Multi-National Companies
Security and Crime Prevention Services	DSL, Lifeguard, Group 4, Control Risk Group, Gurkha Security Guards, Gray Security, Coin Security	Multi-National Companies, Humanitarian Agencies
Logistical Support	Brown & Root, DynCorp, Pacific Architects and Engineers (PAE)	Peacekeeping organisations, Humanitarian Agencies

Table 9 - PMCs' Main Activities, UK Foreign and Commonwealth Office, *Private Military Companies: Options for Regulation*, (2002)

As a study conducted by the UK Commonwealth Office indicated, logistical support is an area in which PMCs operate. Logistical support, including catering operations and other supporting functions, is a crucial part of war-fighting capabilities (Handbook, 2012). Role of supporting functions can include tasks, such as weapon loading, which operators are clearly defined to be part of military personnel under international humanitarian law (Doswald-Beck, 2007).

Due to the controversy direct combat operations have created in the international community, supporting functions are viewed as a more acceptable way to use PMCs and civilian partners. This controversy was a result of several significant incidents, which were dividers of opinion about PMCs' role in direct combat operations. Incidents involving an American company, Blackwater Worldwide, in Iraq in 2004, 2006 and 2007 were events that brought PMCs into public discussion. These events were the deaths of four individuals working for Blackwater and a legal case following the incident, the killing of an Iraqi security guard by a Blackwater employee, a Blackwater intervening in the US military's chain of command during a battle in Najaf and the deaths of 17 Iraqi civilians in Baghdad (Scahill, 2011).

In the development of services in military PPP cooperation, each entity's legal position must be defined. The FDF's enhanced international role demands thorough research on how each service supply chain operator's responsibilities are reflected in international and national laws. This creates a new domain restriction that must be considered during NSD.

2.5.3 PPP in the FDF's domestic catering operations and its effects on NSD

Domestic catering operations in the FDF do not follow the same business principles as those of their fully commercial counterparts. Partner catering operators represent the only large-scale catering operators in any Finnish military bases, so competition is almost absent from the end users' perspective. The FDF is obligated by law to fulfil the nutritional needs of every serviceperson during his or her military service (Säädöstietopankki Finlex, 2007), and mealtime is part of the mandatory service. Therefore, the end users do not define the value of the product they use in commercial terms (Pine & Gilmore, 2011; Grönroos, 2009; Gummesson, 2008; Vargo & Lusch, 2004). On the other hand, catering operations is a service. This is a fact, which must be taken into consideration in both management and development of a function.

One of the first comprehensive studies on PPP in the FDF was introduced in 2008. Transformation to PPP catering operations at Hamina Garrison had already started in 2002 (Hakkarainen, 2008). This case study drew a clear picture of the challenges that the commercial restaurant operator, city of Hamina and Hamina garrison faced. One of the main findings was that 'it was not possible to reach significant cost reduction by using the PPP model used in the case of Hamina' (Hakkarainen, 2008, p. 3). Following research by Kämäräinen (2010) indicated similar results on the FDF's catering operations as a whole.

Hakkarainen's research showed the possible traps and bottlenecks, that could arise if a similar model were followed in other garrisons and catering units. It forced the cost structure of the catering operations to be opened in a way that had not been done earlier. This research covered all the stages in the service's lifecycle and gave an excellent overview of PPP in the FDF framework. One of the positive features of the Hamina case was its flexibility and relatively efficient usage of resources. In the study, catering operations were defined as a supporting function. This notion gave a clear framework for catering services in a military capability development framework (Anteroinen, 2013).

Although catering operations function in a peacetime environment, they have a significant role in the FDF during a crises situation. This cannot be ignored when studying peacetime PPPs between the FDF and its partners. Based on this, it can be concluded that, in a military organisation, there are several different organisational capabilities in an organisation, in which competences need to be developed.

2.6 REQUIREMENTS MANAGEMENT (RM)

RM is a development process in which predefined requirements are documented, analysed, traced, prioritised and agreed on between recognised stakeholders (Institute, 2008; Nakazawa, 2006; Stellman & Greene, 2005*)*. During this process, all the system-related stakeholders and their needs are identified. These must be documented in a way that enables analysis, communication between stakeholders and implementation of the developed system, product or artefact (Nuseibeh &

Easterbrook, 2000). This enables control and communication throughout the development process. To optimise the value of the development project, there must be a clear connection between the development process and developing organisation's business strategy (Too & Weaver, 2014).

RM emphasises communication between the stakeholders to avoid sometimes contradicting and overlapping requirements. This enhances the opportunity to understand existing, and sometimes conflicting, needs between the participants in the development process (Office of Government Commerce, 2009).

A requirement is defined by American Society for Testing Materials (ASTM) International (2012) as 'a singular documented physical or functional need that a particular design, product or process aims to satisfy'. The International Organization for Standardization (ISO, 2015) defines a requirement as a 'need or expectation that is stated, generally implied or obligatory'.

RM is generally viewed as critical and one of the most complex tasks during the creation of inter-functional systems (Parviainen, Tihinen, Lormanms, & van Solingen, 2005). The requirements description should cover how the existing environment is being affected by the newly developed system (Cheng & Atlee, 2007). More than 70% of projects entail at least 100 requirements, and 20% of projects include at least 1000 (Project Management Institute, 2014). These requirements from different stakeholders can be potentially incomplete, inconsistent and conflicting, but they need to be transformed into a complete set of high-quality requirements, such as strategic goals (Aurum & Wohlin, 2005).

The requirements should be developed via collaborative work among stakeholders (Alexander & Beus-Dukic, 2009). Effective communication builds trust and encourages transparency, which may increase engagement and cooperation (Eskerod & Huemann, 2014; Kee & Newcomer, 2008). RM is used during the use phases of the system components and the development of a system. It considers the complete networks of actors throughout the system's lifecycle as a design activity, dividing a (service) system in to smaller subsystems and defining how these systems interact (Diev, 2007). The purpose of RM is to find answers to two questions, as follows: What utility does the new artefact provide? What demonstrates that utility? (Von Alan, March, Park, & Ram, 2004).

Requirements can change because stakeholder needs change, or they can change because the requirements did not represent the need to begin with (Kaindl & Svetinovic, 2010). New, high-level goals can even be identified during the development as the reasons for operational goals are questioned (Van Lamsweerde, 2001). Further, requirements are often removed because of project schedule or cost overruns. Managing requirement change is not only about changing documentation; it is also about the continuous analysis, collection and validation of requirements during the full system lifecycle (Figure 2).

RM as a part of the (service) system development process can be divided into two development domains – the problem domain and solution domain. The first domain's activities relate to the real needs a developed system must meet and stake-

holder expectations. The latter part involves activities related to the following question: How are needs met and how do different system components form part of the developed system. (Hull, Jackson, & Dick, 2011.) Requirements used as a base for development work can be categorised into different types, such as business and technical solutions, with the former referring to stakeholder needs (problem domain) and the latter to how those needs will be implemented (solution domain). RM refers to a process during which requirements are defined, documented and maintained (Blanchard, 2004).

The role of requirements is emphasised in the following areas of the development work:

1. Conflict resolution strategy;
2. Commitment monitoring of the partnering process;
3. Clear identification of responsibilities;
4. Mutual trust;
5. Willingness to improve processes;
6. Early partnering implementation;
7. Sharing resources;
8. Innovation; and
9. Subcontractor involvement (Chan, Scott, & Chan, 2004).

NSD in the PPP domain relates directly to areas 2, 3, 4, 7 and 9 in the PPP definitions introduced by Keating and Keating (2013), Demirag et al. (2012), Forrer et al. (2010), Halls (2010), Moulton and Wise (2010) and Wang and Jing (2009). Areas 5 and 8 are linked to the NSD definitions introduced by De Jong and Vermeulen (2003) and Grönroos (2000).

Requirements can be grouped into classifications, allowing for further refinement and detail as the requirements are elaborated (Bullinger et al., 2003). Requirement classifications included in the problem domain are as follows:

1. Business requirements, which describe the higher level needs of the whole organisation, such as the business issues or opportunities, and reasons why a project has been undertaken; and
2. Stakeholder requirements, which describe the needs of a stakeholder or stakeholder group.

The requirement classifications included in the solution domain are as follows:

1. Solution requirements, which describe features, functions and characteristics of the product, service or result that will meet the business and stakeholder requirements. Solution requirements are further grouped into functional and nonfunctional requirements:
2. Functional requirements describe the behaviours of the product. Examples include processes, data and interactions with the product;
3. Non-functional requirements supplement the functional requirements and describe the environmental conditions or qualities required for the product

to be effective. Examples include reliability, security, performance, safety, level of service, supportability and retention/purging;

4. Transition requirements describe temporary capabilities, such as data conversion and training requirements, needed to transition from the current 'as-is' state to the future 'to-be' state;
5. Project requirements, which describe the actions, processes or other conditions the project needs to meet; and
6. Quality requirements, which capture any condition or criteria needed to validate the successful completion of a project deliverable or fulfilment of other project requirements (Institute, 1987).
7. There are also three different dimensions that need to be analysed, considering their effect on the developed system, as follows:
8. The structure dimension (the structure determines the ability and willingness to deliver the service in question);
9. The process dimension (the service is performed on or with the external factors integrated in the processes); and
10. The outcome dimension (the outcome of the service has certain material and immaterial consequences for the external factors; (Bullinger et al., 2003).

The RM loop is illustrated in Figure 2. A more detailed process description with assessment of the phases is given in the following paragraphs.

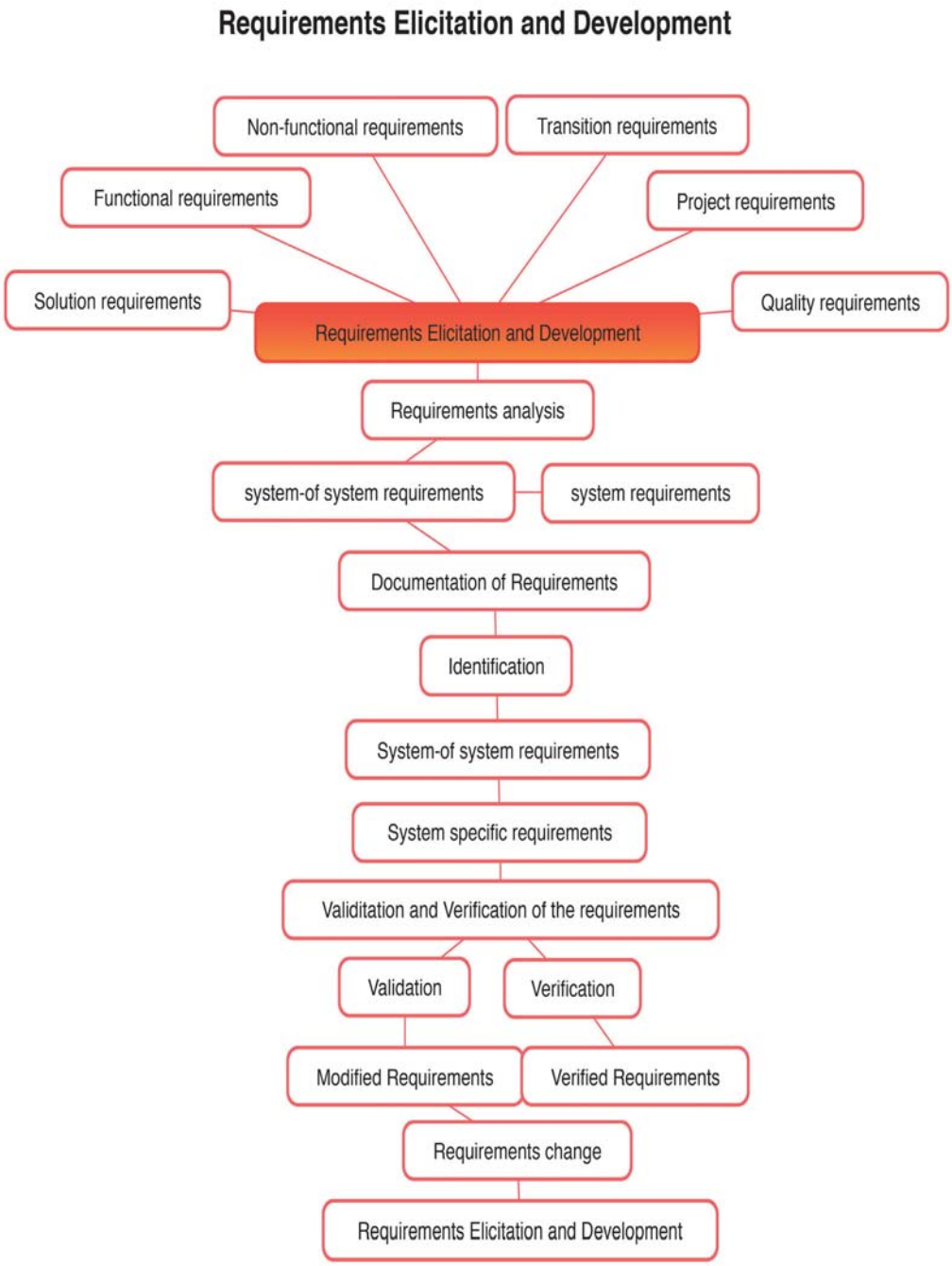

Figure 2 - Requirement elicitation and development, Dick, Hull and Jackson (2011); Pandey, Suman and Ramani (2010)

2.6.1 Requirements elicitation and development

The RM process begins with system/domain boundary identification. In this phase, actors define where and how the new, developed system will fit into the existing operational environment. During this phase, the inter-functionality and interdisciplinarity with other systems around it are established (Nuseibeh & Easterbrook, 2000). As in project management, this process should start with identifying relevant stakeholders (Sharp, Finkelstein, & Galal, 1999) and understanding their goals (Van Lamsweerde, 2001;Nuseibeh & Easterbrook, 2000). At the beginning of the RM process, it is often hard to determine the relevant stakeholders. This can lead to a situation in which too many or too few stakeholders are considered (Sharp et al., 1999). Identifying too many stakeholders leads to inefficient resource usage and can create too much data to handle. However, the requirements create a solid foundation between numerous stakeholders, and they should be used as a KPIs and a basis for contractual management, as our case studies indicate. Several authors have stated that understanding the specific context of the system is crucial for eliciting and analysing the correct requirements (Cheng & Atlee, 2009; Nuseibeh & Easterbrook, 2000). Contingent analysis, open communication and clear and well-defined requirements are essential for successful NSD in network-based organisations like the FDF.

2.6.1.1 Challenges in requirement collection

Goal elicitation is difficult because stakeholder goals may not be explicit, and stakeholders can have difficulties communicating the goals. In addition, it may not be clear how all and often conflicting goals can be satisfied. Often, requirements analysts have to infer goals from the tasks stakeholders perform (Nuseibeh & Easterbrook, 2000). Moreover, stakeholders may not be capable of describing the tasks. This problem is well known in social sciences as the 'say-do' problem and in psychology as tacit knowledge (Goguen & Linde, 1993).

2.6.2 Modelling and analyses of the requirements

Requirements models describe some aspect of the real world for understanding and communication. However, the real world is too complex to be modelled completely; thus, each model only focuses in small part of it. The purpose of the models is to allow reasoning about the real world by checking for inconsistencies and ambiguity in our understanding of the environment. The creation of complete and consistent requirements models is now seen as futile (Nuseibeh & Easterbrook, 2000). A more fruitful strategy is to learn to manage the inconsistencies in requirements models (Nuseibeh, 1996).

Two different general types of models are created in a requirements process, namely 'as-is' and 'to-be' models. An as-is goal model describes what is currently true in the environment, while to-be models are descriptions of the desired state of the environment. The line between these types of models is often blurred in practice, espe-

cially as stakeholder goals can be equally valid for both models (Van Lamsweerde, 2001; Nuseibeh & Easterbrook, 2000).

2.6.3 Communicating requirements

Communication among different system stakeholders throughout the development and different management phases is necessary for a development process's success. Elicitation requires communication with stakeholders, and inadequate communication between the system actors during development work will lead to inconsistencies in the requirements models (Jureta, Mylopoulos, & Faulkner, 2008; Nuseibeh, 1996). As Coughlan and Macredie (2002) stated, poor communication is one of the most common reasons behind failures in the RM process.

There must be a predefined and consistent framework that considers all the participating parties. These actors are likely to have different development goals, approaches to the existing development challenges and areas of expertise. This can lead to communication difficulties, especially in larger development teams (Coughlan & Macredie, 2002). When RM principles are followed, there is a greater opportunity to a reach common understanding among different stakeholders. Requirements and the model based on them must be composed such that they are readable and traceable by stakeholders with different backgrounds (Nuseibeh, 1996). Existing standards, like the International Council on Systems Engineering (INCOSE) Handbook can be used to solve this issue (Haskins & Forsberg, 2011). However, authors like Kovitz (1998) have claimed that a rigid approach and insufficient contingent analysis during RM process is a risk.

2.6.4 Agreeing on the requirements

The collected requirements need to be validated. This ensures that the description interpretation is commonly understood between the stakeholders in the system. The descriptions should follow the outcomes each stakeholder is expecting from the future state of the system. The purpose of the validation process is to increase the confidence in the model, as opposed to finding an objective truth. 'As-is' models are validated to increase analysts' confidence in the trustworthiness of the model; 'to-be' models are validated to check whether they represent what stakeholders want (Potts, 1997). One way to accomplish this using counter-examples. Rough sketches are open to multiple interpretations, making their validation impossible.

2.6.5 Evolving requirements

An iterative approach to RM permits changes throughout the design process, as well as after the system has been implemented. Even if existing models, such as INCOSE, are used throughout the requirement management process, this reduces the risk of failure. It also demands active updates of the requirements at the system level if environmental changes appear. These changes need to be managed and tracked, with an analysis of their effects on the requirements (Nuseibeh & Easterbrook,

2000). A commercially driven environment, as in PPP, demands continuous RM of new and altered requirements in a way that ensures a continuous competitive advantage for the PPP counterparts. There should be specific attention paid to managing requirements dependencies, as Carlshamre and Regnell (2000) suggested.

2.6.6. Criticism of RM

Despite its benefits for successful project management, there is criticism of RM. Such criticism relates to the nonspecific and imprecise form of customer (end user) requirements, difficulties in mapping the relationships between the stakeholders, difficulties in following the changing requirements during the product lifecycle and the need for simplification of the existing operating environment (Haynes, 2015; Jiao & Chen, 2006;). Opportunism between the participating entities and existing governance problems are also among the recognised risks in hybrid organisations, such as PPPs (Dekker, 2004).

Some authors have argued that the criticism is outweighed by RM's positive effects. The Cost and Economic Analysis Branch of the National Aeronautics and Space Administration (NASA), which spent less than 5% of the total project expenditure on RM, exceeded the estimated project budget by 80–200% (Young, 2003). Nelson's (2007) findings indicated that the clear majority of project management mistakes could be categorised as either process mistakes (45%) or people mistakes (43%). Furthermore, insufficient stakeholder management was found to be a reason behind a project failure in 51% of the cases, difficulties in the capabilities among the project team were found to be reason behind the project failure in 37% of the cases and poor requirements management in 31% of the cases. A study by Smith (2014) indicated even higher percentage figure on the importance on the RM. In his research a failure percentage was 37 underlining the importance of RM in the development process. This is also line with previous research by Young (2003).

2.7 CRITICAL INFRASTRUCTURE PROTECTION (CIP)

One of the research assumptions was that modern services depend on networks of providers, and each service provider can form a critical node in which a malfunction will ruin the whole service. The individual nodes are part of a larger infrastructure, and together, they form an interdependent system (Moteff & Parfomak, 2004; Rinaldi, Peerenboom, & Kelly, 2001).

Critical infrastructure forms a society's lifeline. However, the meaning of the term has evolved in recent decades. Although previous definitions considered the infrastructures necessity for society, the phenomenon of critical infrastructure received its present status and importance in the mid-1990s, especially after the World Trade Center attacks on September 11th, 2001. This was a result of the growing terrorism threat and development of the interdependency of the infrastructure and complexity of the systems that form part of the critical infrastructure (Homeland Security Act, 2002).

CIP has risen in importance with the current global security situation (Moteff & Parfomak, 2004). It is now considered one of the most important sectors of governmental protection (Edwards, 2014). Critical infrastructure can be defined as a physical or cyber-based system that has an essential role and *minimum* operations in a society (Clinton, 1998). Critical infrastructure is defined as

> s*ystems and assets, whether physical or virtual, so vital to the [United States] that the incapacity or destruction of such systems and assets would have a debilitating impact on security, national economic security, national public health or safety, or any combination of those matters.* (Homeland Security Act, 2002).

There is a clear difference between this and the traditional definition of infrastructure, which is described as

> t*he basic facilities, services, and installations needed for the functioning of a community or society, such as transportation and communications systems, water and power lines, and public institutions including schools, post offices, and prisons* (Moteff & Parfomak, 2004)

or

> *A network of independent, mostly privately-owned, man-made systems and processes that function collaboratively and synergistically to produce and distribute a continuous flow of essential goods and services* (President's Commission on Critical Infrastructure Protection,1997)

In CIP, the functions of the supply chain systems' operations must be analysed across the domains in which the organisations work. The approach used here has been adapted from the principles introduced by Skyttner (2005). The framework for the holistic CIP approach is given in Figure 3.

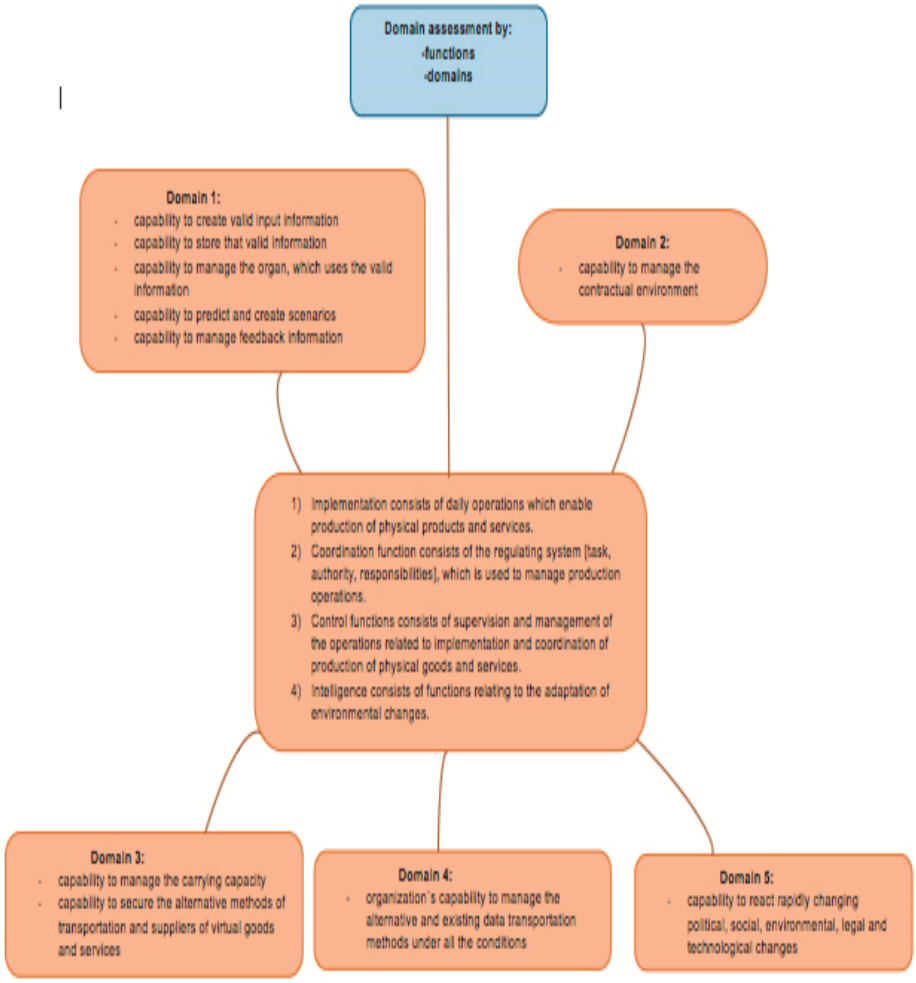

Figure 3 - CIP development framework. Skyttner (2005)

There must be a managerial approach – a methodology – that sets a framework for capability management. The initial goal of domain assessment is to define and create capabilities/competences that enable recognition of an attack and reduce the attacker's ability to operate in the target component. Observation and protection are reactive functions that affect the overall costs.

2.7.1 Contractual environment

CIP demands the comprehensive development of a whole service system. The first and most important assessment covers how capabilities are managed in recognised, critical management areas. During the assessment work, the organisation's competence for creating valid input information, which enables necessary vulnerability analysis, must be covered. Second, there must be the capability to store the valid information in a way that meets the requirements for CIP. Third, the capability to manage the organ that uses the valid information must be assessed. Fourth, an organisation must have the capability to predict and create scenarios, which requires valid information. Finally, an organisation must have the capability to manage feedback information, and most of all, manage the predetermined operations based on the CIP scenarios. The capacity to manage contractual environment processes requires a set of pre-defined capabilities. As Anteroinen (2013) stated, a 'capability is the ability or power to achieve a desired operational effect in a selected environment and to sustain this effect for a designated period (p. 13).

In the modern, network-based service chains, the commercial cooperation between the actors in the service supply chain is regulated with contracts. Contract management is divided into two major approaches. The first concentrates on the structural design of the agreed transaction; this approach focuses on the written contracts between different participating parties. These agreements are legally binding by nature (Lyons & Mehta, 1997). The second approach is more concerned with the relationships between the actors participating in the commercial cooperation. The main factor participating parties rely on is trust, which works as a safeguard for the coordination and control functions. The upside for participants in this approach is the positive outcome of the transaction, despite their possible vulnerability (Rousseau, Sitkin, Burt, & Camerer, 1998).

Following the author's approach to services, the supply chain for a service ecosystem consists of several systems and subsystems. As Vargo and Lusch (2004) stated for FP 6, the service is always the result of multi-actor efforts. The capability for managing all the interrelating contracts in an ecosystem can become extremely expensive if the structural approach is used. In addition, just a trust-based approach is hardly acceptable. After all, we are discussing critical infrastructure, and its vulnerability cannot be protected only with the element of trust.

There are also examples of reciprocal trust relationships based on mutually positive outcomes resulting from the active parties' actions (McCabe, Rigdon, & Smith, 2003). However, this model does not consider the possible role of third parties trying to take advantage of the two parties that have created a reciprocal trust relationship. In addition, the reciprocal altruism introduced by Trivers (1971), among others, demands several repeated interactions with known actors.

The contractual choices are linked to the industry in question, which affects the criticality of the industry, and possibly, the existing relationships between the actors within the industry. Contractual management should also consider the time-related phase observation, comprehension and prediction to which the critical process is

related. The four organisational functions – implementation, coordination, control and intelligence – also require a thorough assessment from the contractual management point of view. These decisions are affected by cultural, political and economic factors, as the main theories of international trade illustrate (Johanson & Vahlne, 2009; Sharma & Henriques, 2005; Buckley & Casson, 1985; Dunning, 1980;).

There are several examples of how CIP has failed with drastic consequences (Lewis, 2014; Crucitti, Latora, & Marchiori, 2004; Moteff & Parfomak, 2004; Rinaldi et al., 2001). The examples show how systems with linking and connected components create a web of systems and subsystems that are connected in a single critical infrastructure and between different critical infrastructures (Homeland Security Act, 2002). These systems and subsystems depend on each other physically, geographically, logically or in a cyber-based context, and a malfunction in one part of any system can have severe effects on the others. Business and economic opportunities and concerns largely define each system's domain (Homeland Security Act, 2002).

Relying only on the financial KPIs drawn from the business and economic opportunities and concerns offers an unambiguous metrics for assessing and managing infrastructure protection in each part of the system. The greatest financial losses are caused by cyber-espionage, which can have affect the whole (Edwards, 2014). To avoid these losses, constant monitoring and countermeasure activities are required, as Edwards (2014) suggested.

2.8 SUMMARY OF THE THEORETICAL FOUNDATION

This chapter illustrated the theoretical foundation of this dissertation. The key concepts, terms and existing gaps in the each of the research areas were introduced. The theoretical foundation is a combination of several managerial areas, and their importance for NSD was clarified in this chapter.

First, the disciplines of service and NSD were examined. In the first part, the importance of the service economy was examined and introduced, and a variety of research areas and methods in NSD were described. In the second part, the concept of CSR and its effects on NSD were opened, discussed and analysed.

Second, the concept of PPP was introduced. The role of PPPs in military organisations was discussed, and the current PPP in the FDF was outlined. A PPP creates a domain boundary to the existing service development. Thus, it is mandatory to understand its effects on the managerial processes and operational environment to understand the NSD, RM and CIP approaches.

Third, the managerial concept of RM was researched and introduced. In this part, the different requirements and RM processes were discussed, and possible shortfalls in the processes and requirements were analysed.

Fourth, the concept of CIP was developed. CIP is a service system component that enables the flow of information and goods under all situations and conditions. This subject clearly cannot be neglected in FDF domain research.

These four parts of the theoretical foundation are combined in the research work. The theoretical foundation of the dissertation is a cross-section of these elements, creating a single theoretical foundation. Each introduced part creates an independent system, but simultaneously, it is an important component of the whole NSD system. It is argued that these systems and the system of the systems demands a development method that enables multi-stakeholder NSD.

Due to the nature of services, the development work is abstract. A service is something that is produced and consumed simultaneously. Therefore the goal of the development work should be measured by the outcomes of the each process, not the process itself (Grönroos & Ravald, 2011). Thus, the success of the PPP is based on the performance of the developed system (Behn, & Kant, 1999). The RM literature on the other hand emphasises requirements elicitation and collection, which is a communication process between different stakeholders (Alexander & Beus-Dukic, 2009; Pasivirta & Kosola, 2005). As a discipline, RM offers a systematic technique that considers the existing stakeholder relations. Inter-functionality between the service providers depends on the communication between the stakeholders, as highlighted by Vargo and Lusch (2016) in FP 6.

If the NSD goals between the stakeholders are not clearly defined, the contents of the new services, relevant development processes and/or required resources cannot be clearly or adequately described. The result is an inefficient, and in many cases, unsuccessful implementation of new services, as well as interface and quality problems (Bullinger et al., 2003).

3

METHODOLOGY

The cross-disciplinary nature of the dissertation requires a research methodology that enables research across all four disciplines of NSD, RM, PPP and CIP in the FDF catering domain. The author's purpose was to offer the readers an opportunity to utilise the results and introduce a development technique that could be used in their domain, as Gomm, Hammersley and Foster (2000) suggested. The diversity of the study subject demands a methodology that is applicable to the separate but interdependent subjects covered in this dissertation.

3.1. METHODOLOGY AND METHOD OF THE DISSERTATION

A methodology consists of two components, as follows:

1. A methodology forms a theory defining how a research should be conducted; and

2. A method, which describes and defines a set of techniques and procedures by which research data are collected and analysed (Gill & Johnson, 2010).

The goal of this research was explorative, which determined the first framework for the philosophic decisions regarding the research ontology and epistemology.

The epistemological approach (theory about knowledge) the author chose was hermeneutics (Niiniluoto, 1980). Since the author used an iterative research method, the research questions in each paper were based on the results of the author's previous study. Despite the hermeneutic epistemology, the researcher used both inductive and deductive research approaches while collecting and analysing the research data (Wilson, 2014;Mark, Philip & Adrian, 2009). The deductive research approach begins with the creation of a universal view, followed by narrowing down the perspective; inductive research builds an overall view from details level to the larger scale (Gray, 2013). Although inductive and deductive research approaches are usually related to the realistic ontology (Niiniluoto, 1980), they were included to increase the research validity.

A hermeneutic approach builds on the relationships between specific research subjects and their interrelationships. The meanings and interrelationships form a structure with parts connected to each other and the whole. According to Siljander (1988), the research objective can only be understood from a dialogue between the individual elements and the whole. Thus, for Siljander (1988), a better understanding of the whole opens opportunities to understand its individual components, and vice versa.

The question posed by epistemology, 'How do we know what we know?', is based on empiricism. Empiricism highlights the role of evidence, especially that discovered in experiments (Niiniluoto 1980). Here, each case study was an experiment in reflection on pre-assumptions in research design.

The research observations were based on data collection in each of the cases, and the data were analysed using quantitative analysis methods. The data collection and analysis followed the research guidelines introduced by Yin (1981). A combination of deductive and inductive research approaches was used because the researcher was creating a conceptual framework, which was then tested in the three case studies.

There was a need for both approaches – deduction and induction – because the theoretical framework creation enabled further research, which was tested using the empirical data. Iterative research freed the researcher from the limitations usually related to the deductive approach, in terms of the use of deduction to create an axiom and a variety of conclusions based on it. If the axiom turns out to be false, all the conclusions following that axiom are false as a result (Bryman, 2015).

As the first research method, a thorough literature review was performed to create a valid research framework. In addition, there was a need to create a descriptive framework for the research. Without a comprehensive literature review, it would not be possible to compare case-study results to the existing research. The iterative approach in the review made it possible to open new interesting research paths, as Saunders (2003) suggested.

The articles covered in the literature review were both content-oriented and methodology-oriented papers. The former made it possible to connect the different disciplines, while the latter ones gave the opportunity to choose valid research design and methods for each discipline. The combination created a solid structure for this new research and made it possible to choose an approach that would support the final research design.

3.2 CASE STUDY

Case study is employed as a research method when in-depth reasoning behind an individual phenomenon is required (Zainal, 2007). In case studies, research is conducted in the context of the research subject. The combination of statistical and narrative methods in a single study, together with the use of empirical methods for case and data selection and causal conclusions, are a proof the versatility of the case study design (Harrison, Birks, Franklin, & Mills, 2017).

RM as a discipline takes into consideration an individual case in a single domain (Hull, Jackson, & Dick, 2011). Therefore, each domain needs to be studied in a way that recognises the domain restrictions affecting the case under research. PPP as a managerial perspective is generalistic by nature. Therefore, in this research, each case needed to be reviewed in a PPP framework, and the reviewed cases considered the general rules affecting the PPP context. According to Yin (1981),

> *As a research strategy, the distinguishing characteristic of the case study is that it attempts to examine: (a) a contemporary phenomenon in its real-life context, especially when (b) the boundaries between phenomenon and context are not clearly evident.*

A valid case study method demands a triangulation of the data, as Thumiki and Bulushi (2017) and Rothbauer (2008) suggested. There are three different types of triangulation, as follows:

1. Data triangulation;
2. Research triangulation; and
3. Methodological triangulation.

During a data-triangulation process, a researcher studies several sources of information to find common results regarding the research subject. Data triangulation includes the verification and analysis of these sources. In research triangulation to increase objectivity, a subject is researched by more than one researcher. Finally, in methodological triangulation more than one research method is used to find a solution to a problem.

In this dissertation, data triangulation helped in providing explanations for the findings in each of the cases and commonalities between the different cases. Methodological triangulation helped in increasing the validity and reliability of the results (Thumiki & Bulushi, 2017). Triangulation methods are described in Table 10.

Publication		Conceptual Paper 1	Conceptual Paper 1	Case 1	Case 2	Case 3
Triangulation Method						
	1) Data triangulation	x	x	x	x	x
	2) Research triangulation		x	x		x
	3) Methodological triangulation			x	x	x
Research Method						
	1)Conceptual analysis	x	x	x	x	x
	2) Simulation			x		
	3) Interview			x	x	x
	4) Documentation			x	x	x
	5) Observation			x	x	
Form of Data						
	1) Qualitative	x	x	x	x	x
	2) Quantitative			x	x	

Table 10 - Triangulation in the research

There has been criticism concerning the case study method's validity and reliability. In this dissertation, the author used both qualitative and quantitative data to enhance the results. Quantitative data gave a better opportunity to generalise the results in the further studies and use the results as KPIs, following the research objectives.

In this part of the dissertation, the author introduced the research methodology used in this study. In the first part, the ontology and epistemology of the research were introduced. In the second part, the data collection method – case study – was introduced and justified. This chapter gave the reader an opportunity to assess how the research results relate to the real-world problems and how well the results contribute to the scientific goals introduced in the beginning of the chapter. Despite the ongoing discussion and criticism concerning case study as a method, research by Eisenhardt and Graebner (2007), Flyvbjerg (2006), Gomm et al. (2000), Riege (2003) and Yin, (1981) support its usability in this dissertation. Since the purpose of the cases was to find specific requirements, it has been argued that use of case studies made it possible to find critical factors affecting NSD in the theoretical framework of PPP in the military domain using RM.

4

FINDINGS

In this chapter, the author summarises the contribution of the five published papers in the relation to the research objectives. In addition, each paper and its contribution to the theory building are presented.

The first two conceptual publications were based on literature reviews. This is acceptable because the research approach was deductive, the discipline under research is fragmented and future research demanded a valid research framework based on previous literature. The results of the conceptual analysis indicated the inter-functional nature of services as a phenomenon. Consequently, a need to recognise, assess and analyse how each macro- and micro-environment affects the domain a service is being developed in was clarified. The results of these two papers underlined a need to have a structured development mechanism that follows the predefined requirements.

During the study, it became clear that the share of combinations of probable factors affecting NSD is large and difficult to control. Therefore, the NSD process requires a methodology to measure the importance and value of factors affecting development work. This finding underlines previous results from NSD research and justifies the use of RM as a development technique: RM's purpose is to control vast amounts of inter-functional variables.

The proposed model, which is based on the research, also allowed the author to illustrate how these factors are connected. The author argued that these connections should be defined and managed using RM, and there is a theoretical rationale for utilising RM in NSD. The starting point for the development work in our model is a thorough macro- and micro-environmental analysis for all the research areas. This creates a basis for the development of domain assumptions as a part of RM. These domain assumptions work as constraints for incremental and discontinuous development (reactive and proactive, respectively), as illustrated by researchers like Johnson et al. (2008), Kotler (2007) and Olsen and Sallis (2006). They defined the NSD environment as an 'as-is' condition. Based on this and other previous studies (e.g. Sandén, 2007), the service promise could be used in the form of requirements.

The findings of the first publication indicated that, despite its similarities to service science as a discipline, RM is used surprisingly infrequently, if at all, among NSD practitioners. NSD has concentrated on small areas of development. Therefore, based on this research, we could argue that *RM is an underutilised development technique* among NSD practitioners outside the information and communication technology (ICT) industry.

The findings of the second publication showed that, in the partnership literature, the competitive process is seldom discussed. In the PPP context, the EU purchasing

directive stipulates a legal process for selecting partners under circumstances where the directive applies. The green Directive 2014/95 by Commission (2014) stated that the conditions and terms for performance of the contract must be formulated by the purchasing authority in descriptive documents (e.g. technical specification) so that all tenderers can consider them. In addition, there can be mechanisms for evaluating the partner's performance regularly. In all, the Commission has prepared a legal framework to implement PBC/PBL in PPPs, while the requirements definition must be open and clearly formulated in the documents for tendering. Again, this research supported using RM to create KPIs, which facilitate both PPP's efficiency and effectiveness in the military domain.

The next three publications were case studies. The first two cases, a university catering unit and Santahamina garrison, had significant similarities. Fixed and easily predictable numbers of consumers, public steering mechanisms as a basis for the service management and restricted competitive environments enabled similar research designs and conclusion comparison between the two cases, within the limits of the case study method. Following the principles laid-out by Yin (2013), the researchers used multiple data-collection methods.

In the third publication, the authors concentrated on wastage data, due to the importance of sustainability management for NSD. Increased green attitudes cannot be neglected if customer satisfaction aspirations and better financial results are to be achieved (Green, Chakrabarty & Whitten, 2007).

The findings indicated that the importance of contingent information as a source for NSD was high. This data should be presented to all participating parties in the most transparent manner. In his research regarding adaptive supply chains, Davidrajuh (2006) identified transparency as a mandatory component for achieving the greatest velocity and ability to manage variability. These elements are important if NSD's purpose of creating new, desired service outcomes in co-creation with customers is to be met. The analyses showed that the data, which are collected throughout the service processes, are crucial for NSD. The inter-functional and interdisciplinary nature of services demands knowledge of each participant's role in the outcome. Transparency in service production helps in creating a responsible corporate culture, which is line with customer requirements. Organisational development, which enables CSR in its various forms, is the result of a comprehensive, and most of all, constant continuous development of variables affecting the outcomes.

Front-line employees can also achieve positive results from the material flow and waste data measurement. The role of front-line employees necessitates a description of individual competences in the form of requirements, but this should not neglect systematic screening of operational efficiency and effectiveness metrics, as our research showed. These screening mechanisms should be implemented for all on-site activities in the production phases as an integral part of the workflow. Simple metrics like the efficiency ratio introduced in publication 3 help operators in starting to follow their material flow. This enables them to alter their production

procedures to meet all the stakeholder requirements sustainably. A daily comparison between the amount of dishes sold and the planned amount, measurement of unspecified waste and tighter portion control are just a few examples of easily adapted requirements-based screening mechanisms. In addition, more precise demand projections based on the historical data and utilisation of simulations founded on these data should be considered.

The results of the fourth publication underline both the need to use requirements as a basis for development and their usability to achieve better embeddedness between the PPP entities. Following the researcher's assumptions, much of the interaction between parties involved with PPP is automated, either in the form of data or processes. Therefore, there is a need to have a 'common ground', a set of predefined agreements that are not purely economically driven (Granovetter, 1985). The author refers to this common ground in the form of requirements as *embeddedness*. These predefined requirements are realised through capabilities/competences, which are utilised in the interaction following the principles stated by Grönroos (2009) and Vargo (2008), which demands transparent, variable and measurable metrics requirements.

The results of the publication indicated that, in the best-case situation, efficiency and effectiveness figures could be used to create an 'embeddedness ratio'. This would consider both service provider and service consumer needs, relying on transparent communication and social interaction. This gives an opportunity to follow both non-economic and economic activities based on a single, transparent metrics in an environment, combining commercial and non-commercial activities like the FDF and commercial catering operations.

Based on the results, it can be concluded that FDF catering operations create KPIs, which would enable inter-functional cooperation and service development with the help of the embeddedness ratio. These KPIs would support both efficiency and effectiveness in PPP catering operations better than the individual metrics currently in use do. In addition, the results clearly indicated a need to streamline operations and alter the principal foundation of the contract in the case domain.

The fifth publication illustrated two domain-specific cases. An assessment model required empirical data, which were collected from the previous documentation to validate the introduced model. The data collection emphasised financial aspects, as financial requirements are crucial in the FDF domain. The subject in question – CIP – set limitations on the data collection due to the sensitivity of the subject for the organisations possibly affected by the threats to their infrastructure.

Because a supply chain consists of many multinational actors, each player is potentially a critical node due to the efficiency standards, which are defined by financial requirements. However, unless an individual node affects predetermined critical processes in the critical domain, a total collapse of the supply chain is not foreseeable. Thus, there is a need for a systematic method that enables the assessment of

entire systems and their subsystems. This requires a description of the capabilities in the form of requirements, which are needed to manage both the functions and basic components of system-wide vulnerability and risk management. Without these descriptions, there is no possibility of calculating the financial effects of CIP or assessing the contractual environment and its effects on NSD.

5

DISCUSSION AND CONCLUSIONS

The purpose of this research was to define how RM could be used in the interdisciplinary subjects, such as service, as a development and management technique. From a practical perspective, the objective of this dissertation was to explore institutional catering operations and show how individual KPIs could be used as metrics in the form of requirements in the service development process. From a scientific perspective, this research attempted to provide a view that considered the variables affecting the service outcome from multiple stakeholder perspectives.

The aim of this dissertation was to reach the following ROs:

1. Does RM create KPIs that enable cohesiveness between the strategic partners, supporting both the efficiency and effectiveness of PPP in catering operations?

2. Is it possible to use RM as a development technique in NSD?

3. What are the mechanisms that should be used to create sufficient KPIs in the contractual environment in which these operations are being run?

To meet the research objectives, five studies were conducted. RO 1, *'Does RM create KPIs that enable cohesiveness between the strategic partners, supporting both the efficiency and effectiveness of PPP in catering operations?'*, was covered in the conceptual publications 1 and 2 and case 2.

The research in publication 1 was based on a notion that, in a rapidly moving business environment, service companies struggle to keep up with changes in customer needs and the business context. According to previous research (Sanden, 2007; Olsen & Sallis, 2006), NSD plays an important role for service companies and service as an industry. According to Sanden (2007), in service organisations, 40% of sales, on average, are created by service products that were developed in the past 5 years.

Constant, incremental service development is needed, but simultaneously, there is a need for wider, discontinuous development. Although there are existing frameworks for NSD, one that combines the best practices from the disciplines of project management and RM is in need of further study.

Situations arise even when development tasks are managed. The Project Management Body of Knowledge (PMBOK) guidelines create an operating environment that reduces already acknowledged difficulties in NSD in a multi-stakeholder environment. Based on the literature review, this paper presented an RM-centric construct, which was created to manage and further develop NSD. This construct was critically assessed based on the literature review findings. The importance of system-

atic development, which allows different stakeholder groups to participate in development, was explained.

The purpose of publication 1 was to increase the understanding of both the NSD process and the nature of services as delivered to customers. In this publication, the author studied how RM combined with the PMBOK framework could be utilised more efficiently for NSD. In the research, the author tried to address the following question:

> *How should a performance requirement for the final (service) product be translated into the performance requirements for the suppliers who provide critical components?* (Kim, Cohen, & Netessine, 2007, p. 1844).

Conceptual development is not a widely used approach in NSD, and the clear structural framework for NSD is not based on the previous research (Syson & Perks, 2004; Jones, 1995). Therefore, the author combined existing and validated development models to create a research framework. These generic models, such as PMBOK's model (Project Management Institute, 2014) for project management, ITIL's for information technology (IT) service development (Publishing, V. H., 2007), as well as industry-specific ones from the FDF (Anteroinen, 2013), should be used and combined into one comprehensive meta-framework.

RO 1 was also researched in the second conceptual paper. The second publication covered PPP and PBC/PBL as a performance measurement method in PPP. PBC/PBL is an area of management focuses on the outputs, quality, and most importantly, outcomes of service provisions. If the requirements are not unambiguously expressed and managed, there are several risks that can materialise as a failure in the service production process. This paper explored how RM could support PCB/PBL in public services through a conceptual approach and literature study.

In the past 25 years, there have been more than 1300 new PPP contracts established in the EU worth €5 million or more. The monetary value of these contracts has exceeded €250 billion (Kappeler & Nemoz, 2010). The role of PPP has increased to cover all industries and functions in Western societies (Krtalic & Kelebuda, 2010). Areas that have traditionally been publicly run core functions of society, such as the military, security and health care, have utilised several PPPs to perform their tasks.

As the role of PPPs has grown, theoretical studies between these two important drivers in society, public and private sectors, are too broad without the necessary criticism, and too often, the arguments follow the paths developed in previous studies (Jacobson & Choi, 2008). Although different forms of PPPs, questions about the responsibilities and roles of publicly funded, profit-generating enterprises without a democratic responsibility to the citizens have increased, causing heated debate. However, privatisation has also been shown to deliver cost savings, more effective and efficient service delivery, and in some cases, an alternative form of financing for public infrastructure and services (Keating & Keating, 2013). While the core of this study was PBC/PBL and RM, without a connection to PPP, the whole phenomenon of PBC/PBL would have been irrelevant and loose. A reflection point is needed, since the key difference between traditional and performance-based contracting

is the clear separation between the customer's expectations and deliverer's implementation of service. The findings for case 2 showed the opportunities of a requirements-based approach to KPI creation as a base for PBC/PBL.

RO 2, *'Is it possible to use RM in NSD?'*, was covered in cases 1 and 2. Case 1 examined the idea of Sustainable NSD (SNSD), following the conclusions by Aragon-Correa and Rubio-Lopez (2007). The publication explored their conclusions in the context of food and hospitality services, which concern the management of material and people. Specifically, we used a restaurant case study to ask the following question: How can waste management data be used to increase the efficiency and effectiveness of hospitality operations in the PPP context?

The research suggested that SNSD is not only part of the future, but also an important part of contemporary service operations. However, evaluation methods in this field remain underdeveloped. This publication offered one example of how contingent data on operation performance and waste streams could be used to improve SNSD. Specifically, it quantified the amount of food waste produced by a typical managed catering business unit to evaluate these data as a measurement of the efficiency of operations management. SNSD was studied empirically by employing a case study approach. The authors used data simulation to establish insights into SNSD. Another purpose was creating new, easily applicable metrics for the future SNSD work outside the case study unit.

The study contributed to the area of NSD by offering the utility of a case study–based simulation as a development technique. The results indicated how small changes in menu planning, production processes and demand management could create positive and significant financial and environmental outcomes. The authors' results linked the literatures on contingent operations awareness, the triple bottom line paradigm and SNSD to create a baseline condition for future sustainable hospitality development.

RO 2, *'Is it possible to use RM in NSD and does use of RM support both efficiency and effectiveness of PPP in catering operations?'*, and RO 3, *'What are the mechanisms that should be used to create sufficient KPIs in the contractual environment in which these operations are being run?'*, were addressed in case 2. In this publication, the author indicated how RM could be utilised in connection to a service performance measurement system. PPP in FDF catering operations was studied as a case example. This research introduced a practical implication – a mechanism that can be utilised in KPI creation.

PPP is a widely studied subject, but questions remain referring to the responsibilities and overall roles of these profit-generating enterprises; most importantly, debate has arisen concerning the management of the relationship. This debate reflects the ideological background of the debate participants and easily takes the focus away from the possible, proven benefits of the PPP.

Evidence from the previous studies indicates that there should be a single 'power-by-the-hour' metrics unit which enables the transparent follow up of performance-based operations (Smith, 2013;Neely, 2007, 2008). This research highlighted requirements' value in the creation of economic efficiency and effectiveness from the

end-user point of view and the reciprocal value creation between inter-functional service systems. It was concluded that a focus on a service's outcome can produce information that enhances inter-functional cooperation between PPP stakeholders.

To address RO 3, *'What are the mechanisms that should be used to create sufficient KPIs in the contractual environment in which these operations are being run?*, case 2 was conducted. The aim of this case was to suggest practical implications for creating KPIs. CIP was the subject of case 3, which focussed on the contractual environment in which the service supply chains operate.

Current global trading operates in an environment that is highly vulnerable to abnormalities in all parts of the supply chain. International business demands seamless service and IT infrastructure throughout the supply chain. However, dependencies between different parts of this vulnerable ecosystem form a fragile web; this is a lifeline for modern societies, and therefore, it requires protection. While the web is a necessity for its members, it is simultaneously vulnerable to malfunctions. Such malfunctions have direct and indirect effects on all the network participants. No economies are immune to these effects, and furthermore, none of them can turn a blind eye to the existing threat.

Combining the systems-wide approach and explaining the theoretical background behind the various models creates a comprehensive model that assists in CIP. It shows that individual supply chains are a collection of extremely complex systems and subsystems backed up with sometimes contradicting theories and practices.

The research on which the five publications is based has made it possible to propose a methodology for utilising NSD in PPP. A methodology consists of the 'methods, rules, and postulates employed by a discipline', in this case, service science (Merriam-Webster, 2017). This is an initiated contribution to service science, as stated in the introduction of this dissertation. The results indicate how these variables affect each other, and how the complexity of the subject can be managed despite the vast number of variables affecting the outcome. The five published publications give evidence that this interdisciplinary subject demands a holistic approach for development. There is a need to recognise the number of connections, their interrelationships and importance to each other from the end-user perspective.

The author argues that development work must consider *all the recognised variables* from the both the micro- and macro-environment. This simply statement is far from being self-evident. In an RM framework, these variables form either domain restrictions or domain assumptions. Without a thorough requirement validation and verification from each participating entity, it is difficult to continue system-wide, systematic development based on the 'as-is' state of the development ecosystem.

The development framework first emerged in the results of publications 1 and 2. In these publications, the author created a high-level framework for development work. Following the epistemological approach, each part of the framework was studied further in the following publications. The framework for this development is introduced in Figure 4.

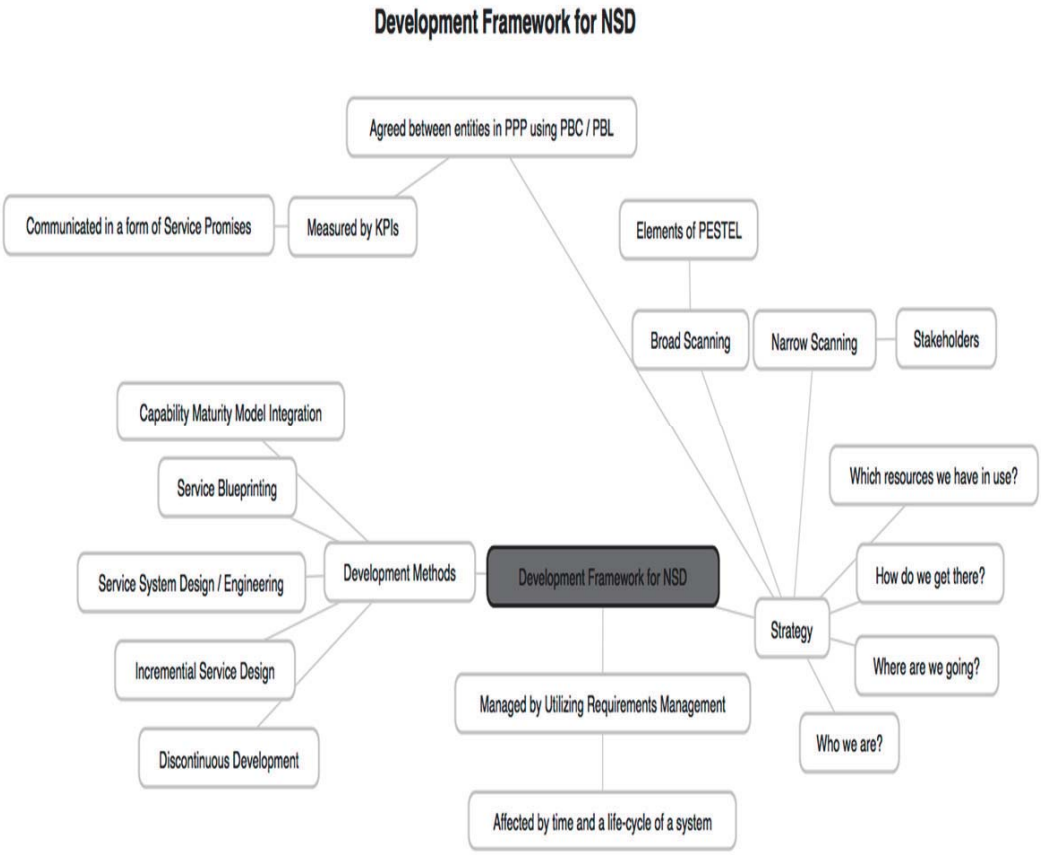

Figure 4 - Development framework for NSD

The suitability, advantages and disadvantages of the different development methods in the research domains were studied prior to the case studies. Conclusions on the suitability of each method were highlighted in section 2.2. Despite their restrictions for this research, they cannot be excluded from the overall development framework due to their overall relevance to NSD.

Strategy as a subject was not covered in the dissertation. Still, as the description of the research domain in chapter 1 explained, it forms the basis for the development work in this research domain. The author followed the guidelines published on Finland's MOD report, *Puolustusministeriön Starateginen Suunnitelma* (Puolustusministeriö, 2011). As a strategy, the FSF rely on their strategic partners for many of their critical functions, such as catering operations. These strategic partners are commercially managed catering operators with commercial goals, operating in competitive environment under stabile, normal conditions in Finnish society. Since they are strategic partners, they need to consider their cooperation with the FDF under possible crises, but at the same time, they need to meet their commercial goals and investors' expectations. These goals and expectations are formed, followed and developed based on both broad and narrow scanning.

The questions related to the strategy are part of the so-called design school's approach to strategic management, as stated by Mintzberg, Ahlstrand and Lampel (2009). This approach emphasises a deliberate process in strategy formulation that follows the principles of RM, and vice versa. The use of PBC/PBL was justified in publication 2. Related to this, case 2 showed the opportunities of the requirement-based KPIs as a basis for successful agreement between PPP counterparts.

In the service-development process in PPP in the military domain, the ecosystem and all the framework parts create their own subsystems. The introduced framework should be viewed as a system-of-systems. It forms the high-end requirements for the development work and creates domain restrictions in PPP in the military domain.

To apply the methodology, it is necessary to divide the military domain into its systems. Based on the research, NSD in the military domain can be divided into multiple elements, which all create subsystems and sets of requirements. These elements and their connections are presented in Figure 5.

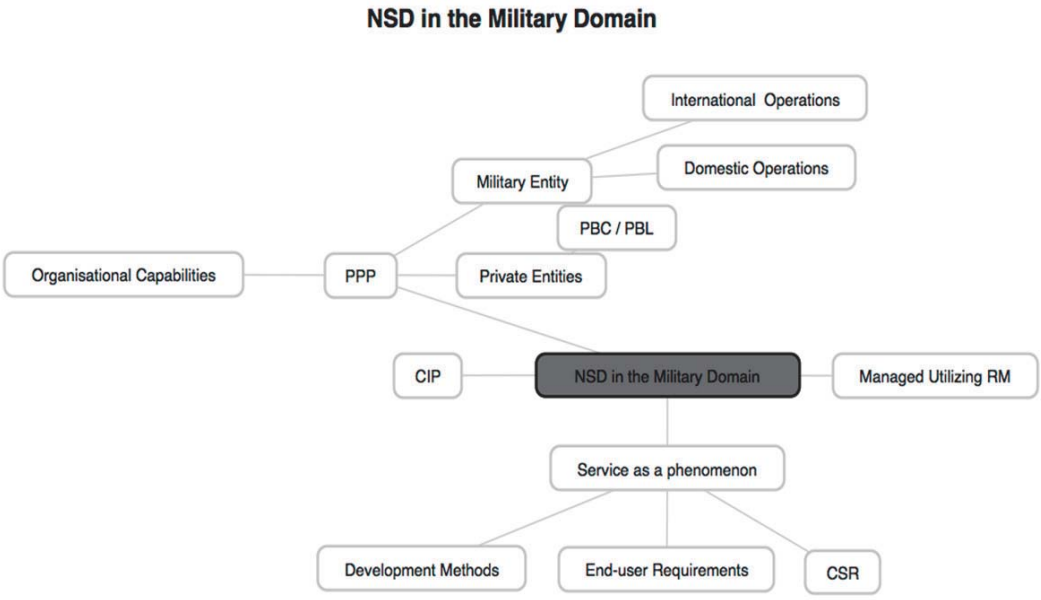

Figure 5 - NSD framework in the military domain

Based on the research, it can be concluded that NSD in the military domain must consider several elements. First, the substantial differences between the product development and NSD highlight the need for an inter-functional and multidisciplinary approach to the development process. Service as a phenomenon demands an outcome-based development approach, which must be assessed and managed using predefined performance-related metrics. This notion steers the development toward the outcome-based result, namely requirements. The development framework must follow the domain-specific, predefined end-user requirements. These requirements form customer requirements and domain restrictions, and as the author explained in

sections 2.2 and 2.6, they should be managed in the framework of SD-Logic. Secondly, the agreement between the service provider and FDF creates unambiguous end-user requirements for the catering operations. These requirements are presented in the form of the amount of energy served, cost of individual ingredients and nutritional values. These requirements define the domain restrictions, as concluded in case 2. Third, consumers' environmental awareness and the FDF's commitment to the international treaties demands the assessment of CSR activities in the development work. The role of CSR was highlighted in case 1. Fourth, each entity either forms a critical infrastructure or is a part of it, as the results of case 3 indicate. For the PPP part of the model, there is a need to define the required capabilities that enable co-operation between the PPP entities. Again, these capabilities must meet the restrictions of the PPP in the specific operating domain. On the military side of the PPP, international and domestic operations create operating domains with different preconditions, as the author stated in section 2.5.2. This proposed model is an iterative model, following the principles of RM elicitation and modelling principles introduced in section 2.6.

It is necessary to keep in mind that the two frameworks are transverse and interfunctional. Each subsystem creates a set of requirements, and there cannot be contradictions between the requirements drawn from any entity if NSD is to be successful. The metrics drawn from the end-user (customer) requirements should be viewed as a starting point for the development work. Service is developed and consumed simultaneously, so all the requirements must be predefined while considering the approach to the management of the development work. The two frameworks can be used as a theoretical *and* practical framework for the development work, adding valuable insights to NSD, especially in PPP in the military domain. This framework can be used as an operational concept in NSD in PPP in the military domain, thereby encapsulating the practical contribution goal of the dissertation.

To explain and clarify the findings of the published papers, the results were combined. Their relationships to the existing theory and existing gaps in the research area were illustrated. The validity of the development methodology and results were reflected on in terms of the previous research and the author's research. The results of the individual case studies were described, and their association to the research questions was clarified. In addition, a mechanism for NSD in the PPP in the military domain was illustrated, and a framework for future development work was introduced. The rationale for using RM as a service development method in the military domain was explained and supported with the results from the individual case studies.

The findings suggest that PPP, especially in the military domain, demands an NSD methodology that considers the inter-functionality and cross-disciplinary nature of service as a phenomenon. As a managerial approach, RM forms a base for the KPIs needed to manage this development work and the transparency this method requires, thereby diminishing the obstacles for NSD. As an outcome, the author came to the conclusion that there is a need for each one of the entities to manage a unique set of requirements, which cannot contradict each other.

The findings of this dissertation indicated that combining the system-wide approach and explaining the theoretical background behind the various models creates a comprehensive model that facilitates NSD. It showed that individual service provisions are a collection of extremely complex systems and subsystems backed up with sometimes contradictory theories and practices. In addition, each entity must have predefined competences (in the form of requirements) for managing the RM process and operations to achieve the set development goal.

6

EVALUATION OF THE RESEARCH'S VALIDITY AND RELIABILITY

In this chapter, the validity and reliability of the research are assessed. The chosen research ontology and research method are discussed and explained from the research validity perspective. Possible validity and reliability concerns are explained and reflected on in terms of the research.

6.1 VALIDITY OF THE RESEARCH

To assess a study's validity, there is a need to evaluate the ontology and epistemology of the research. Ontology refers to the 'reality' of the research subject, while epistemology is the relationship that connects the researcher and that reality (Healy & Perry, 2000). The methodology answers the need to address research objectives while meeting the needs of the chosen ontology and epistemology approaches. In this dissertation, the ontology was based on the hermeneutic philosophy.

The hermeneutic research philosophy emphasises the contextual relationships of the research subject (Palmer, 1969). An abstract subject in the form of requirements requires the clarification of each requirement in a specific context (Mantzavinos, 2016). As a managerial method, RM requires research on an individual domain and domain restrictions affecting the case under research. This approach validated the heuristic ontology approach, thereby increasing the validity of the research.

The validity of the hermeneutic ontology approach this dissertation utilised and its effects on the validity were maximised by following the iterative principles of a hermeneutic circle (Bleicher, 2017; Boell & Cecez-Kecmanovic, 2010). A hermeneutic circle represents the process of knowledge creation combined with further development of the research subject. The use of the case studies as a research method increased the knowledge of the parts, enabling comparison to the whole.

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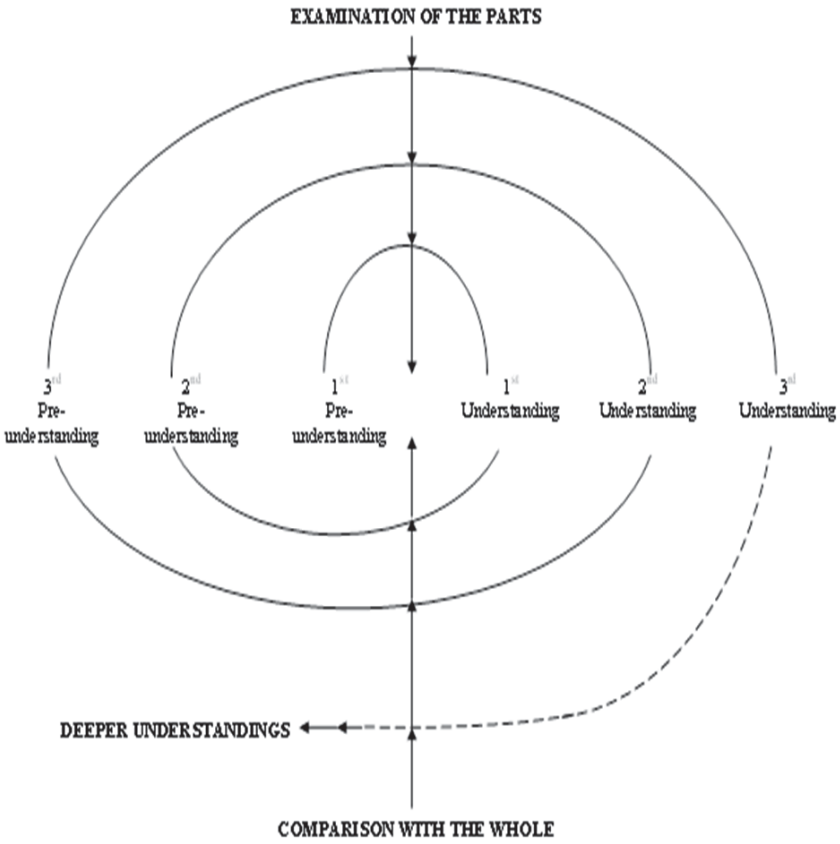

Figure 6 - Hermeneutic circle, Dilthey (1979)

Constructive validity refers to the question of whether a measure used to assess a concept truly reflects the concept it is supposed to denote (Bryman, 2015). Here, the iterative research approach, following the principles of the chosen epistemology, required a comprehensive evaluation of a subject.

This comprehensive evaluation was conducted in three ways. First, the research was based on the comprehensive conceptual analysis of the research subject, as illustrated in publications 1 and 2. Second, data triangulation was used in each case study to avoid problems relating to the constructive validity. Third, combinations of quantitative and qualitative data collection were used to further avoid possible negative issues relating to the constructive validity of the research. The inclusion of qualitative data increased the opportunity of assessing alternative explanations for the results. This diminished the possible misinterpretation of the results, thereby increasing the internal validity (Teddlie & Tashakkori, 2009).

External validity relates to the generalisation of the results. Traditionally, the external validity and generalisation of the results are based on the assumptions, analogy with nature and existence of natural laws. If such analogies are presented in the research, generalisation of the results across different research settings is valid (Ferguson, 2004).

Analysing the data from an individual case study is at the heart of theory building for case studies (Eisenhardt & Graebner, 2007). Generalisation of the research results based on statistical information is accepted when the sample population is truly representative of the population researcher assumes it represents (Lynch, 1982). Case studies in this dissertation covered the research population in a statistically accepted manner and conclusions can be withdrawn to the more general level. It can be stated that a thorough quantitative analysis based on the research data gave the opportunity to answer external validity concerns in the research's case studies. Specific concerns relating to the case study methodology and external validity, such as the research setting and research sample, must be considered while interpreting and generalising the results (Bryman, 2004; Yin, 1994). The structured form of managed catering operations increased the accuracy of the research setting, thereby enhancing the external validity. In addition, the research sample represented the population in a statistically acceptable manner.

The third case study on CIP was a conceptual analysis. The research results' generalisation is more difficult in such a case, except in the form of the analytical generalisation. The analytical generalisation results of the individual case studies should be compared to the previously developed theory, as introduced by Yin (1994). The analytical generalisation in the third case study was based on the previous theory, introduced, for example, by Zaerens (2015), Nissinen (2015) and Sonnenwald and Pierce (2000).

In this section, the validity of the case study as a research methodology in the field of service science was clarified. This is in line with the previous service science research on the areas of SD-Logic and Nordic the School of Marketing, which formed the philosophical background for the research.

6.2. RELIABILITY OF THE RESEARCH

Research reliability is concerned with whether a forthcoming study yields similar results to previous presented research (Saunders et al., 2012; Yin, 1994). In a study that fulfils scientific reliability, there is an opportunity to reach similar insights if research is conducted following the introduced research steps (Gibbert, Ruigrok & Wicki, 2008). Research reliability is also linked to the stability of the results over time and similarity of the results in the given time (Golafshani, 2003). The key element in research reliability is to presenting research results in a manner that is fully transparent and gives the opportunity to repeat the research if a researcher wishes to do so. Practical factors affecting the research reliability are participant or researcher related.

Researcher bias in the case study data collection was reduced by using research assistants. These assistants were trained and instructed thoroughly to systemise the data collection. The data collection process is introduced in the publications. To reduce participant bias, a systematic random sample was used when selecting individuals participating to the research. The collected data were recorded on the questionnaire templates and crosschecked with the employees in the case study units to diminish misinterpretation. These templates were based on the data from the existing menu

management system and Enterprise Resource System (ERP), and these data can be utilised for future research.

The transparency of the research was increased by thorough illustration of the research framework in each of the publications. The results of case study 2 were also introduced to the research sponsor before the publication process, and a summary of the results was published in the FDF information system. The abstracts of each publication were also peer-to-peer reviewed as conference papers before the publication process. This gave the opportunity to discuss the subject matter, thereby enhancing the transparency of the research process.

The reliability of case study 3 is based on the comprehensive literature review and the transparent approach to introducing the cases. The introduction of the mathematical formulas gives the possibility to conduct future research and replicate the research in the CIP area (Gibbert et al., 2008).

7

RECOMMENDATIONS FOR FUTURE RESEARCH

This dissertation proposed a model for NSD in the PPP context. Future research in this area should focus on the existing project management methods, such as PMBOK, and their utilisation for NSD. Research on the dependence relationships introduced in the proposed NSD model using structural equation modelling would enhance the usability of the model during the development life cycles.

The research findings are based on the one industry sector – catering operations. More empirical evidence is needed to increase the external validity of the proposed model for PPP. Future research should cover industry sectors outside catering to meet this goal. Studies concerning the other service development methods in the PPP context would increase the validity of the RM as a development method in the service area.

This dissertation covered contractual management issues in the specific area of CIP. However, the research covered only two cases in this domain. A thorough comparative study of differences in the contractual environment, performance- versus process-oriented contracts and these contracts' effects on successful PPP service development would bring the valuable insights to the research areas of NSD and CIP. This type of study would enable scholars to empirically assess the variances between the existing contractual models and that proposed in this dissertation.

For capability/competence development, a psychometric assessment of individual competences would narrow the research perspective and offer first-hand information on organisational competence development. A description of the capability/competence demands would increase the scientific evidence on how to recognise the following:

1. Interfunctional and multidisciplinary human connections in an NSD system;
2. The necessary capabilities/competences related to such connections; and
3. Which requirement-based human resources service systems need.

Future research on how these areas are managed and developed following the guidelines of an RM-based performance measurement system should be conducted. This would open a research path on individual performance measurement systems based on well-defined requirements. Research in this area would optimise the ability to address crisis readiness needs and simultaneous peacetime operational requirements.

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ORIGINAL PUBLICATIONS

I

New Service Development: Structured model and development management in hospitality industry, publication date Jul 19, 2014 publication description Euro-CHRIE 2014

New Service Development: Structured model and development management in hospitality industry

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Abstract

In a rapidly moving business environment, service companies struggle to keep up with the pace of changes in customer needs and business environment. Constant, incremental service development is a must, but simultaneously there is a need for wider, discontinuous development. Although there are existing frameworks for the New Service Development, one, which combines best practices from discipline of project management and requirements management, does not exist. Situation occurs despite the fact that development tasks managed according to PMBOK guidelines create an operating environment, which reduces already acknowledged difficulties in NSD in a multi stakeholder environment. Based on extensive literature review this paper presents a requirements management centric model, which was created to manage and further develop New Service Development. This model is critically assessed based on the literature review findings. Importance of the systematic development, which allows different stakeholder groups to participate in development, became obvious. Then again more thorough, statistical, empirical study is required to back-up these initial findings.

Key Words: New Service Development, Service Science, Requirements Management, Stakeholder Management

Theme: Theme 6 - Futures Topics, coping with innovation and change

Introduction

Research area called New Service Development (NSD) tries to find answers to issues relating services and their development. Previous research (e.g. Olsen & Sallis, 2006; Sanden, 2007;) indicates that New Service Development plays a crucial role for service companies. According to Sanden (2007) in service organisations 40% of sales on the average are created by service products that are developed during the past 5 years.

The purpose of this paper is to increase understanding of both process of New Service Development (NSD) and the nature of services as delivered to customers. In this paper, author has studied how requirements management combined with PMBOK framework could be utilized more efficiently to New Service Development (NSD). During the research author tries to find an answer to a question:

> "How should a performance requirement for the final (service) product be translated into the performance requirements for the suppliers who provide critical components?" (Kim & Cohen et al., 2007, p. 1844).

Conceptual development is not a widely used approach in NSD and clear structural framework for NSD is not based on the previous research (Jones, 1995; Syson & Perks, 2004). Therefore author has combined existing and validated development models in order to create a research framework. These generic models, such as PMBOK's model (Institute, 2012) for project management, and ITIL's for IT-service development, (Publishing, V. H., 2007) and industry specific ones from Finnish Defence Forces (Anteroinen, 2012) should be used and combined to one comprehensive meta framework.

In this research author follows the guidelines published on Finland's Ministry of Defence report "Puolustusministeriön Starateginen Suunnitelma" (2011). Finnish Defence Forces relies on their strategic partnes on many of its critical functions, such as its catering operations. These strategic partnes are commercially managed catering operators, who have commercial goals and who operate in competitve environment under stabile, normal conditions in the Finnish society. Since they are strategic partners, they need to take in to account their co-operation with the Finnish Defence Forces under possible crises but at the same time they need to meet their commercial goals and investors expectations.

Many companies face constantly service development problems. Since new services developed by firms are not clearly defined, contents of the new services, relevant development processes and/or required resources are not clearly or adequately described. Result of all of this is a non-efficient and, in many cases unsuccessful implementation of new services as well as interface and quality problems. (Bullinger & Fähnrich et al. 2003.) The previous NSD research has concentrated on small pockets of knowledge in the area of service science, but framework, or an umbrella that would collect the existing development tools

together, is lacking. However, previous research has showed the importance of the NSD on their area of research. Some of the findings of these researches are illustrated on a table 1.

Table 1. Research areas within NSD

Research area, Author(s),	**Findings**
Discontinuous New Service Development Johne & Storey (1998)	Discontinuous NSD research has focused on -the corporate environment -the process itself; - the people involved; - analysis of opportunities; - development and - implementation
Market Scanning Olsen & Sallis (2006)	Differences between narrow and broad scanning - customers play a more active role in the service development process - narrow scanning has a strong positive effect on profitability through incremental service adaptation - broad scanning has a weak but significant effect on profitability through incremental service adaptation, and broad scanning positively influences spin-off knowledge
A framework for marketing management Kotler & Keller (2007)	Service as a development object - simultaneous consumption and production of service products - vast amount of uncontrollable variables affecting both, consumption and production - multi stakeholder environment - contradicting goals among stakeholders - ambiguity in SLA:s (Service Level Agreements) - lack of coherent theoretical background for NSD
Emergence of innovations in services Toivonen & Tuominen (2009)	Difficulties on NSD from organisational perspective - lack of organized R&D department in service companies - difficulties of recognizing service innovations due to a co-creation process with the customer - subjectivity of experiences, so improvement is more difficult to detect

Despite the lack of development framework and obstacles this situation creates, there is obviously a set of benefits that accrue from providing new services. If NSD is successful, benefits exceed development investments in several ways:

1. enhancing the profitability of existing offerings
2. attracting new customers to the firm
3. improving the loyalty of existing customers
4. opening markets of opportunity

(Menor & Tatikonda et al., 2002)

Development discipline: Service Science

Service science aims to develop a general framework and theory of services with well-defined questions, tools, methods and practical implications. Service science studies service management in a multi stakeholder, inter-functional environment, which form service systems. These systems co-create value within complex configurations of resources. (Vargo & Maglio et al., 2008.) It is a study of individual and organisational capacity together with equipment. These services are developed in an inter-functional environment through co-creation processes with a customer (Spohrer & Maglio, 2008;Grönroos, 2011; Brax, 2013).

Term "Service ecosystem" is used to describe inter-functionality in research and inter-functionality in practice (Ng & Maull et al., 2009; Grönroos, 2011). One must decide, does he accept individuals and members of a same organisation as a part of the ecosystem, but in our case, members of the ecosystem can represent same organisation. One of the reasons for this is that the organisation-wide importance of process development oriented new service development is well clarified by Parker (2012). His study indicates that only 5% of the company activities added value to end user, some 35 % were "necessary" non-value adding activities and 60 % added no value for the customer at all (Parker, 2012). Therefore, recognising valuable roles within a service ecosystem is a good and practical starting point for the work to make sense of the relationships between different functions and functional boundaries. Economic exchange and revenue creation in a commercial organisation depends on voluntary, reciprocal value creation between service systems. During this chain of processes all the actors in service creation must willingly interact, and all service systems must be improved. (Smith & Fischbacher, 2005; Spohrer &Vargo et al., 2008.)

New Service Development

Our current understanding of the critical resources and activities to develop new services is not at the adequate level, when keeping in mind New Service Development's importance as a service competitiveness driver (Menor & Tatikonda et al.,2002). Although New Service Development is covered in present-day academic literature, research subject is not as well covered as in goods development (Bullinger & Fähnrich et al. 2003). Especially hospitality industry, which our primary study catering is part of, NSD is not according to our review that well covered. Jones´(1995) study on in flight catering discusses the issue, but not from requirements managements perspective.

NSD has its legacy on NPD (New Product Development) and therefore development methods still follow NPD development framework and as Johnson et.al. (2000) stated at the beginning of the century that:

> "…NSD research is at the same stage today as NPD stood during the early 1970s"
> (Johnson et.al, 2000, p. 6).

Requirements management

Requirements are decisions concerning the desired state of a future system and most of all communicated between different stakeholders. Among these stakeholders are potential and existing customers and end users. More than 70 percent of projects contain at least 100 requirements, and 20 percent of projects contain at least 1,000 (Project Management Institute, 2014). These requirements from different stakeholders can be potentially incomplete, inconsistent and conflicting between stakeholders, but they need to be transformed into a complete set of high quality requirements (Aurum & Wohlin, 2005). These high-quality requirements should be developed by collaborative work among stakeholders (Alexander & Beus-Dukic, 2009).

Table 2. Requirement definitions

	Definition
Alexander & Beus-Dukic (2009)	Variable condition of a (class of) **product** or **system,** initially false, that must be made become true by the development project. Traditionally written is a style such as "The system shall do XYZ", for inclusion in a (commercial) contract
Vogel et.al.,(2011)	1. a condition or capability needed by a user to solve a problem or achieve an objective 2. a condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed document 3. a documented representation of a condition or capability as in (1) or (2)

These definitions do not take a stance on subject to be developed. Developed subject can be an operant or operand resource, terms very often used by service researchers Vargo and Lush (2004). Use of requirements also answers the question "what" in stead of "how", following the Vargo's and Lusch's Foundational premise 10, illustrated in Vargo and Maglio (2008):

> "Value is always uniquely and phenomenologically determined by the beneficiary"

Requirements management literature (Pasivirta & Kosola, 2007; Alexander & Beus-Dukic, 2009) on the other hand emphasises requirements elicitation, which is a communication process between different stakeholders. If a goal oriented requirements management is the main development tool, as in our model, the first obvious step, following PMBOK framework (Institute, 2008) would be to define the most important, inter-functional stakeholder connections. Johnsson and Menor (2000) emphasise iterative and cyclical approach in NSD. This is a statement that follows the approved and basic principles of requirements management. These so-called spiral models are at present practically unknown as a method for developing services. Bullinger & Fähnrich et.al. (2003) recon that Shostak and Kingman-Brundage's model (1991) is one of a very few exceptions.

Abstract, co-created services need to have specific, detailed and most of all common outcome or common goal focused requirements. This can become very difficult if a service provider has not identified necessary links between stakeholders (Lormans & van Dijk et al., 2004). Therefore we must accept the multi stakeholder approach in our work. This approach is well reasoned, as Scheuing and Johnson (1989) show, and whose work is well refered and accepted among NSD researchers. These stakeholders' needs in NSD should be defined using requirements management as a primary development tool. This part of the NSD is also illustarted on a study by Fischbacher and Smith (2005):

> "Multiple stakeholder involvement places a growing emphasis on the need for new service development (NSD) managers to be skilled in managing complex, multi-layered and multi-faceted processes, often without legimate power"
> (Fischbacher & Smith, 2005, p. 1025)

If co-creating value and the benefits are not made explicitly clear, there is a risk that possible conflicts may occur due to different stakeholders delivering to different perceived value. Requirements management plays such an essential role in our framework, since 32% of project failure (of all the projects) is based on inaccurate requirement elicitation (Project Management Institute, 2014). Since service, by the definition author follows, is a process and the end-product is co-created with a customer, we actually manage knowledge of the benefits created during simultaneous co-creation process (Vargo, 2008).

If requirements are not unambiguously expressed, there are several risks, which can materialize in a NSD process or service production process. Almefelt and Berglund (2006) list several risks based on their study on services in co-creation in automotive industry.

These risks include:

1. Failure of the requirements specification to highlight the key issues for development, resulting in different interpretation by different parties.
2. Insufficient knowledge about requirements, or their context, limiting the holistic view needed to develop attractive solutions.
3. Late introduction or changes of requirements and features, causing expensive changes, project delays, and affected product attribute balance.
4. Insufficient follow-up of the requirements specification fulfilment, along with lack of function or attribute responsibilities, resulting in driving factors being lost during the development.
5. Mismatch between the development competencies available at the car manufacturer or at the system supplier and the needs of the specific project, affecting the development leadership and the ability to develop solutions meeting the requirements.
6. Unclear roles, resulting in inefficient work-split and division of responsibilities.
7. Communication problems, intra-company as well as extra-company, leading to inefficient requirements management.

(Almefelt & Berglund et al., 2006).

Research questions

There were two research questions author used, while doing literature review. These questions were:

1. Is requirements management used as a development tool among NSD?
2. Does combining PMBOK project management framework and requirements management create a managerial work model to NSD, which suits both incremental and discontinuous development?

Research questions have their roots on several previous researhes. A work by Scheuing and Johnson (1989) showed that despite recognized twelve development steps introduced in their research, these steps were rerely used. Also, research conducted by Olsen and Sallis (2006) clearly made a separation between “narrow scanning” and “broad scanning” and their end-results in NSD process. Recent study on service development by Ojasalo (2012) had some similarities to now presented model. Ojasalo’s study focused on higher education and KIBS (Knowledge Intensive Business Services) businesses. Multistakeholder NSD is covered ny Ng (2009) and Anteroinen’s research (2012) covered military capability through the whole of the product life cycle including concept development and experimentation (CD&E). Company wide competences and their importance to NSD were studied in Menor’s (2000) research. Also, article by Spohrer & Maglio (2009) helped to create a clear and systematic picture of Service Science as a discipline.

Research method

In order to build a research framework for this study, a comprehensive, systematic literature review was conducted. Database used was ProQuest ABI/INFORM. Initial idea was to select peer-review articles, conference papers and books using the following criteria:

- each item should be have published during the last 10 years
- each item should have had more than 30 references

Search word combinations which were used were: New Service Design, New Service Design and hospitality, New Service Design and managed catering (all together 1933 hits), New Service development, New Service development and hospitality and New Service Development and managed catering (all together 2552 hits), ITIL and hospitality and service development (202 hits). Articles were also handpicked from the Emerald database or Google scholar search tool, if relevant hospitality industry or marketing articles were not covered for some reason in ProQuest ABI/INFORM.

From this vast amount of research material author chose, according to their relevance to the research subject, 100 articles. Other source for relevant material was conference papers from the 19th annual Frontiers in Service –conference. Again, according to their relevance to the research subject, 20 articles were chosen to a closer review. Altogether, 120 articles were used for systematic literature review.

Results and discussion

Research question 1 was: "Is requirements management used as a development tool among NSD?" This research indicates that customer centric approach, in which production and consumption of a service product are simultaneous, would be impossible, if customer requirements would be completely neglected. Then again, requirements management, despite its similarities to service science as a discipline, is surprisingly little, if at all, used among NSD practitioners. NSD has concentrated on the small areas of development, as stated earlier. Therefore based on this particular literature review, we could argue that *requirements management is an underutilized development tool* among NSD practitioners. There are NSD mechanisms in use, but a requirements management based model that would cover *down-to-top* all the development areas, is non-existing.

In order to find the most important internal functional and interdisciplinary connections, author mapped factors, which, based on the literature review, can have an effect to NSD and service outcome. This mapping indicated almost 100 development areas with several sub-categories with influence to NSD. These areas are presented in appendix 2. As a result, it was possible to combine a number of accepted business management development and analysing tools in order to create a robust NSD framework model. Graphical illustration (appendix 1) was made to clarify these connections. This illustration combines the elements that need to take in to consideration during a NSD process.

During the study, it became clear, that the share amount of combinations of probable factors affecting NSD is large and difficult to control. Therefore NSD process requires a methodology to measure the importance and value of factors affecting development work. This finding underlines previous findings of NSD research and justifies the use of requirements management as a development tool. The whole purpose of requirements management is to control vast amounts of inter-functional variables.

The model which is based on the research, also allowed author to illustrate how these factors are connected. Author argues that these connections should be defined and managed using requirements management and a theoretical rationale of utilizing requirements management to NSD exists.

Starting point to development work in our model is a thorough macro and micro environmental analysis. It creates a base for development of domain assumptions. These domain assumptions work as constraints for incremental and discontinuous development (reactive and proactive, respectively) as illustrated among others by Olsen and Sallis (2006), Kotler (2007) and Johnson and Scholes et al. (2008). They define NSD's environment in "as is" –condition. Strategy based service promise rationalizes development subjects and works as a development guideline. Based on this and previous studies e.g. by Sandén (2007), service promise could be used in a form of requirement for requirements.

Services are dependent on knowledge as stated by several authors (Kotler, 2004; Spohrer & Vargo et al., 2008; Grönroos, 2011). Use of requirements management would create a situation in which accumulation of knowledge helps identifying, extracting and exploiting information in NSD process. Use of requirements management would also include important softer elements of service (Dasu & Chase, 2010) to be covered, included and transformed in to service attributes.

Use of requirements management, author argues argue, would diminish NSD problems arising from:

1. simultaneous consumption and production of service products
2. *vast amount of uncontrollable variables affecting both*
3. multi stakeholder environment
4. contradicting goals among stakeholders

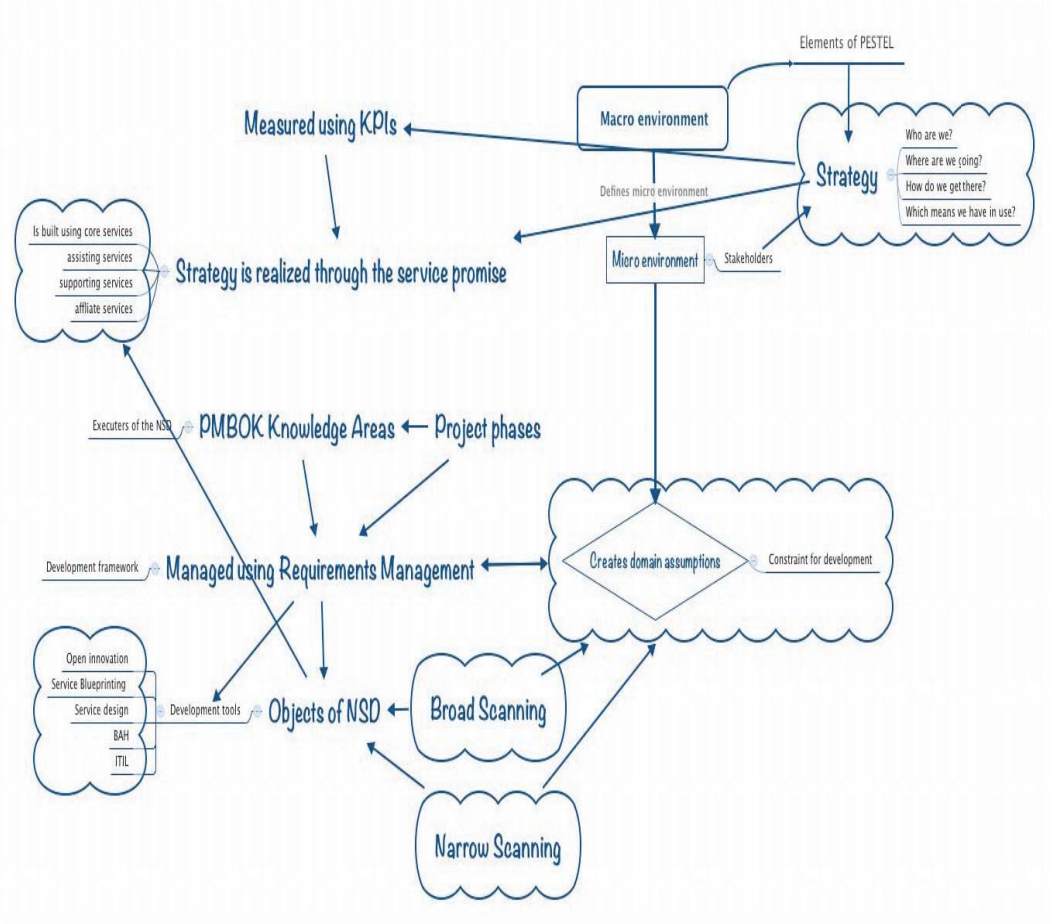
Despite proven benefits from other industries (e.g. defence industry), there is a need to empirically prove requirements management's benefits to service and hospitality industry. Based on research findings on this paper and previous researches, author suggests further development of the model showed in appendix 1. This would also give an opportunity to represent an answer to research question 2. Since author did not find answer to the research question 2, this research has a limitation. This limitation on the other hand opens an important path for future research, and it would develop a better measure for both incremental and discontinuous NSD.

Furthermore, the author suggests, that future research must empirically demonstrate the relationships between mapped variables and their importance to the NSD process. Relationships, which are based on

requirements between variables affecting NSD, should be translated into series of structural equations for each dependant variable shown in the appendix 2. Number of multivariate analysis and most of all extensions of them, structural equation modeling, would examine a series of dependence relationships between variables in our model. This statistically tested model would be comprehensive and scalable tool in the future NSD work.

Finally, one has to realize, that the NSD success will not be indicated within the systematic development method. Success is based on the insights drawn from the analysis of the trends and changes of the recognized primary success factors. Therefore the comprehension of the key requirements of these success factors in short and long term is essential. Requirements management in the PMBOK framework is the method to do so.

Appendix 1, Inter-functional connections in NSD as a part of service system development, a high level mind map



Appendix 2
Examples of development areas in a model illustrated in appendix 1 with several sub-categories with influence to NSD

1) *Macro environment (on global, national and local level)*

Based on research e.g. by: Olsen & Sallis (2006); Kotler (2007); Johnson & Scholes et al. (2008)

Political	
	Taxation
	Globalilsation
	Public spending
	Other policies
Economic	
	Economic growth
	Interest rates
	Inflation
	Unemployment
	Consumer spending
Social	
	Demography
	Culture
	Lifestyle
	Ecology
Technology	
	New products
	Information handling
	Distribution
	Communication
Environment	
	Climate Change
	Natural Disasters
	Pandemias
Legal	Consumer protection
	Labour Laws
	Laws of contract

2) *Micro Environment*
The set of forces close to an organization that has direct impact on its ability to serve its customers.

Based on research e.g. by: Olsen & Sallis (2006); Kotler (2007); Johnson & Scholes et. al. (2008); Spohrer & Maglio (2009)

Market	Number of identified customer segments
Competitors	Number of identified competitors direct / indirect
Investors	Number of investor groups
Media	Amount of media with will and capability to affect one's operations
Suppliers	Number of suppliers needed to produce NSD outcome
Employees	Number of employee groups effected by NSD outcome
Pressure Groups	Number of pressure groups effected by NSD outcome
Intermediaries	Number of intermediaries effected by NSD outcome
Locals	Number of groups affected ny NSD process / outcome
Agencies	Number of agencies affected by NSD
Regulatory bodies	Number of Regulatory bodies affected by NSD

3) Objects of development which link to service promise(s)

Based on research by: Sanden (2007); Spohrer & Maglio (2009); Huppertz (2012)

Service Consumer Benefits
Service-specific Functional Parameters
Service Delivery Point
Service Consumer Count
Service Delivery Readiness Times
Service Consumer Support Times
Service Consumer Support Languages
Service Fulfilment Target
Service Impairment Duration
Service Delivering Duration
Service Delivery Unit
Service Delivering Price

4) Requirements **As defined** by: Lormans, et al. (2004); Alexander & Beus-Dukic (2009); Vogel et.al.,(2011); IEEE (2014)		
	Life-Cycle Requirements	
	Functional Requirements	
	Non-Functional Requirements	
	Performance Requirements	
	Interface Requirements	
	Environmental Requirements	
	Infrastructure Requirements	
	Quality Requirements	
	Security and Safety Requirements	
	Design Requirements	
	Documentation Requirements	
5) PMBOK Knowledge Areas **As modelled** by: PMBOK Institute, P. M. (2008)		
Each one of the Knowledge Groups affects project work. There are altogether 42 processes which these knowledge groups manage and each one of these processes should be considered as a variable with possible effects on NSD process	Project Integration Management	Develop Project Charter Develop Project Management Plan Direct and Manage Project Execution Monitor and Control Project Work Perform Integrated Change Control Close Project or Phase
	Project Scope Management	Collect Requirements Define Scope Create WBS Verify Scope Control Scope
	Project Time Management	Define Activities Sequence Activities Estimate Activity Resources Estimate Activity Durations Develop Schedule Control Schedule
	Project Cost Management	Estimate Costs Determine Budget Control Costs
	Project Quality Management	Plan Quality Perform Quality Assurance Perform Quality Control

	Project HR Management	Develop Human Resource Plan Acquire Project Team Develop Project Team Manage Project Team
	Project Communications Management	Identify Stakeholders Plan Communications Distribute Information Manage Stakeholder Expectations Report Performance
	Project Risk Management	Plan Risk Management Identify Risks Perform Qualitative Risk Analysis Perform Quantitative Risk Analysis Plan Risk Responses Monitor & Control Risks
	Project Procurement Management	Plan Procurements Conduct Procurements Administer Procurements Close Procurements

6) Project phases **As modelled** by: PMBOK Institute, P. M. (2008)

Each one of the project phases creates a new set of stakeholder connections and demands different kind of communication between NSD participants

Initiating
Planning
Executing
Monitoring and controlling
Closing
(Demolishing)

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II

Requirements management and PBC: how can requirements management help in purchasing public services through performance based contracts? Publication date Dec 2, 2014
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TITLE: Requirements management and PBC
Subtitle: how can requirements management help in purchasing public services through performance based contracts?

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Performance based contracting (PBC) is an area of management which focuses on the outputs, quality and most of all outcomes of service provisions. If requirements are not unambiguously expressed and managed there are several risks that can materialize as a failure in service production process. This paper explores how requirements management could support PCB in public services through conceptual approach and a literature study.
Keywords: Requirements Management, Performance Based Contracting, Public Private Partnership
Submission category: working paper

Introduction
During the past 25 years, there have been more than 1300 new Public Private Partnership (PPP) contracts in the EU worth € 5 million or more. Monetary value of these contracts has exceeded EUR 250 billion. (Kappeler & Nemoz, 2010). These days role of public private partnerships have increased to cover all industries and functions in the western societies (Krtalic & Kelebuda, 2010). Areas, which have traditionally been publicly run core functions of society, such as military, security and health care have utilized several PPPs to perform their tasks.
As the role of public private partnerships has grown, theoretical studies between these two important drivers in society are too broad and without necessary criticism and too often argument follow paths developed by previous studies (Jacobson & Choi, 2008). PPP as a phenomena is not a new one, since there is evidence that public private partnerships date back to biblical times (Forrer, Kee, Newcomer & Boyer, 2010). Despite the fact that PPPs in different forms have a long history, questions about responsibilities, role of publicly funded, profit generating enterprises without democratic responsibility to members of society, has increased and caused heated debate. On the other hand privatization has proved to deliver cost savings, more effective and efficient service delivery, and in some cases an alternative form of finance of public infrastructure and services (Keating & Keating, 2013). Despite the fact that the main focus and the core of the study was PBC and requirements management, without a connection to PPP, the whole phenomena of PBC/PBL would have been irrelevant and loose. Reflection point is needed, since the key element and difference between traditional and performance-based contracting is the clear separation between the customer's expectations of service and the deliverer's implementation of service.

Performance Based Contracting
Public procurement and contracting are often a necessity for the public-private service management, and a mix of commercial and non-commercial operations requires studying contracting needs thoroughly. Only then identifying and prioritizing the often politically contradicting stakeholder preferences at each stage of the contracting process is possible.

Public entities are also forced to follow political decision-making cycles. Therefore there is a risk, that long-term decisions follow policy formulation. This leads to incremental decision making and long term goals are sacrificed to short term political goals (Peter, 2001).
Industries such as human service industries and health care and abuse treatment have used a method called "Performance Based Contracting (PBC)" – to help service suppliers and buyers to negotiate and agree outcome based contracts. Most of all PBC should be used to measure vital and important metrics for the buyer of the service. Performance based contracting is an area of management which focuses on the outputs, quality and most of all outcomes of a service provision. Monetary rewards are also often tied to any contract extension or renewal to contractor's achievement (Martin, 2002). Examples such as one from Brucker and Stewart (2011) show, that PBC was implemented first and foremost as a performance measurement tool to enhance the data-driven decision-making capabilities. Francois (2000) describes how the goal of the new system was to foster efficiency and quality of service within the treatment system by tying performance to actual payment level.

Glas (2012) has identified 11 definitions to PBC. In our research we follow the PBC definition by The Acquisition Center of Excellence (ACE) for Services:

> "*Performance-based contracting methods are intended to ensure that required performance quality levels are achieved and that total payment is related to the degree that services performed meet contract standards. Performance-based contracts-*
>
> 1. *Describe the requirements in terms of results required rather than the methods of performance of the work*
> 2. *Use measurable performance standards (i.e., terms of quality, timeliness, quantity, etc.) and quality assurance surveillance plans*
> 3. *Specify procedures for reductions of fee or for reductions to the price of a fixed-price contract when services are not performed or do not meet contract requirements*
> 4. *Include performance incentives where appropriate."*
>
> (Definition of PBC, n.d.)

There is a need for legally binding and formal contracts, which set the terms under which partners share risk and responsibility for mutual financial gain and other benefits (Sagalyn, 2007). On the other hand, the purpose of a service system can be described by defining what resources other service systems need, and specifications describe how those requirements are met. The purpose of a service system can be described without saying anything about the system implementation. US Ministry of Defense describes specifically that:

> "*Minimal contract management involvement is anticipated as long as the contractor meets contractually specified performance metrics. However our involvement may increase if the contractor systems and processes are not functioning correctly and end users are not appropriately supported"*.
>
> (Department of Defence, n.d.)

One of the reasons, which prevents wider use of PBC are its risks. These risks are associated to changing client requirement and therefore PBC, as a form of contracting is not seen desirable. From the operational management point of view risks are defined as the

combination of the probability of an event and the value of its consequence. This raises important questions concerning the identification and management of risks under PBC from a contractor's point of view. (Gruneberg, Hughes, & Ancell, 2007).
Risk management procedures can compromise the need of transparent co-operation and mutual risk sharing. This kind of situation is closer to a normal buyer-seller relationship than partnership between equal partners. Monitoring partnerships for impact and performance is critical, but methods in this process must respect both parties. These measures should be neutral, fact based, following pre-determinated agreements, variables and most of all requirements, which affect final changes.
Recognising valuable roles within a service ecosystem is a good and practical starting point for the work to make sense of the relationships between different entities and their functional boundaries. Economic exchange and revenue creation between commercial and public organisations depends on voluntary, open, value creation between these two systems and during this chain of processes all the actors participating in this co-operation must willingly and openly interact. (Smith & Fischbacher, 2005; Spohrer, Vargo, Caswell, & Maglio, 2008). Efficiency of these roles should be measured following the principles described by Bendick (Bendick, 1994 in Doerr et.al.,2005):

1. In producing the services … do the private sector's production
2. processes and input costs allow it to generate output at a lower total cost than could the public sector?
3. Are the administrative costs incurred by government to mobilize and control the private sector less than the cost savings from more efficient production?
4. Is the supply side of the market sufficiently responsive that private firms enter markets rapidly and smoothly?
5. Are purchasers sufficiently rational and careful, and the quality of the service sufficiently definable and measurable, that effective, informed consumer sovereignty can be exercised?

(Doerr et.al., 2005, p.167)

Performance Based Logistics
On a military organization context a Performance Based Contracting follows the principles of Performance Based Logistics (PBL). Performance Based Logistics is more precise, narrower approach to PBC with clear focus on defense industry and military context. PBL is defined by Berkowitz et.al (2003) as follows:

> *"An integrated acquisition and sustainment strategy for enhancing weapon system capability and readiness, where the contractual mechanisms will include long-term relationships and appropriately structured incentives with service providers, both organic and non-organic, to support the end user's (warfighter's) objectives."*
> (Barkowitz et.al, 2003, p.5)

Based on this definition, organizational activity, which is managed under the PBL framework, must fulfill the following criteria:

1) Performance based logistics must answer how user, buyer or developer of PBL reaches his goals while utilizing PBL
2) PBL is related to change, since the purpose of the PBL is to enhance existing systems
3) PBL is system wide approach to contracts/agreements
4) PBL is a time-bound relationship

These definitions are in line with requirements management and PBC principles. Difference between PBC and PBL is, as stated earlier, PBL's focus on military domain. There is well documented evidence (Gansler & Lucyshyn, 2006) that PBL has created significant benefits for both contractual parties.
Then again these benefits are accountable and reliably measurable under peacetime operations, since difference between mission-oriented metrics and normal operations centric metrics can be significant as illustrated by Doerr, Lewis and Eaton (2005). Also, metrics used in corporate logistics (in Doerr et.al 2005, by Caplice & Sheffi, 1994) are very difficult to utilize or transform to services due to simultaneous consumption and supply of service by its definition, the very nature of services. (Brax, 2013; Grönroos, 2009; Kotler, 2003). One must remember, that the process nature of services described by the list of previously mentioned authors requires accounting all the variables affecting the outcome of the desired service. One way to set metrics which could be followed and measured in PBC or PBL is given by Martin (2007), who uses systems approach in his study. There are five areas according to Martin "inputs (needed in process), process, outputs, quality and outcomes" (Martin, 2007, p. 132).
Each one of the areas is divided in to smaller components, but there is a fundamental difference in this approach compared to requirements management. Firstly, it defines a set of attributes, instead of set of requirements, which could be reached by utilizing any of the listed components. Secondly, looking at the agreement or contract from a requirements management point of view, one should be interested only on the outcome of the delivered product (service) regardless of the input, process or in some cases quality. Also, the ambiguity in description of outcomes (e.g. "results") does not support use of this framework.
In an interdisciplinary business environment, it is essential that the firm and customer systems are designed to provide value-in-use for the company (public or private) and the customer (public or private). If co-creating value and the benefits are not made explicitly clear, there is a risk that possible conflicts may occur, due to different organisations or people delivering their effort to different perceived value. There is a possibility to measure PBC in terms of a contract, which focuses on achieving a required outcome rather than a contract to supply a set of prescribed specifications. This, according to Gruneberg, Hughes et.al, (2007) involves the use of functional terms, like in a description how a completed building will operate rather than specifying how a building will be constructed, which would be the traditional way to negotiate and form a contract.

Requirements management

Requirements are decisions concerning the desired state of a future system. More than 70 percent of projects contain at least 100 requirements, and 20 percent of projects contain at least 1,000 (Project Management Institute, 2014). These requirements from different stakeholders can be potentially incomplete, inconsistent and conflicting between stakeholders, but they need to be transformed into a complete set of high quality requirements (Aurum & Wohlin, 2005). These high-quality requirements should be developed by collaborative work among stakeholders (Alexander & Beus-Dukic, 2009).
Authors will follow explicit process and outcome-based approach of services illustrated by Grönroos (2009) and Brax (2013), which address the process nature of services. Therefore service as a phenomenon will be studied as an end result of a series of interdependent processes. Main question is, as Kim and Cohen (2007) state in their study "How should a performance requirement for the final product be translated into the performance requirements for the suppliers who provide critical components?" Developed subject can be an operant or operand resource, terms very often used by service researchers Vargo and Lush (Vargo & Lusch, 2004). Use of requirements also answers the question "what" in stead of "how", following the Vargo's and Lusch's Foundational premise 10, illustrated in Vargo and Lusch 2004:

"Value is always uniquely and phenomenologically determined by the beneficiary"

Requirements management literature (Alexander & Beus-Dukic, 2009; Pasivirta & Kosola, 2007) on the other hand underlines requirements elicitation, which is a communication process between different stakeholders. If co-creating value and the service benefits are not made explicitly clear, there is a risk of conflicts because different stakeholders will be delivering to different perceived value. Decisions related to requirements are involved with calculations of risks and financial management decision like return on investment. Since these two sets of requirements and management decisions led from them are dependent on several stakeholders and related to several business operations, there is a potential to conflicts between these parties. Open and transparent communication between stakeholders, comparison to pre-determined decisions and milestone points with continuous design and re-design within the contracted activities sets a common ground and enables performance based contracting to be utilized. These decisions are repeated from a development phase to development phase. Decisions reflecting this continuous communication in a form of requirements can reduce uncertainties in the final cost, schedule, performance, and functionality, which in many cases are otherwise inevitable. Since goal oriented requirements management (Van Lamsweerde, 2001) steers functions towards a common goal, risk that contracting parties build more efficient individual systems, at the cost of overall effectiveness of the contract (due to more altercations and transactions) leading to sub-optimal outcomes, diminishes (Almefelt, Berglund, Nilsson, & Malmqvist, 2006; Ng, Maull, & Yip, 2009).

Table 1, Requirements Management Definitions

Author	Definition
Oberg, Probasco and Ericsson, 1998	…a condition or capability to which the system [being built] must conform
Nakazawa & Masuda, 2006	a) Qualitative and quantitative inputs to the product and the components b) Qualitative properties and characteristics of the product and the components c) Quantitative expectation for the behaviors of the product and the components

Public Private Partnership

Public Private Partnership (PPP) agreement creates a situation where the knowledge, skills and assets of each entity are shared and used in delivering a service or facility for the use of the general public. Alongside of the resource sharing, all entities should share the risks and rewards of the partnership. (Halls, 2010.) However, real transparent and working partnerships can only be created through development of social relations (LaFrance & Lehmann, 2005). These relations are created through commitment and bilateral trust, common goals and clear unambiguous communication between participating parties.

According to the previous research, there is a risk, that public-private partnerships face a situation where responsibility among the partners is imbalanced. This leads to a situation where one organization has unequal responsibility to the partnership. This can be avoided, as stated earlier, by using effective communication, which diminishes distrust and encourages transparency among parties and as a result increases engagement to co-operation (Forrer, Kee, Newcomer & Boyer, 2010).

As one goes through the different definitions of PPP (table 2), it becomes clear, why it can be difficult to create a comprehensive framework to study purchase of services, delivered by PPPs. Despite their similarities some of the definitions are almost opposite to each other. To use an old phrase, to comparing different PBC/PBL cases in public private partnerships is like

comparing “apples and orenges”. Yes, both are fruit, but there are significant and obvious differences as pointed out by several authors (Martin, 2005 p. 134; Brown et.al, 2006 p.324).

Table 2,Definitions of Public Private Partnership

Researcher(s)	Definition
Forrer, Kee et al.,2010, p.476	“Public-private partnerships are ongoing agreements between government and private sector organizations in which the private organization participates in the decision-making and production of a public good or service that has traditionally been provided by the public sector and in which the private sector shares the risk of that production.”
Halls, 2010, p.22	“…contractual agreement between a public agency (federal, state sector) entity. Through this agreement, the skills and assets of each sector (public A or local) and a and private) are shared in delivering a service or facility for the use of the general public.”
Keating and Keating, 2013, p.178	“…a long-term relationship between the state and a private non-profit or profit-seeking firm for designing, constructing, maintaining, and delivering infrastructure or social services.”
Wang, 2009, p.779	“…partnerships, involves a far more intensive interaction (or synergy), which requires strategic collaboration and intertangled action between the public and private parties from the very beginning of a project. ln a partnership, two parties conduct joint decision making and specify the problem, solution, and product in the joint process.”
Moulton and Wise, 2010,p.350	“Public-private configurations exist wherever government authority is extended to private firms for the production of outcomes that achieve public (as well as private) objectives.”
Demirag et.al, 2012, p.1318	“…involves the public and private sectors sharing the risks and rewards on clearly defined projects financed by the private sector.”

All of these definitions are very close to each other, but some significant differences exist. Definitions by Forrer and Kee et.al (2010) and Halls (2010) state that PPP is an agreement between parties. Agreement is a fairly precise term:

> “*An arrangement, contract, etc., by which people agree about what is to be done*” (Gove, 2002)

In the first definition, one is more concerned about the way, how the arrangement between entities is described. Keating and Keating (2013) highlight the functional part on cooperation. Their definition is concerned about what is done, in a similar way as Halls (2010) does. Another variable, which should be studied, is time. Only Keating and Keating (2013) underline the importance of a long-term relationship. Then again, according to Forrer and Kee (2010), an on-going relationship is one of the key indicators in a true PPP. Wang (2009) description is relatively strict, but it is the only one, which clearly includes all the lifecycle stages used either in service marketing (Kotler, 2004) or project management (Institute, 2008). Demirag, Iqbal, Stapleton, & Stevenson's (2012) definition is surprisingly the only one with Forrer and Kee’s definition, which mentions risks. Risk, that a public entity gains losses in a privately run operation has been one of the main sources of PPP criticism. Political

decision making mechanism want to decrease risks and public entity managers have limited amount of control over variables which create risks in PPPs (Brown, Potoski, & Van Slyke, 2006).

Research question and methodology

Based on the critical literature review, authors tried to find an answer to a single research question:

> How could requirements management be used to manage PBC in purchasing public services?

Database used was ProQuest ABI/INFORM. Author chose for the review peer-reviewed articles, conference papers and books using the following criteria:

- each item should be published during the last 10 years
- each item should have had more than 30 references

Search word combinations used were: performance based contracting and public services, performance based logistics, requirements management and public services and public private partnership. From this vast amount of research material author chose, according to their relevance to the research subject, 41 articles. Articles were also handpicked from the Emerald database or Google scholar search tool, if relevant articles were not covered for some reason in ProQuest ABI/INFORM. Purpose of this initial research was to suggest more pragmatic development steps and give a better opportunity to narrow down future research on the subject. The literature review is still on-going.

Initial conclusions

Academic debate and research surrounding public service management and purchasing policies is ample. Amount of approaches to subject is extensive but not unambiguous. Abstract, co-created services need to be treated in a way that detailed and most of all common outcome or common goal focused requirements are measured instead of the methods used to meet these goals. This can become very difficult if a service provider has not identified necessary links between stakeholders (Lormans, van Dijk, Van Deursen, Nocker, & de Zeeuw, 2004.) Mutual goals, in a form of PBC, unambiguously expressed and managed in a form of requirements should be defined using requirements management as a primary service development and management tool.

Each process in the service production can be described in a form of a requirement, which is elicited and defined between service provider, buyer and most of all final service beneficiary. Final beneficiary can be a service end-user or an entity, which benefits from the end result of somebody using the service.

Despite their differences there are also obvious similarities between the previous research. The most obvious similarity is the need to have a framework, which enables cooperation between public and private parties. There is a need to create effective trade-offs between public demand and private supply in order to achieve goals set to the PPP. Use of resources in the adequate way at the correct time requires a system, which covers all the lifecycle stages and takes into account different operations in the service production.

Current state in the new service development is well described by Clayton et.al. (2012), who refers to research conducted by Tucker and Tischner in 2004. Researchers recognized 13 different product-service development methodologies and according to Clayton, none of these 13 methods covered the whole project life cycle or took in to account service inputs by customer or service development outcomes (Clayton, 2012). There are a large number of requirements, which do not have similar values either to service provider or to a service consumer. This recognition of different values affects the possibilities to meet business goals and use business processes in the most efficient way.

In the partnership literature, competitive process is seldom discussed. In the PPP context, EU purchasing directive stipulates a legal process for selecting the partners under circumstances where directive applies. In the green book (Comission, 2004) states that conditions and terms for performance of the contract must be clearly formulated by the purchasing authority in descriptive documents (e.g. technical specification) so that all tenderers can take them into account. In addition, there can be mechanisms to evaluate the performance of the partner at a regular basis. In all, the commission has prepared a legal framework in order to implement PBC in public-private partnerships while requirements definition has to be open and clearly formulated in the documents for tendering.

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Sustainable New Service Development: Insights of Food Wastage Data – Case: University Catering Unit

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Abstract

There are clear implications that sustainable new service development (SNSD) is not only part of the future, but also an important part of contemporary service operations. However, evaluation methods in this field remain underdeveloped. This paper offers one example of how contingent data on operation performance and waste streams could be used to improve SNSD. Specifically, this research quantifies the amount of food waste produced by a typical managed catering business unit to evaluate this data as a measurement of the efficiency of operations management. In this research, sustainable new service development was studied empirically by employing a case study. Authors used data simulation to bring insights to SNSD. Another purpose was to create new, easily applicable metrics for the future SNSD work outside the case study unit.

This study contributes to the area of new service development (NSD) by offering the utility of a case study-based simulation as a development tool. Results indicate how small changes in menu planning, production processes and demand management can create positive and significant financial and environmental outcomes. Our results link together the literatures on contingent operations awareness, the triple bottom line paradigm and SNSD to create a baseline condition for the future sustainable hospitality development.

Keywords: service, sustainability, development, corporate social responsibility, CSR

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Introduction

Even as the global economy turns to focus more on services, arguments about environmental sustainability continue to focus largely on the trade of goods. In part, this makes sense since decoupling value from resource use is more straightforward for services than it is for goods production. However, the environmental footprint of service industries is far from sustainable.

This paper examines the idea of Sustainable New Service Development (SNSD) following the conclusions by Aragon-Correa and Rubio-Lopez (2007). This paper explores their conclusions in the context of food and hospitality services, which concern the management of material and people. Specifically we use a restaurant case study to ask: how can waste management data be used to increase efficiency and effectiveness of hospitality operations. The research had two objectives:

1. To measure the amount of waste produced by a single managed catering business unit.
2. To evaluate the potential of using insights from food wastage data in SNSD

According to research by Halonen (2015), the role of sustainability data affects both commercial purchasing policies and consumer attitudes. Thus, we hope that the answers to these research questions will lead to more efficient hospitality operations by increasing awareness among catering practicioners and consumers of the role of sustainability in services.

Research Problem

Globally, as much as one third of produced food is lost. From this massive amount of nutrition waste, 35% is wasted during consumption. (Gustavsson et al., 2011.) If we look at the nutritional value lost in the food production value chain, final-stage consumption remains the largest cause of waste in five out of seven global geographical areas (Figure 1).

The share of consumption-stage waste is rises with the income level of the population. Thus, the scale of the problem is likely to increase as the standards of living rise.

According to Lipinski et al. (2013), the food loss can be categorized by five stages in the production and consumption chain:

1) Production
2) Handling and storage
3) Processing and packaging
4) Distribution and market
5) Consumption in the form of food purchased by consumers, restaurants, and caterers but not eaten

Authors focused their research on the last stage, because it is the largest source of waste in western societies. While there is a broad literature on the topic of food waste, there is a clear gap in our understanding of how to develop and measure sustainable new services. In addition, there is a need for sustainability metrics in a form of unambiguous customer requirements. Several studies have shown that poorly managed sustainability requirements have a drastic effect on the development process and, most of all, on the end result of service development (Almefelt et al., 2006; Aurum and Wohlin, 2005; Barney and Aurum and Wohlin, 2008; Hull et al., 2011).

This case study looked into a single business unit that serves daily 330 customers on average. Management tracks the number of customers on a daily basis by using data from the cash register/automated inventory system. The unit is operated by a global franchise, which has been granted a Finnish Standards Association's (SFS) environmental certificate.

Due to the nature of services, empirical data collection during a service development process should include components other than the end product (Spohrer and Maglio, 2010b; Grönroos, 2011). A lack of empirical data from actual service-enabling processes can lead to situations in which it is impossible to compare obtained results to a set development goal.

This analysis follows the definitions of waste used by Gustavsson et al. (2011) "Global food losses and food waste" report published by Food and Agriculture organization of the United Nations (FAO) to make this study comparable to prior ones.

Corporate social responsibility (CSR) activities emphasize social or environmental issues. Thus terms like "green" and "environmental" are used in practice as synonyms for "sustainable". Development of these areas in the service context is being referred as sustainable new service development.

This paper consists of five sections. The first two sections review the literature on the subject and describe how this paper contributes to existing research in the area of sustainable new service development. The third section describes the research methodology. Sections four and five are the results and conclusions with suggestions for further research and limitations of the study.

Corporate Social Responsibility

Corporate Social Responsibility (CSR) is a term describing actions meant to promote positive outcomes for the surrounding community and society (Schubert et al., 2010).

In the CSR context, "sustainability" refers to sustainable development - defined originally as meeting the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland et al., 1987). In the business context, sustainable development is linked to the so-called triple

bottom line thinking, which notes that companies should measure their success not only by economic but also in environmental and social terms (Elkington, 1997).

This area of business development has been studied for decades but the increasing effects of climate change and negative impacts of globalization have brought the issue from academia and media to boardrooms (Moir, 2001). Discussion about companies' initial motivation to implement CSR is ongoing, but typically two types of drivers are identified: CSR can be either internally or externally driven (Masurel, 2007; Bonilla-Priego et al., 2011). The former is connected to goals such as increasing profitability or developing competitive resources, whereas the latter is driven by legal regulations or explicit stakeholder expectations. Shareholder and stakeholder value perspectives have been clear dividers of the discussion, but whether it is even possible to separate these two from each other (Johnson et al., 2008).

Opportunities to enhance operative savings and increase firm value in the industry from socially responsible operations serve both approaches (Kang et al., 2012). This requires a thorough contingent analysis of business environment as a whole. Very good examples of this are a Leadership in Energy and Environmental Design (LEED) certified and LEED qualified building projects in the US hotel industry illustrated by Butler (2008). In his study, Butler shows the positive financial effects and stakeholder attitudes of green policies. Also, reference points like LEED offer an opportunity to describe the need for resources in the form of requirements (Butler, 2008).

New Service Development

New Service Development (NSD) is a relatively new subject, and as a result, comprehensive studies - especially in the area of innovation - are scarce (de Mark, 2010). According to Sanden (2007) 40% of sales in service organizations are created by service products, that were developed within the previous 5 years. Authors combined the principles of sustainability and generic service development into the idea of sustainable new service development (SNSD). SNSD combines the principles of NSD but takes into account the triple bottom line paradigm.

Services are processes created and consumed simultaneously by the service provider and consumer (Grönroos, 2006). There are several academic definitions of a service (Gummesson, 2010; Kotler, 2007; Spohrer and Maglio, 2010a; Vargo and Lusch, 2004), and some significant differences exist between them. As Bharadwaj's et al. (1993) research illustrates, factors like equipment intensity (automated service, like ATM) versus people intensity (personal banking service) and service delivery process (served vs. self-service) differentiate services even within same industries. Intensity of the service process and modification variability also dictates both development and operations of a service product. Intensity refers to the amount of

customer's participation in a service process and in general hospitality services are considered to belong to so-called high-contact intensity operations. High-contact intensity operations require participation from the customers' part, but rather limited amount of customization (Bullinger et al., 2003). Also, a study by Melton (2007) clearly underlines the importance of frontline employee and customer participation to service development across different service industries.

NSD is a multifunctional and multidisciplinary process. Its purpose is to create new, desired service outcomes in co-creation with a customer (Spohrer et al., 2008). The purpose of the new service development is to enhance the profitability of existing offerings, attract new customers to the firm, improve the loyalty of existing customers and open markets of opportunity (Menor et al., 2002).

Our approach assumes that the customer obtains service benefits created by the service provider. The main development and management area in service development is capability utilization, since it enables the final service offering (Grönroos, 2006; Vargo and Lusch, 2004). This capability utilization aims to create service outcomes of a process, developed and consumed simultaneously with a service provider and end user, as described by Manor, Tatikonda and Sampson (2002) and Grönroos and Voima (2013) among others. Communication between all parties involved with development process should be transparent, open and most of all fact-based.

Sustainable Hospitality Operations: A Divided Responsibility?

The importance of market scanning in hospitality product development is significant in two different dimensions illustrated by Veflen Olsen and Sallis (2006). Their work divides scanning into narrow (micro) and broad (macro) scanning. Narrow scanning focuses on day-to-day information, while broad scanning tries to find factors, which might have significant effect on the long-term effects of the company or the industry. The purpose of thorough scanning is to reduce the service producer's uncertainties in the three areas in production process and planning: market, creative and process uncertainty (Anderson and Joglekar, 2005).

There are already several environment management systems in use in the hospitality industry, and based on the research by Font (2002), there are over 100 ecolabels in use. On top of this, there are industry-specific best practices and codes of conduct, intended to increase green thinking and awareness. Ecolabels are meant to assure customers and other stakeholders that the product itself, processes used to produce a product and the whole management system is managed according to a certifier's requirements (Chan, 2009).

Green attitudes of consumers have been a topic that has received a fair amount of attention in the academia during the past years. These studies range from individual consumer's willingness

to pay premium fees for environmentally sustainable services to the effects of more sustainable services. But hospitality industry as a whole has not been at the forefront of green operations development (Kang et al., 2012; Szuchnicki, 2009; Chan and Lam, 2001).

Marketing literature (Weber et al., 1989; Szuchnicki, 2009; Kotler, 2007) emphasizes psychographic segmentation, which is based on their values and actual motives for consumption as a means to reach existing and potential customers. For example, according to Kujanen (2013), higher education correlates with more conscious consumption behavior and greener attitudes towards consumption. Market responsiveness is also found to be one of the nine key areas in service development in hospitality industry (Ottenbacher and Gnoth, 2005).

Research Methodology

Many studies of sustainable development in the service industry are based on fragmented industry data (De Jong and Vermeulen, 2003). In this research, sustainable new service development was studied empirically by employing a case study. The methodology was chosen because Yin (2003, p. 2) states that: "a case study research would be the preferred method, compared to the others, in situations when:

1) The main research questions are "how" or "why" questions;
2) a researcher has little or no control over behavioral events;
3) And the focus of study is a contemporary (as opposed to entirely historical) phenomenon."

Data triangulation is typically used in case studies (Johansson, 2003; Yin 1994). The purpose is to cover as many aspects of a single case as possible and enable further generalization of the results by reasoning, as illustrated by Johansson (2003).
The five collection methods used are:

1) Literature review
2) Documentation (previous research)
3) Direct observations
4) Interviews
5) Data simulation

This successful research method has also been introduced by (Ranta and Takala, 2007).

Case study unit

The case study restaurant offers publicly subsidized student meals. It is operated in a university of applied science under a global franchise, which has been granted a Finnish Standards Association's (SFS) environmental certificate. The unit operates in the same building as a franchise hotel and uses hotel kitchen premises, equipment and personnel in its operations. Also, unit has

to take into consideration its international client base.

The government organization responsible for the subsidization scheme, Finnish Social Insurance Institution (KELA), funds student restaurants meal-by-meal based on legislation that prescribes the general requirements for the subsidies. These general rules state the maximum price and the contents of the meal. For example, a subsidized meal has to include a drink, salad, bread and a spread in addition to the main dishes (KELA, 2012). Health and nutritional aspects are mentioned, but sustainability is not. The legislation is accompanied by a more detailed but non-binding set of guidelines, which do mention sustainable development as an aim to be addressed in student restaurants (KELA, 2011).

A vast majority, roughly three quarters of daily revenue, is generated from lunchtime sales. Customer base is divided between university personnel (27%) and students (73%). (Karjalainen, 2015). This information underlines the importance of students as a source of revenue.

Collection of empirical data

The data collection process took place during the week of April 16, 2015. A sample of 150 observations was collected from a sample frame of 1569 lunchtime customers. Five different teams of six research assistants collected the data, and at least one member of the research team was present at all times to help assist the teams and ensure that good academic procedures were followed throughout the data collection process.

Data was collected from two randomly chosen, separate client groups. Due to a limited time frame and time-consuming data collection method, a daily sample was restricted to 30 individuals. The first group consisted of customers collecting their meals, and the other group of those delivering their dishes to washing-up and to a bio-waste collection bin. The arrangement was done in order to reduce research bias

The first observation subject was randomly chosen, subsequently, every fifth customer was selected. A similar systematic random selection process was adopted in waste measurement.

Each portion was measured menu item by menu item, while a client collected it from a self- service line. Measurement was done using two separate scales, whose accuracy was controlled using a standardized comparison weight.

During the research period, a unit served 20 different dishes or side dishes and three types of bread along with milk, water or sour milk. There were 79 different ingredients used during the observation period.

The amount of energy and the price of the measured ingredient were calculated per 100 g, based on the information gathered from purchasing database. The total amount of energy and price of the portion for each individual dish was calculated. Initial results were gathered in spreadsheets to facilitate statistical analysis, which allowed researchers to compare results between the

individual units of observation.

The total amount of unspecified bio-waste was measured after the lunch period each day and possible issues reflecting to the observation day's results were discussed with the head-chef of the unit on the spot.

Data about overall waste was also collected, in order to find and compare the main source of the waste in the unit. This information was collected after each day by scaling the ingredients of the waste bin. The amount of total plate waste could not be added to the consumption waste without further analysis, because the total amount of waste included parts of ingredients such as skin, bones, peels and other non-edibles, which are not included in food wastage by the FAO standards. Also paper napkins are thrown to the bio-waste bin, which adds-up to the weight of the waste bin.

Interviews and documentation

Although wastage information itself offered insight into sustainable new service development, there were still gaps in our understanding of the process. This impacts operations because even after analysis, researchers had to seek alternative explanations for poor financial results, which came to the authors' attention after the interviews.

As a part of the data triangulation method used here, authors interviewed both the head chef of the unit and other members participating in the production process. Specifically we sought their views on the efficiency and the effectiveness of the existing CSR and eco-label policies. We also collected historical data by interviewing the previous head-chef of the unit and analyzing results from previous development cases.

Interviewees articulated an obvious need to streamline business processes from a financial management point of view. This must be done while simultaneously following the guidelines of the SFS eco-label and satisfying a demanding customer base. They also expressed an underlying will to use more organic ingredients in food preparation, but implementation of this is limited by a higher purchasing price (Erkkonen, 2015.) Despite the existing SFS eco-label, organic food ingredients were not demanded to meet eco-label's certification criteria.

Different approaches to the CSR and SNSD required as objective information about the existing operations as possible. This information needed research data, which took both financial and environmental aspects in to consideration.

Data simulation

We implemented a business simulation to introduce statistical data into the analysis. Simulated data offers insight into how service provision could be developed, thus providing an opportunity to create metrics, which could be used to track progress during the service development process.

There were 150 direct observations of customers' buying behavior. In order to innovate on the methods used in the field of

SNSD, we simulated answers using the whole sample frame. The focus of the observations was on the financial value of the ingredients and nutritional value in the form of amount of energy customers received in the dishes.

Computer-aided simulation of business systems and business processes is a well-established way to study systems and processes (Proctor, 1994; Laguna and Marklund, 2005). However, there must be an underlying structure in a homogeneous set of selected variables. Therefore, the collected data was initially analyzed (Appendix 1) using SPSS software to assure that it met the requirements for further statistical analysis. Distribution of both price /dish and energy / dish was analyzed and outliers were dropped.

Simulations require the use of pre-defined rules, including distributions and weighting factors. This allows interaction based upon trends, norms and incomplete information (Hansford et al., 1992). Keeping this in mind authors made sure that variables were statistically and conceptually valid so that further analysis was statistically sound following the guidelines by Hair et al. (2006).

Initial statistical analysis (see Appendix 1) showed that customers' purchasing data was normally distributed. During the second phase of analysis, the authors computed the normal probabilities using the NORMINV function. This function returns the inverse of the normal cumulative function for the specified mean and standard deviation, which were calculated from the observed data. These results were simulated to respond to the actual number of customers during each day of the data collection period and sampling frame.

Lehtonen and Seppälä (1997) describe the need for data reduction as a benefit of data- simulation. In our case the purpose of the simulation was quite the opposite, but the goal of the simulation was in line with their study. One of Lehtonen's and Seppälä's (1997) key findings was, that the main difficulty and disadvantage of simulation is the data collection process. This statement underlines the importance of simulation to help focus development on key development areas in a service system organization. The inter-functional and inter-disciplinary nature of service provisions is hard to analyze without data simulation as described by Hansford et al. (1992) due to a vast amount of data from various service processes. Dependency on the several information management systems, which enable the final service delivery emphasises the use of simulation (Kano et al., 2005). Also, Pasivirta and Kosola (2007) and Hansford et al. (1992) emphasise simulation as one of the development tools in a situations where possibilities to actual observation are limited.

Results

The research had two objectives:

1. To measure the amount of waste produced by a single

managed catering business unit.

2. To evaluate the potential of using insights of food wastage data in SNSD

Following the principles of methodological triangulation, several research iterations, in which different research methods were utilized, took place.

In the early stages of the observation period, it became clear that the actual amount of "plate waste", food bought but not consumed, was surprisingly small. Due to our research approach in which we followed the principles laid–out by FAO, the authors wanted to measure ingredient waste as precisely as possible. The purpose of this was to create food waste segments following the criteria FAO uses. This approach did not enable before-and-after measurements from the same customers, since in a single unit the word-of-mouth of the on-going observation created a significant risk of measurement bias. Also, the small number of wastage observations did not make it possible to simulate statistically viable wastage results. However, aggregate results offer enough information to draw conclusions. A comprehensive, 269 ingredients table of food wastage by customers is given in Appendix 2.

The smallest amount of unspecified waste was produced on a same day as smallest plate waste results were observed. Also, the third day of the observations did not meet the requirements set to the institutional catering served by universities with the average energy value of 306 kcal. The lower average energy content of Friday resulted lower unspecified waste, but there was no effect to other wastage results. The lower number of overall customers could explain this. These results are illustrated in the Table 2.

The data collection method made it possible to divide wastage according to main ingredients. These results show a large portion of salad and salad buffet among the wastage. Among the other major sources of food waste were side orders and meat. The overall results are shown in Figure 4.

Climate impacts of the food wastage

An essential part of CSR is management of the environmental impacts of operations. In the analysis of the environmental impact of the waste, climate impacts were used as a proxy for overall environmental impacts. The assumption is that the same drivers such as energy, fertilizer and land use are causing both the most significant climate impacts as well as other, more local environmental degradations. The climate impacts of different food items were estimated based on a set of guidelines developed by the Finnish Environment Institute (Nissinen et al., 2010). Estimating the environmental impacts of food, taking into account the whole life cycle, is notoriously difficult, and therefore, the values depicted in Figure 3 should be considered only as indicative.

The production of meat has a larger environmental

footprint compared to produce like vegetables. Also, due to the time of the year, the majority of ingredients were imported, most likely causing a higher environmental impact.

Based on our estimations, some observations of the climate footprint of different food items can be made. Despite the fact that meat represented 18% of the wastage, its climate impact was as high as 39% of the overall impact. A large amount of the overall impact was caused by salad and salad buffet. These ingredients had the highest overall environmental impact of 47%. One has to bear in mind that their share was clearly the largest of all the waste ingredients. As mentioned in the case description, offering salad is a mandatory requirement for a student restaurant. A breakdown of wastage figures is given in Appendix 2.

Paradoxically, in the waste phase, the impact can actually be considered to be positive, since in Helsinki, organic waste is separated and is either composted or used in biogas production. Also, a growing role of biofuels as a source of energy for transportation is predicted to rise from 1,5 % to 6,8 % by the year 2030 (Mykkänen, 2016). A significant source of bio-energy is bio-waste generated by households and commercial food providers. This increasing role of bio-fuels will also reduce the final environmental impact of food waste.

From the life cycle point of view, of course, this is not the case, since much more energy and resources go into production of the food than can ever be recovered by recycling. Thus it is more reasonable to measure the impacts of the waste based on the impacts of the original food items, not the type of waste. Based on the interview data, this was also the line of thinking in the restaurant management. Their focus was on purchasing local and organic material and reducing unnecessary waste.

Efficiency and effectiveness of the operations

The initial research objective was to analyze the efficiency and effectiveness of the operations with respect to CSR. Thus, the researchers focused on the early stages of the consumption. This included the serving of the ingredients as final dishes and the customers' service process and their effects on the CSR of the unit. The rationale was that positive CSR findings, which gave financial incentives to the catering operator, would be more easily adapted. Development of sustainable new services demands a comprehensive process development among all the participants in the service process. Therefore, the authors included also a food production process and demand management processes to the research. Due to a research focus, purchasing policies were excluded, despite their importance to CSR and successful SNSD.

The researchers knew in advance that outside regulations set by the Finnish Social Insurance Institution (KELA) dictated largely how day-to-day servings were planned and offered to the student customers. These regulations set constraints on the price of the individual ingredients and, on the other hand, the demands on the energy and nutritional values of the meals and their components.

This highly regulated business environment creates even more demand to efficiency from the service provider's point of view. Service provider's hands are tied by the public funder, whose regulations do not necessarily take sustainability in to account as a regulating factor. With very little negotiating power, all the catering operators operating in a subsidized environment face similar challenges as the case unit due to a metrics (the maximum price and the contents of the meal) used to follow their efficiency and effectiveness.

Data from the simulated results were used (Appendix 3) to draw conclusions, create SNSD metrics and to prescribe clear development suggestions, which would take into consideration the following:

- official nutritional guidelines
- financial aspects
  - from a buyers' side
  - from a supplier's side
- CSR

The researchers created a set of indicators from the analyzed data set. These indicators/ratios were:

- calorie/price
- price/portion
- production waste

The first figure was created to help suppliers understand how efficiently their operations were able to produce the necessary amount of energy to answer the demand set by official guidelines. The figure was calculated as an average price for each calorie. If the average calorie amount was low or average, but the total production price of the dish was high, the supplier's production efficiency was poor. If the operator did not succeed in producing enough calories at the acceptable price, it was not efficient for the buyers (university) perspective and ineffective for the final users. Based on the simulated data (Appendix 3), there were large deviations in efficiency over different periods of time. The results are illustrated in Figure 4.

This ratio gives a good overall view of operational efficiency, but its dependency on two (or more) characteristics requires further explanation. The ratio suggests poor performance during the last three days, but this is a result of two separate issues. On Wednesday, the amount of energy is below official guidelines (minimum of 500 kcal/day), and costly ingredients draw the figure down on Monday, Thursday and Friday.

The final figure of interest is the production waste. Data collection concentrated on the production of eatable food, not the raw ingredients. The rationale behind this came from the FAO report, which clearly shows that over-manufacturing is a larger problem than preparation wastage. The data collection method overcame the flaws in the cash register and inventory management system, and the results indicated a clear overproduction of the

dishes. On Tuesday, the vegetable casserole (1) was bought by only two customers out of the 30 observed customers, the celery soup (2) by only 1/30, on Wednesday, only a single customer bought lentil curry (3) and on Thursday, pea soup (4) was favored by only two individuals. When these figures are multiplied to correspond to the total amount of customers, and proper confidence levels are taken into account, results for these days are as follows:

- Tuesday (1) CI 95% [2, 17], (2) CI 95% [2,18].
- Wednesday (3) CI 95% [1,17]
- Thursday (4) CI 95% [2, 18].

According to the former and the present head chef of the observed unit, the minimum number of portions prepared for a lunch is 30. As results show, wastage is mainly caused by poor menu management. Observations show that several kilos of prepared food are thrown away as waste every single day.

Conclusions and Discussion

This study assessed the potential of using different types of wastage data as a source for SNSD. Results indicated that the importance of contingent information for SNSD was high. This data should be presented to all participating parties in the most transparent manner, as suggested by prior studies. In his research regarding adaptive supply chains, transparency is a mandatory component to achieve greatest velocity and ability to manage variability (Davidrajuh, 2006). The price of ingredients per portion is a figure followed throughout the catering industry. Students' meals are subsidized by the government, production prices should be closely monitored, and alterations should be minimal in order for production to be efficient.

These elements are crucial, to new service development's mission to create new, desired service outcomes that satisfy customers' requirements. Also, increasing awareness of environmental sustainability cannot be neglected if the industry aspires to satisfy customers and achieve better financial results (Green et al., 2007).

The main source of the global food waste is the purchase of food by consumers, restaurants, and caterers, that is left uneaten. Unfortunately, results did not make an exception to this. The small role of plate waste supports current studies conducted by Häyhtiö (2016), and production waste figures corroborate industry averages illustrated by Koivupuro et.al., (2010) and Silvennoinen (2012). The average amount of food waste in the institutionalized catering is slightly over 20%. This figure includes preparation waste, service waste and plate waste. Industry averages for the following areas are 4,3%, 10,4% and 5,4% respectively.

Without any normative framework, it has been operators' responsibility to follow the principles of CSR, but this is about to change. A new European Union wide purchasing directive will

demand more transparent and precise traceability of goods and services in order to push service providers to increase their overall transparency (Hankinnat, 2016). As an end result, it is likely to increase the need to develop services and service metrics following the principles of SNSD.

Therefore, in the process of sustainable new service development both narrow and broad methods should be utilized. It can be concluded; that factors affecting sustainable service development, decision-making and capability management represent either of the two scanning areas:

- environmental awareness in the service company (narrow)
- environmental awareness of the consumers (broad)
- process development to create cost reduction (narrow)
- suppliers demand (narrow and broad)
- employee satisfaction (narrow)

(Kassinis and Soteriou, 2003)

Since food life cycle assessments are very complex, the only practical way for the restaurant to reduce the environmental impact of the stages prior to preparation and consumption is to rely on external certificates and key assumptions in purchase decisions, like preferring organic or local food. The actual effects of these decisions, however, remain unclear thus limiting their usefulness for service development.

Broad and narrow scanning are, as our work indicates, not separate areas within the SNSD. Both areas have a significant weight with respect to our case study unit, so neither can be neglected. Then again, this work manages to show what the possible obstacles are, when both areas are covered in the manner needed to achieve SNSD goals. The role of an outside regulator in SNSD, such as KELA, should not be overlooked. External operators play an important part as a source of information and regulations needed to conduct SNSD.

The work also shows the importance of well-managed operations. The role of accurate data, which is in an easily utilizable form among all the stakeholders, is crucial and should steer day-to-day development work. As Qin et al. (2009) have shown, deviations in pre-assumed service quality and food quality have effects on the overall customer satisfaction. Thus financial results are jeopardized and principles of the triple bottom line paradigm neglected.

For the case restaurant, the most significant factor in the environmental impact was the food served, and in particular, its identity, origin, and the amount wasted. The biggest source of waste is the food that goes untouched, that is, which is prepared but never delivered to customers because demand is lower than expected. Although some of it can be recovered and reused, it is unnecessary waste that could have been eliminated without any service implications. This finding was, as stated already earlier, unfortunately in line with industry averages. On the other hand, this case study showed how to effectively investigate industry wide food waste issues.

There is ongoing discussion around the topic of CSR and green approaches to the hospitality industry. This paper used another approach: a detailed case study and simulation of initial results. Simulation enhanced the ability to analyze initial data and draw more accurate results from a limited amount of data. This method should be further developed. More detailed and sophisticated service models should also be used while assessing the service processes and their environmental effects during the different service processes.

Analyses showed that the data, which is collected throughout the service processes, is crucial for SNSD. The inter-functional and inter-disciplinary nature of services demands knowledge of each participant's role in the end result. Transparency in service production helps create a responsible corporate culture that is line with customer requirements. Organizational development, which enables CSR in its various forms, is the result of a comprehensive and, most of all, constant continuous development of variables affecting the end results.

Having said that, positive results from the material flow and waste data measurement can also be achieved by the front line employees, but not without systematic screening of operational efficiency and effectiveness metrics, as our research shows. These screening mechanisms should be implemented to all on-site activities at the production phases as an integral part of a workflow. Simple metrics like efficiency ratio introduced in this paper can help operators to start to follow their material flow, enabling them to alter their production to procedures in order to meet all the stakeholder requirements sustainably. Daily comparison between the amount of dishes sold to the planned amount, measurement of unspecified waste and tighter portion control are just a few examples of easily adapted screening mechanisms. Also, more precise demand projections based on the historical data and utilization of simulations based on this data should be considered.

Based on the results, production processes and changes to the service intensity should be changed in the case unit. Current forms of self-service reduce service provider's ability to control portion sizes and material consumption. This poses a challenge for predicting daily consumption and leads to overproduction of food. Reduction of different dishes served during the lunchtime is also recommended. Limited consumption of several main courses indicates clear need to this.

While relying on certifications in purchases is a simple way to include CSR in the operations, focusing on contingent issues and operational activities is more suitable in achieving pay-offs in multiple dimensions. It is especially useful in combining different types of performance goals such as service quality, economic viability, regulatory compliance and environmental impacts.

Relying *only* on a certifications can exclude areas crucial to SNSD, such as operational efficiency, and focus the CSR activities to meet certification needs instead of contingent issues, which can more heavily impact actual sustainability, as our research indicates.

Also, operational activities create a constant and steady stream of information, which can be interpreted and used to the needs of SNSD. It is also a form of information used in the day-to-day operations management, aiding communication between different stakeholders even with sometimes contradicting goals. Partial information can be found from a number of sources, but the legacy of new product development and a great deal of competing approaches to CSR make research and development a challenging task.

Limitations of the Research

The limitations of this study are twofold:

- generalization of results from an individual case study;
- poorly managed menu management operations in the case study unit.

The first limitation is, as stated earlier, in the nature of a case study, as the first of its kind to be conducted.

The authors' suggestion for future research in SNSD development and research is that it should focus on empirically demonstrating the relationships between operational variables and their importance to the SNSD processes. Success in SNSD requires analyzed data drawn from the analysis of trends in the acknowledged key success factors. Full understanding of these key requirements in the short and long term is essential to the efficiency and effectiveness of SNSD activities.

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Figures, Images and Tables

Figure 1, Share of total food available that is lost or wasted, Source: Lipinski et.al, 2013, p 9.

Monday	13,5 kg
Tuesday	19,5 kg
Wednesday	8,5 kg
Thursday	13,5 kg
Friday	11,5 kg

Table 2, The amount of unspecified waste

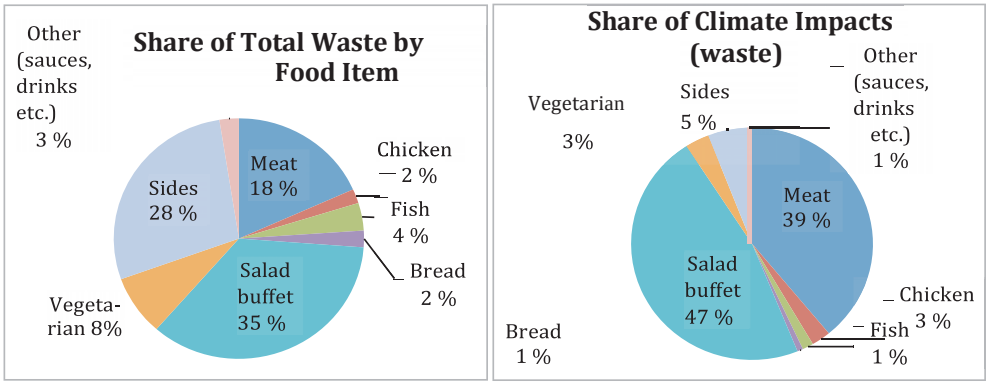

Figure 3, Share of total waste and climate impacts by food item, N=83

Efficiency ratio, counted as average calories / average price of ingredients / simulated data	**Day**	**Ratio**	**Mean energy**	**Mean price**
	Monday	**302,96**	751,70 kcal	€ 2,48
	Tuesday	**594,77**	732,47 kcal	€ 1,23
	Wednesday	**235,25**	312,76 kcal	€ 1,32
	Thursday	**247,55**	559,31 kcal	€ 2,25
	Friday	**220,76**	422,27 kcal	€ 1,91

Figure 4, Efficiency ratio

Appendix 1, Daily distribution of the **original** data (N=150) / 5 days(n=30)

Monday

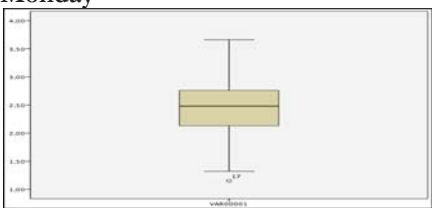

Figure 1, distribution of dish prices, n=30

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of VAR00001 is normal with mean 2,497 and standard deviation 0,67.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

[2] This is a lower bound of the true significance.

Figure 2, Test of normal distribution, dish prices, n=30

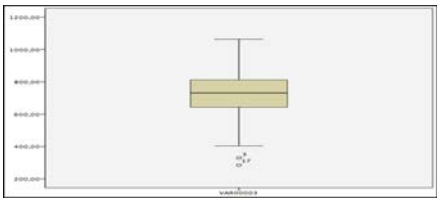

Figure 3, distribution of energy value, n=30

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of VAR00003 is normal with mean 729,320 and standard deviation 187,11.	One-Sample Kolmogorov-Smirnov Test	,155[1]	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

Figure 4, Test of normal distribution, energy value, n=30

Tuesday

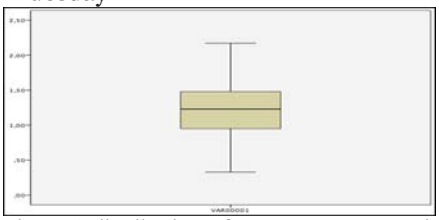

Figure 5, distribution of dish prices, n=30

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of VAR00001 is normal with mean 1,223 and standard deviation 0,45.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

[2] This is a lower bound of the true significance.

Figure 6, Test of normal distribution, dish prices, n=30

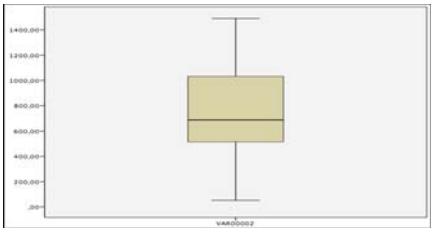

Figure 7, distribution of energy value, n=30

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of VAR00002 is normal with mean 746,502 and standard deviation 367,41.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

[2] This is a lower bound of the true significance.

Figure 8, Test of normal distribution, energy value, n=30

Wednesday

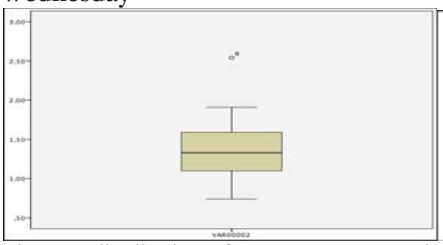

Figure 9, distribution of dish prices, n=30

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of VAR00001 is normal with mean 2,497 and standard deviation 0,67.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

[2] This is a lower bound of the true significance.

Figure 10, Test of normal distribution, dish prices, n=30

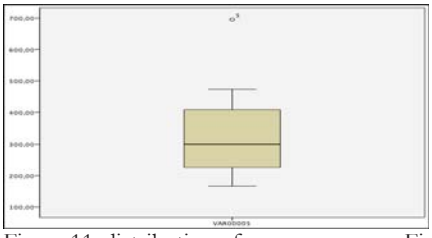

Figure 11, distribution of energy value, n=30

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of VAR00005 is normal with mean 319,325 and standard deviation 118,84.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

[2] This is a lower bound of the true significance.

Figure 12, Test of normal distribution, energy value, n=30

Thursday

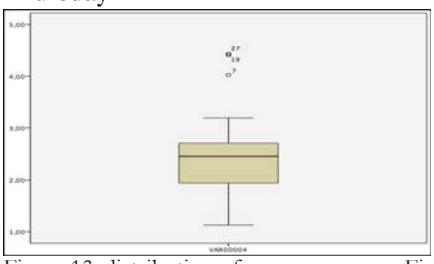

Figure 13, distribution of dish prices, n=30

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of VAR00004 is normal with mean 2,277 and standard deviation 0,55.	One-Sample Kolmogorov-Smirnov Test	,056[1]	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

Figure 14, Test of normal distribution, dish prices, n=30

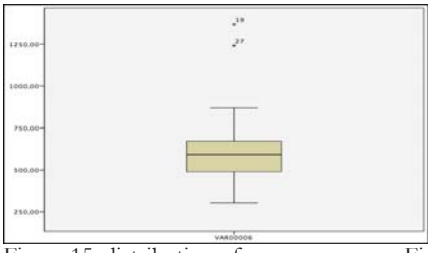

Figure 15, distribution of energy value, n=30

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of VAR00006 is normal with mean 556,251 and standard deviation 140,59.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

[2] This is a lower bound of the true significance.

Figure 16, Test of normal distribution, energy value, n=30

Friday

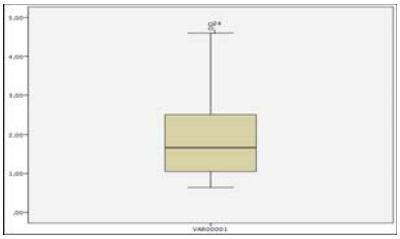

Figure 17, distribution of

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of VAR00006 is normal with mean 1,967 and standard deviation 1,11.	One-Sample Kolmogorov-Smirnov Test	,054[1]	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

Figure 18, Test of normal distribution, dish prices, n=30
dish prices, n=30

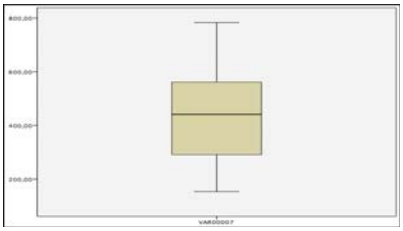

Figure 19, distribution of
n=30

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of VAR00007 is normal with mean 435,755 and standard deviation 167,34.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

[2] This is a lower bound of the true significance.

Figure 20, Test of normal distribution, energy value,
energy value, n=30

Appendix 2, Break-down of wastage

MONDAY	Number of observations	Average Amount of energy waste (kcal)/ ingredient	Average € waste / observation / ingredient
Potatoes	12	23,18	0,24
Broccoli	0	0,00	0,00
Cheese	0	0,00	0,00
Salad	9	14,76	0,09
Onion	0	0,00	0,00
Oil	0	0,00	0,00
Flour	8	48,45	0,02
Meat	0	0,00	0,00
Cottage cheese	0	0,00	0,00
Fish	8	12,54	0,10
Sour cream	6	6,93	0,01
Bread	0	0,00	0,00
Milk	0	0,00	0,00

TUESDAY	Number of observations	Average Amount of energy waste (kcal)/ ingredient	Average € waste / observation /ingredient
Pasta	5	50,61	0,04
Oil	5	53,39	0,01
Pesto	1	26,67	0,04
Onion	6	1,45	0,01
Carrot	1	1,86	0,01
Leek	1	2,60	0,02
Champignon	1	0,96	0,02
Egg	5	9,72	0,01
Milk	6	9,87	0,02
Potato	1	10,03	0,10
Celery	1	4,09	0,02
Cream	1	6,42	0,02
Salad	9	17,77	0,11
Meat	4	15,50	0,06
Bread	2	23,90	0,04

WEDNESDAY	Number of observations	Average Amount of energy waste (kcal)/ ingredient	Average € waste / observation / ingredient
Rice	6	15,77	0,01
Onion	2	0,73	0,00
Garlic	2	1,05	0,01
Vegetable mix	6	2,71	0,02
Eggplant	2	1,07	0,01
Zucchini	2	0,87	0,01
Lentil	2	2,45	0,01
Potato	0	0,00	0,00
Carrot	0	0,00	0,00
Cream	0	0,00	0,00
Tarragon	0	0,00	0,00
Salad	7	14,56	0,09
Chicken	4	6,26	0,04
Tomatoe	2	1,12	0,01
Parsley	4	0,39	0,04
Bread	3	28,68	0,05
Milk	1	36,80	0,08

THURSDAY	Number of observations	Average Amount of energy waste (kcal)/ ingredient	Average € waste / observation / ingredient
Chickpea	0	0	0
Mayonnaise	0	0	0
Potatoe	13	44,01	0,45
Milk	13	4,67	0,01
Butter	13	26,31	0,03
Salad	13	12,97	0,08
Peas	1	66,30	0,12
Ham	1	30,60	0,13
Onion	3	4,19	0,03
Meat	2	91,38	0,16
Flour	2	28,64	0,01
Oil	2	14,76	0,00
Cream	2	24,38	0,06
Bread	1	78,87	0,15

FRIDAY	Number of observations	Average Amount of energy waste (kcal)/ ingredient	Average € waste / observation / ingredient
Bbeef	8	26,24	0,13
Sweet pepper	8	2,06	0,04
Onion	8	2,21	0,01
Potato	6	50,29	0,52
Egg	0	0,00	0,00
Onion	11	2,66	0,02
Garlic	3	3,47	0,02
Tomato	3	10,36	0,09
Salad	16	22,52	0,14
Bread	1	35,85	0,06
Milk	0	0,00	0,00
Flour	8	75,63	0,02

Appendix 3, Simulated nutritional and financial values

Monday

Statistics VAR00008,		
N	Valid	302
	Missing	4
Mean		751,70
Std.,Error,of,Mean		8,60
Std.,Deviation		149,43
Range		819,22
Minimum		335,11
Maximum		1154,33
Percentiles	25	656,44
	50	748,01
	75	858,02

Monday

Statistics VAR00009	CASH*simu	
N	Valid	302
	Missing	4
Mean		2,4812
Std.'Error'of'Mean		0,03662
Median Std.'Deviation		2,45
Range		0,63638
Minimum		3,26
Maximum		0,89
Percentiles	25	4,15
	50	2,03
	75	2,45
		2,9325

Tuesday

Statistics VAR00003	NUTRI,simu	
, N	Valid	340
	Missing	0
Mean		732,471
Std.,Error,of,Mean		20,44916
Median		739,03
Mode		E355,82a
Std.,Deviation		377,06388
Range		2000,32
Minimum		E355,82
Maximum		1644,5
Percentiles	25	497,5
	50	739,03
	75	999,7575

a,Multiple,modes,exist.,The,smallest,value,is,show

Tuesday

Statistics VAR0000	CASH*simu	
4 N	Valid	340
	Missing	0
Mean		1,2315
Std.'Error'of'Mean		0,02436
Median		1,2263
Mode		C,11a
Std.'Deviation		0,4491
Range		2,5
Minimum		C0,11
Maximum		2,39
Percentiles	25	0,9107
	50	1,2263
	75	1,524

a'Multiple'modes'exist.'The'smallest'value'is'shown

Wednesday

Statistics'NUTRI'simu VAR00001'		
N	Valid	337
	Missing	0
Mean		312,7668
Std.'Error'of'Mean		5,30952
Median		308,1
Mode		188,19
Std.'Deviation		97,46986
Range		537,16
Minimum		37,8
Maximum		574,96
Percentiles	25	239,345
	50	308,1
	75	381,625

Wednesday

Statistics'CASH'simu VAR00002'		
N	Valid	337
	Missing	0
Mean		1,3295
Std.'Error'of'Mean		0,01621
Median		1,32
Mode		1,35
Std.'Deviation		0,29758
Range		1,87
Minimum		0,34
Maximum		2,21
Percentiles	25	1,15
	50	1,32
	75	1,52

Thursday

Statistics VAR00003,	NUTRI,simu	
N	Valid	340
	Missing	0
Mean		732,471
Std.,Error,of,Mean		20,44916
Median		739,03
Mode		E355,82a
Std.,Deviation		377,06388
Range		2000,32
Minimum		E355,82
Maximum		1644,5
Percentiles	25	497,5
	50	739,03
	75	999,7575

a,Multiple,modes,exist.,The,smallest,value,is,show

Thursday

Statistics VAR00004	CASH*simu	
N	Valid	340
	Missing	0
Mean		1,2315
Std.'Error'of'Mean		0,02436
Median		1,2263
Mode		C,11a
Std.'Deviation		0,4491
Range		2,5
Minimum		C0,11
Maximum		2,39
Percentiles	25	0,9107
	50	1,2263
	75	1,524

a'Multiple'modes'exist.'The'smallest'value'is'shown

Friday

Statistics'NUTRI,sim VAR00005'		
N	Valid	234
	Missing	103
Mean		422,27
Std.'Error'of'Mean		10,48777
Median		424,785
Mode		475,26
Std.'Deviation		160,43208
Range		937,97
Minimum		I·72,76
Maximum		865,21
Percentiles	25	313,0525
	50	424,785
	75	519,4175

Friday

Statistics'CASH*simu VAR00006'		
N	Valid	235
	Missing	102
Mean		1,9128
Std.'Error'of'Mean		0,06641
Median		1,93
Mode		1.88
Std.'Dev		1,0180
Range		5,19
Minimum		E0,76
Maximum	25	4,43
	50	1.24
Percentiles	75	2,68

IV

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REQUIREMENTS AS OPERATIONAL METRICS? – CASE: FINNISH DEFENSE FORCES

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Abstract
The purpose of this paper is to study how requirements management could be utilized in connection to a service performance measurement system. Public private partnership (PPP) in Finnish Defence Forces' (FDF) catering operations is studied as a case example.
There are two research questions, which are studied: Firstly, do catering operations create KPI's, which enable inter- functional co-operation and service development? Secondly, do these KPIs support both efficiency and effectiveness of PPP catering operations?
Evidence from the previous studies on the subject indicates that there should be a single "power-by-the-hour" metrics unit, which enables a transparent follow-up of the performance-based operations. This research highlights requirements value in creation of economic efficiency and effectiveness from the end-user point-of view and reciprocal value creation between inter-functional service systems. This research's results show that focus on portion control can produce information, which enhances inter-functional co-operation between PPP stakeholders.

Keywords
requirements management, performance based logistics, catering operations, public private partnership.

Introduction

Role of privately operated, previously public functions have increased their importance in Europe during the last decade. Over the past 25 years there have been more than 1300 public private partnership (PPP) contracts in EU worth more than 5 million [1]. Purpose of the PPP is to reduce costs, enhance efficiency and transfer operational risk in the operations previously run by public entity by transferring these functions to a privately run entity/company [2]. PPP is a widely studied subject but still questions referring to responsibilities, overall roles of these profit generating enterprises and most of all management of the relationship causes debate. This debate reflects the ideological background of the debate participants and easily takes the focus out of the possible, proven benefits of the PPP [3]. This research highlights requirements value in creation of economic efficiency and effectiveness from the end-user point-of view and reciprocal value creation between inter-functional service systems.

In this paper there are two research questions, which are studied: Firstly, do catering operations create KPI's, which enable inter- functional co-operation and service development? Secondly, do these KPIs support both efficiency and effectiveness of PPP catering operations?

The purpose of this paper is to study how requirements management could be utilized in connection to a service performance measurement system. Two variables representing financial requirements and customer requirements have been chosen: financial value per dish or ingredient and energy value per dish or ingredient.

Concept of Key Performance Indicators (KPIs) was introduced by two Harvard professor Robert Kaplan and David Norton already 1992 [4]. Purpose of

the KPIs is to measure non-financial metrics and add them to the more traditional financial metrics while assessing company's results. A decision to use KPIs in the service operations' development is a quite natural one. Having said that, there are service specific features, which must be taken in to consideration.

According to [5], services are produced and consumed simultaneously. Therefore there is a real risk that predefined KPIs do not reflect the actual production/consumption process. KPIs in the form of requirements increase transparency and offer an unambiguous form of communications between stakeholders. More precise, but simple customer centric outcome metrics enable development of operations without compromising each stakeholders predetermined goals. This demands a structured mechanism to gather, collect and analyse these goals and use of requirements management can improve these processes. Further more, well-defined requirements contribute to the service operations management development relevant disciplines, such as strategic management, organizational behaviour and service marketing.

PPP requires a management model or an approach, which combines service production, transparent metrics in a form of requirements and interfunctional process management. Performance based logistics is a system, which focuses on the outcome of the service processes which value is always defined by the beneficiary of the service product [6, 7]. Outcome of the service processes should be in the form of pre-defined requirements. Results from the earlier researches indicate that requirements management enhances the overall effectiveness. Goal oriented requirements management steers sub-system development and management and reduces individual subsystem development at the cost of the common goal [8, 9]. Management model is scalable to other industries than one research here, but there must be a high contingent operations' awareness. Development requirements must be formed to suit existing operational production environment and process beneficiaries.

Public Private Partnership

A Public private partnership exists when a public authority is transferred to private sector. This authority transfer fulfils private and public outcomes previously offered by a public entity [10]. In PPP a long-term goal is to increase public service efficiency by using private service provider [1]. In PPP the whole life-cycle of the contract is linked to the several metrics such as quality of the service delivered and level of the service delivered [11]. These metrics should enable constant follow-up and development in a way, which can help to negotiate performance based contracts. Metrics should be transparent and both risks and rewards should be shared following the basic principles of the PPP, illustrated in the Table 1.

Table 1
Public Private Partnership.

Wang, 2009, p. 779 [12]	"... partnerships, involves a far more intensive interaction (or synergy), which requires strategic collaboration and inter-tangled action between the public and private parties from the very beginning of a project. ln a partnership, two parties conduct joint decision making and specify the problem, solution, and product in the joint process."
Demirag et al., 2012, p. 1318 [2]	"... involves the public and private sectors sharing the risks and rewards on clearly defined projects financed by the private sector."

As reference [11] research's results showed, diversity in PPP has increased during the past years. Part of this change is also witnessed in Finland. A public entity, Finnish Defence Forces (FDF) has formed strategic PPPs with several private operators [13]. One of these strategic partners is Leijona Catering, which runs all the catering operations on behalf of the FDF.

In a PPP all financial rewards should be tied to any contract extension or renewal to contractor's achievement [14]. Controlling and monitoring process of the partnership should respect both parties and measures should be as neutral as possible. Efficiency should be measured in a way that the principle described by Doerr et al. (2005, p. 167) is met:

"Are purchasers sufficiently rational and careful, and the quality of the service sufficiently definable and measurable, that effective, informed consumer sovereignty can be exercised?" [15].

One should bear in mind that in their research by [16] bring to a readers attention a fact that benefits of privatization are not clear-cut.

Performance based logistics (PBL) – a service management model in a military context

Service as a research discipline is very fragmented and development of services requires a multidiscipline approach [9]. One of these approaches (in

military context) is PBL, a combination of several logistics function [17]. Each of these logistics functions/services and the whole service system requires a measurable outcome, a KPI. These intra-entity and inter-entity KPIs form the service system measurement network. Therefore management and development of a PBL system requires a goal given in the form of requirements and embedded network, as work by [4] and [18] shows.

In performance-based logistics (PBL) responsibility of the product/service system management is on a supplier of the system, unlike in the traditional end-user – supplier relationship [19]. In PBL according to Berkowitz et al. (2003, p. 5):

"...contractual mechanisms will include long-term relationships and appropriately structured incentives with service providers..., to support the end user's (warfighter's) objectives." [20].

In PBL a customer buys predetermined outcomes. These outcomes are dependent on and simultaneously vulnerable to outcomes of sub-systems. This interdependency is similar to the service systems and demands close co-operation among the whole supply chain [21]. A widely used example of the PBL is the case of Rolls-Royce. Rolls-Royce built a contract model in which a fixed price per flying hour covered all the maintenance and spare parts. This made it possible to predict the cost of the service and reduced the uncertainty of the purchaser [9].

Efficient PBL operations demand a completely transparent set of simple, realistic, consistent and easily quantifiable metrics [6]. They should support all the operations and take into account all the stakeholder groups participating to the service production [3]. Therefore a traditional customer centric service development perspective is not fully valid notwithstanding research by authors such as [5, 7, 22, 23].

In our case example FDF purchases an outcome of the service, provided by the catering operator Leijona Catering. There are two outcomes of this service purchase: firstly, FDF fills it's obligation according to national legislation to offer nutrition to every serviceman and secondly service supports the individual capabilities of a single serviceman by providing a necessary nutrition and energy [24]. These outcomes form the base for the service requirements.

Requirements management

Requirements are either qualitative or quantitative properties, characteristics, expectations of the product or behaviours of the product [25]. Use of requirements management in the service development is almost self-evident. Because a value of the service is defined by the beneficiary as described by [7] this value is evaluated not how something is done but what is the outcome of the obtained service. In PBL services are defined in terms of results rather than how results are achieved. Therefore there is a need to use standards, which measure performance a system must conform in a form of requirements [26, 27].

Research design

Evidence from the previous servication studies indicates, that there should be a single "power-by-the-hour" metrics unit, which enables a transparent follow-up of the operations [28]. Purpose of the empirical research was to find statistically valid KPIs, which would meet customer, buyer and end-user requirements. In the study catering operations were defined as a supporting function for the military. This notion gave a clear framework to catering services in a military capability development framework, as stated by [29]. Although catering operations function in a peacetime environment, it obviously has a significant role in the FDF during a crises situation. This is a fact, which simply can't be ignored while studying peacetime PPP between FDF and its partners. Research framework is illustrated in the Fig. 1.

The catering operations were studied in one food service unit for a time period of five days in February 2016. Before the data collection period a restaurant manager was interviewed, recipies of each meal were researched and standardised data collection methods were agreed. This reduced the research bias during the observation period.

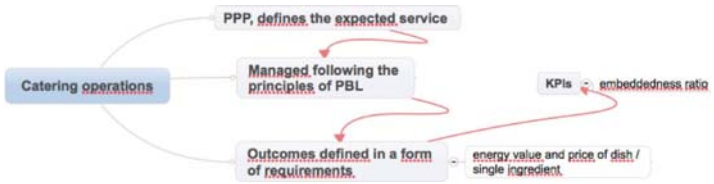


Fig. 1. Research design.

Case unit offers its services daily approximately to 700 customers, three times a day [30]. Of these 700 customers, 40 individuals were daily randomly chosen during each meal for measuring energy (kcal), realized financial value (euros) per dish and possibly produced plate waste also in kcal and euros.

A number of observations per meal was restricted due to the research environment and restricted time frame per meal. Only background information collected from the observed servicemen was their height and weight. These figures were collected for identification purposes and for the possible further analysis.

During the data collection process authors used minimum six research assistants to collect and measure empirical data. Each research assistant used precision scale which accuracy was guaranteed by using a standardised comparison weight. Each portion in the sample was weighted before and after consumption, component by component. Results were recorded by the author and transferred to the Excel spread sheet program for the further analysis.

During the observation period service provider offered 73 breakfast items, 69 lunch items and 63 dinner items. There were 11 to 15 articles served on each meal even without separation of the ingredients in the dishes. Separation of ingredients was not necessary, because service provider had calculated energy and monetary values per dish. Also, same items such as porridge, milk and bread were served during the observation period on various meals, but they were taken into consideration during the calculations due to the energy value and cost they created. In the first phase energy and financial value sums of each observations were calculated.

Altogether there were 2 (collection and waste)*600 observations (servicemen) and each of these observations had 11–15 articles as observation points. For the each individual observation point energy value and financial value was calculated and distribution and t-tests of these values were calculated using SPSS program. Results of these tests are illustrated in the Appendices 1 and 4. If a distribution did not follow the normal distribution a box-plot analysis was conducted. Purpose of this analysis was to find the possible outliers in the data set. Results of this analysis are illustrated in the Appendix 2.

These results were compared to the figures, which form the base for the contract between FDF and a service provider. After the comparison authors studied a change to create an "embeddednes ratio", which would act as a single "power-by-the-hour" – figure. This ratio would be built using the following variables if current metrics did not provide adequate information about efficiency and effectiveness of catering operations:

a = taken portion or ingredient calculated by the monetary value, €;

b = taken portion or ingredient calculated by the energy value, kcal;

c = predetermined monetary value of a portion or ingredient, €;

d = predetermined energy value of a portion or ingredient, kcal;

e = plate waste by energy value, kcal;

f = plate waste by monetary value, €;

g = number of customers informed in advance;

h = actual number of customers.

Results

There were two research questions studied: Firstly, do catering operations create KPI's, which enable inter- functional co-operation and service development? Secondly, do these KPIs support both efficiency and effectiveness of PPP catering operations?

Two variables representing financial requirements and customer requirements were chosen: financial value per dish or ingredient and energy value per dish or ingredient.

These variables represented efficiency and effectiveness, respectively. Results indicate that there is a need to improve both areas. This could lead to reduced costs, enhanced efficiency and transfer operational risk in the operations previously run by the public entity.

Efficiency

Efficiency was researched by calculating variables measuring service provider's ability to produce predemanded amount of dishes for the predetermined financial value. These figures are strongly affected by the information given by the service buyer in the form of number of expected customers.

During the research period alterations of the manpower figure were between +6% to −19%, where a negative number indicates that the actual number of customers was smaller than announced.

Second computed metrics, which affected efficiency was a plate waste created by each customer. Rationale behind this figure was that if there was no plate waste, service provider managed to offer its products efficiently. Thus, service offering was created in a manner, which was efficient, because customer (end-user) requirements in the form of energy (there was right amount food) and taste (no left-overs) were met.

Role of plate waste was found to be almost insignificant. None of the daily observations followed the normal distribution. Amount of zero plate waste varied between 24–34 observations per meal and total amount of plate waste in kcal is very small. Results of plate waste t-tests and t-test of distribution are illustrated in the Appendix 3. Actual figures from the sample are illustrated in the Table 2.

Third computed efficiency metrics concerned the monetary value of meals, calculated by the mean sum of all ingredients each serviceman collected from the self-service line. An alarming notion was, that there were only three meals, which met predetermined financial values. Overall results are illustrated in the Table 3.

Table 2
Amount of plate waste created by the sample.

		Plate waste (kcal) created by 40 servicemen	Offered energy/ 40 servicemen	Offered – plate waste [kcal]	% difference
Monday	Breakfast	1034	36160	35126	2.86
	Lunch	756	35680	34924	2.12
	Dinner	1278	38000	36722	3.36
Tuesday	Breakfast	347	34040	33693	1.02
	Lunch	359	42800	42441	0.84
	Dinner	776	41480	40704	1.87
Wednesday	Breakfast	3799	32360	28561	11.74
	Lunch	2852	58560	55708	4.87
	Dinner	3360	38960	35600	8.62
Thursday	Breakfast	1985	34760	32775	5.71
	Lunch	1049	48040	46991	2.18
	Dinner	1383	34640	33257	3.99
Friday	Breakfast	744	31240	30496	2.38
	Lunch	1516	46000	44484	3.30
	Dinner	3445	52000	48555	6.63

Table 3
Mean financial value per meal, predetermined, difference and confidence interval (CI), values calculated as the difference between predetermined and actual in euros.

		Mean financial value [%]	Difference, Pre vs. mean [%]	CI** [%]
Mon	Breakfast	54	46	3.2
	Lunch	84	16	4.3
	Dinner	94	**6*****	1.0
Tue	Breakfast	59	42	4.2
	Lunch	81	19	1.6
	Dinner	103	**−3*****	3.8
Wed	Breakfast	68	32	10.3
	Lunch	57*	43	3.0
	Dinner	91	9	11.1
Thu	Breakfast	57	43	6.2
	Lunch	85	15	3.8
	Dinner	91	9	6.2
Fri	Breakfast	49	51	4.0
	Lunch	70	30	4.3
	Dinner	112	**−12*****	8.8
		% from the pre-determined	Pre vs. mean [%]	

* – distribution was not normal, ** – confidence interval mean financial value taken,
*** – predetermineated financial value met

Effectiveness

Effectiveness of the operations was calculated by the energy provided to the servicemen. Overall results are illustrated in the Table 4. Again, drastically only one meal met or exceeded the predetermined energy levels. A "Difference" variable from these effectiveness observations should be multiplied by the amount of actual customer and divided by the number of predetermined energy level, in order to follow production *efficiency* and to control over production.

For the further statistical analysis a one-sample T-test was run. Its results illustrated in the Appendix 4 show the confidence interval, which should be taken into consideration when comparing results.

When all the variables were added up and converted to monetary values, the total difference during the five day observation period was as high as €5147,12. This amount takes into account energy value not consumed and a mistakes in manpower figures. Kcal to € conversion is illustrated on a Table 5.

Table 4
Mean energy taken, predetermined energy, difference and confidence interval.

		Mean energy taken +/− CI** [kcal]	Predetermined Energy [kcal]	Difference Pre vs. mean [kcal]	CI** +/−
Monday	Breakfast	657	904	247	73.844
	Lunch	723	892	169	72/50
	Dinner	857*	950	93	79.953
Tuesday	Breakfast	534*	851	317	61.828
	Lunch	714	1070	356	73.892
	Dinner	797	1037	240	78.247
Wednesday	Breakfast	551	809	258	58.425
	Lunch	1065	1464	399	105.097
	Dinner	773	974	201	72.522
Thursday	Breakfast	512	869	357	52.010
	Lunch	966	1201	235	82.567
	Dinner	640	866	226	51.1631
Friday	Breakfast	438	781	343	66.970
	Lunch	812	1150	338	63.927
	Dinner	1405	1300	−105***	130.023

* –distribution was not normal, ** – confidence interval mean energy taken, *** – predeterminated energy value met

Table 5
Kcal converted to monetary values.

		Average difference between pre-announced and actual consumption [kcal]	Number of servicemen using the service	Total difference in kcal	Pre-announced kcal/whole meal [kcal]	Total difference in pre-announced meals	Pre-announced monetary value/meal all ingredients [€]	Total financial effect [€]
Monday	Breakfast	247	933	230451	904	255	0.94	239.70
	Lunch	169	684	115596	892	130	1.82	236.60
	Dinner	93	648	60264	950	63	1,17	73.71
Tuesday	Breakfast	317	749	237433	851	279	1.15	320.85
	Lunch	356	619	220364	1070	206	1.50	309.00
	Dinner	240	614	147360	1037	142	1.37	194.54
Wednesday	Breakfast	258	706	182148	809	225	1.28	288.00
	Lunch	399	612	244188	1464	167	2.84	474.28
	Dinner	201	748	150348	974	154	2.64	406.56
Thursday	Breakfast	357	779	278103	869	320	0.96	307.20
	Lunch	235	661	155335	1201	129	0.9	119.97
	Dinner	226	723	163398	866	189	1.39	262.71
Friday	Breakfast	343	824	282632	781	362	0.82	296.84
	Lunch	338	550	185900	1150	162	1.39	225.18
	Dinner	**−105**	195	**−20475**	1300	**−16**	1.37	**−21.92**
								3733.22

Conclusion

In the best-case situation efficiency and effectiveness figures could be used to create an "embeddedness ratio". If the optimal situation were met a figure would indicate three things. Firstly, portions' energy and monetary value would match the planned and bought outcome. Secondly, no plate waste would be created, indicating good end-user value of the provided service. Thirdly, production process would be efficient, because no over production would exist. This figure would function as a single "power-by-the-hour" – figure and give a transparent and objective base for PPP development following PBL principles.

Even without a new ratio, results clearly indicate that there is a need to streamline operations and alter the principal foundation of the contract. Based on the results it can be concluded that catering operations create KPI's, which would enable inter-functional co-operation and service development with the help of "embeddedness ratio". This KPI would support both efficiency and effectiveness of PPP catering operations better than currently used individual metrics.

Current metrics are not simple, realistic, consistent and easily quantifiable and therefore they do not serve PBL purposes in the PPP between FDF and Leijona Catering.

Service provider followed its own efficiency and sales margin by each individual meal. In PBL framework this figure should be compared to the served energy value and if predetermined energy values are not met, a service provider should return an agreed amount of compensation. This is not possible if the financial deviations are not specified. Only three meals met predetermined financial value indicating overpricing of served meals.

Efficiency was affected by the FDF's own inefficiency too. Currently FDF uses only headcount of the servicemen as a base of its efficiency metrics. Duty officers inform catering unit the manpower figures calculated in the companies. Rapid changes in the training program, calculation mistakes and other human errors make this figure highly unreliable. In order to specify this figure, catering unit calculates used trays after each meal and gives a deviation figure in percentages. Both of these methods are vulnerable to inaccuracies and malpractice.

Used percentage figure told very little about efficiency in the terms of requirement set by FDF. Demand fluctuation in the observed catering unit was large. In the Monday morning restaurant served 933 servicemen and on the Friday dinner there were only 195 customers. On the other hand this Friday dinner had the largest percentage deviation in the informed and actual customer number. Therefore the actual difference calculated by the number of customers (43 individuals) is obviously smaller despite a significantly larger percentage figure (−19%) compared e.g. to Monday breakfast 103 individuals and −10%. Manpower alterations increase the overproduction of dishes reducing efficiency significantly.

Effectiveness of the operations was researched studying the energy values of the served dishes. Only one meal reached or exceeded the predetermined energy value. This has imminent effect to the efficiency due to the over production of food. It can be stated that in the PBL framework the service provider does not meet the service buyers or end-users' objectives.

While going through the conclusion, one has to bear in mind that this research was limited to an individual business unit within a single industry. Having said that results are very much in line with the previous researches. Examples by [31, 32] indicate both benefits of PBL and possible limitations of it which are similar to our results.

Limitations of the study

Limitations of study relate to the nature of the case study. Firstly, this study represents only one individual garrison at the capital area of Finland. Secondly, the observed food service unit is located closely to the commercial foodservices. There is a risk that consuming behavior outside the service hours makes generalization of the results more difficult. Thirdly, there is always a risk that case study in the closed environment affects the individuals, whose behavior is monitored and studied. Fourthly, a closed environment, such as garrison makes it difficult to generalize these results to the purely commercial environment.

Author used data triangulation in order to minimize all described but still possible limitations.

Recommendation for the future research

Further empirical research on the use of embeddedness ratio would increase transparency and reduce misinterpretations between stakeholders. For further studies authors recommend analysis, which would concentrate on identifying possible cluster centers from the vast amount of collected data. Cluster analysis run on all the individual cases (customers), each answer responding to individual ingredients served in the form of requirements would help

to create more efficient and effective PPP. Also nutritional values and environmental effects of the food production could be researched using the vast empirical data. Purely customer centric survey would increase customer perspective and possibly gain service provider's efficiency and effectiveness due to better customer satisfaction. These issues were outside the scope of this research but they can't be neglected in the future research.

Appendix 1

Test of normal distribution, kcal and monetary value of **taken** meals.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of VAR00003 is normal with mean 0,578 and standard deviation 0,21.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
2	The distribution of VAR00004 is normal with mean 657,016 and standard deviation 230,89.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
3	The distribution of VAR00005 is normal with mean 1,516 and standard deviation 0,44.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
4	The distribution of VAR00006 is normal with mean 723,679 and standard deviation 226,69.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
5	The distribution of VAR00007 is normal with mean 1,096 and standard deviation 0,33.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
6	The distribution of VAR00008 is normal with mean 857,432 and standard deviation 250,00.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Reject the null hypothesis.
7	The distribution of VAR00009 is normal with mean 0,675 and standard deviation 0,28.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
8	The distribution of VAR00010 is normal with mean 534,832 and standard deviation 193,32.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Reject the null hypothesis.
9	The distribution of VAR00011 is normal with mean 1,217 and standard deviation 0,37.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
10	The distribution of VAR00012 is normal with mean 714,498 and standard deviation 231,05.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
11	The distribution of VAR00013 is normal with mean 1,412 and standard deviation 0,50.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

[2] This is a lower bound of the true significance.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
21	The distribution of VAR00023 is normal with mean 0,821 and standard deviation 0,29.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
22	The distribution of VAR00024 is normal with mean 966,902 and standard deviation 258,17.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
23	The distribution of VAR00025 is normal with mean 1,256 and standard deviation 0,35.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
24	The distribution of VAR00026 is normal with mean 648,444 and standard deviation 159,98.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
25	The distribution of VAR00027 is normal with mean 0,404 and standard deviation 0,23.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
26	The distribution of VAR00028 is normal with mean 438,172 and standard deviation 209,40.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
27	The distribution of VAR00029 is normal with mean 0,966 and standard deviation 0,31.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
28	The distribution of VAR00030 is normal with mean 812,390 and standard deviation 199,89.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

[2] This is a lower bound of the true significance.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
12	The distribution of VAR00014 is normal with mean 797,864 and standard deviation 244,66.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
13	The distribution of VAR00015 is normal with mean 0,874 and standard deviation 0,30.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
14	The distribution of VAR00016 is normal with mean 551,914 and standard deviation 182,68.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
15	The distribution of VAR00017 is normal with mean 1,613 and standard deviation 0,62.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Reject the null hypothesis.
16	The distribution of VAR00018 is normal with mean 1 020,890 and standard deviation 328,62.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
17	The distribution of VAR00019 is normal with mean 2,389 and standard deviation 0,70.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
18	The distribution of VAR00020 is normal with mean 773,364 and standard deviation 226,76.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
19	The distribution of VAR00021 is normal with mean 0,554 and standard deviation 0,19.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
20	The distribution of VAR00022 is normal with mean 512,726 and standard deviation 162,62.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

[2] This is a lower bound of the true significance.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
29	The distribution of VAR00031 is normal with mean 1,535 and standard deviation 0,44.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.
30	The distribution of VAR00032 is normal with mean 1 405,306 and standard deviation 406,56.	One-Sample Kolmogorov-Smirnov Test	,200[1,2]	Retain the null hypothesis.

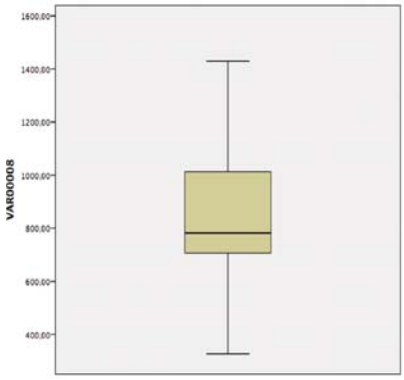
Asymptotic significances are displayed. The significance level is ,05.

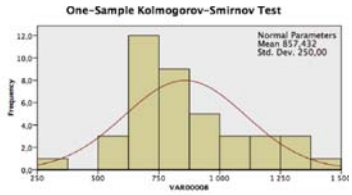
[1] Lilliefors Corrected

[2] This is a lower bound of the true significance.

Appendix 2

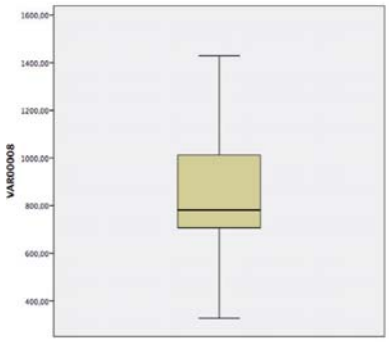
Test of outliers, observations which did not follow normal distribution.

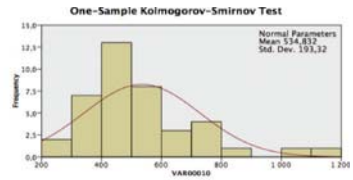




Total N		40
Most Extreme Differences	Absolute	,159
	Positive	,159
	Negative	-,088
Test Statistic		,159
Asymptotic Sig. (2-sided test)		,012[1,2]

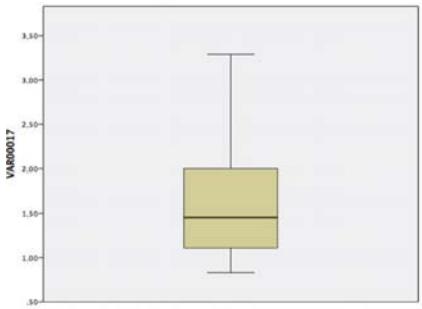
[1] Lilliefors Corrected
[2] This is a lower bound of the true significance.

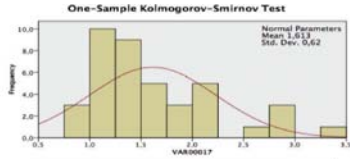




Total N		40
Most Extreme Differences	Absolute	,167
	Positive	,167
	Negative	-,098
Test Statistic		,167
Asymptotic Sig. (2-sided test)		,006[1,2]

[1] Lilliefors Corrected
[2] This is a lower bound of the true significance.





Total N		40
Most Extreme Differences	Absolute	,171
	Positive	,171
	Negative	-,102
Test Statistic		,171
Asymptotic Sig. (2-sided test)		,005[1,2]

[1] Lilliefors Corrected
[2] This is a lower bound of the true significance.

Appendix 3

T-test and test of distribution for **plate waste** values.

One-Sample Test

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Mon, *B, €	3,694	39	,001	,03125	,0141	,0484
Mon, B, kcal	4,007	39	,000	25,84925	12,8003	38,8982
Mon, *L, €	2,276	39	,028	,04350	,0048	,0822
Mon, L, kcal	2,006	39	,052	18,89725	−,1601	37,9546
Mon, *D, €	1,837	39	,074	,00550	−,0006	,0116
Mon, D, kcal	2,121	39	,040	31,94950	1,4814	62,4176
Tue, B, €	2,428	39	,020	,02875	,0048	,0527
Tue B, kcal	2,664	39	,011	8,67575	2,0896	15,2619
Tue, L, €	2,456	39	,019	,01450	,0026	,0264
Tue, L, kcal	2,705	39	,010	8,96725	2,2611	15,6734
Tue, D, €	2,010	39	,051	,02600	−,0002	,0522
Tue, D, kcal	2,265	39	,029	19,39025	2,0736	36,7069
Wed, B, €	4,485	39	,000	,14675	,0806	,2129
Wed B, kcal	4,483	39	,000	94,98600	52,1253	137,8467
Wed,L, €	2,968	39	,005	,06175	,0197	,1038
Wed, L, kcal	3,465	39	,001	71,30575	29,6791	112,9324
Wed, D, €	4,630	39	,000	,33650	,1895	,4835
Wed D, kcal	5,209	39	,000	84,00050	51,3855	116,6155
Thu, B, €	3,041	39	,004	,04500	,0151	,0749
Thu, B, kcal	2,888	39	,006	49,62525	14,8654	84,3851
Thu, L, €	2,222	39	,032	,02000	,0018	,0382
Thu, L, kcal	2,388	39	,022	26,23675	4,0164	48,4571
Thu, D, €	3,049	39	,004	,06550	,0221	,1089
Thu D, kcal	3,046	39	,004	34,57125	11,6152	57,5273
Fri, B, €	2,140	39	,039	,01725	,0009	,0336
Fri, B, kcal	2,940	39	,005	18,60850	5,8078	31,4092
Fri, L, €	2,458	39	,019	,03600	,0064	,0656
Fri, L, kcal	3,142	39	,003	37,90875	13,5052	62,3123
Fri, D, €	2,956	39	,005	,08850	,0280	,1490
Fri, D, kcal	3,127	39	,003	86,11950	30,4181	141,8209

*B – breakfast, L – lunch, D – dinner.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of VAR00001 is normal with mean 0,031 and standard deviation 0,05.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
2	The distribution of VAR00002 is normal with mean 25,849 and standard deviation 40,80.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
3	The distribution of VAR00003 is normal with mean 0,044 and standard deviation 0,12.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
4	The distribution of VAR00004 is normal with mean 18,897 and standard deviation 59,59.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
5	The distribution of VAR00005 is normal with mean 0,006 and standard deviation 0,02.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
6	The distribution of VAR00006 is normal with mean 31,950 and standard deviation 95,27.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
7	The distribution of VAR00007 is normal with mean 0,029 and standard deviation 0,07.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
8	The distribution of VAR00008 is normal with mean 8,676 and standard deviation 20,59.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
9	The distribution of VAR00009 is normal with mean 0,014 and standard deviation 0,04.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
10	The distribution of VAR00010 is normal with mean 8,967 and standard deviation 20,97.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
11	The distribution of VAR00011 is normal with mean 0,026 and standard deviation 0,08.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
12	The distribution of VAR00012 is normal with mean 19,390 and standard deviation 54,15.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
13	The distribution of VAR00013 is normal with mean 0,147 and standard deviation 0,21.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
14	The distribution of VAR00014 is normal with mean 94,986 and standard deviation 134,02.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
15	The distribution of VAR00015 is normal with mean 0,062 and standard deviation 0,13.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
16	The distribution of VAR00016 is normal with mean 71,306 and standard deviation 130,16.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
17	The distribution of VAR00017 is normal with mean 0,336 and standard deviation 0,46.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
18	The distribution of VAR00018 is normal with mean 84,000 and standard deviation 101,98.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
19	The distribution of VAR00019 is normal with mean 0,045 and standard deviation 0,09.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
20	The distribution of VAR00020 is normal with mean 49,625 and standard deviation 108,69.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
21	The distribution of VAR00021 is normal with mean 0,020 and standard deviation 0,06.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
22	The distribution of VAR00022 is normal with mean 26,237 and standard deviation 69,48.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
23	The distribution of VAR00023 is normal with mean 0,066 and standard deviation 0,14.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
24	The distribution of VAR00024 is normal with mean 34,571 and standard deviation 71,78.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
25	The distribution of VAR00025 is normal with mean 0,017 and standard deviation 0,05.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
26	The distribution of VAR00026 is normal with mean 18,608 and standard deviation 40,03.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
27	The distribution of VAR00027 is normal with mean 0,036 and standard deviation 0,09.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
28	The distribution of VAR00028 is normal with mean 37,909 and standard deviation 76,30.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
29	The distribution of VAR00029 is normal with mean 0,088 and standard deviation 0,19.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.
30	The distribution of VAR00030 is normal with mean 86,120 and standard deviation 174,17.	One-Sample Kolmogorov-Smirnov Test	,000[1]	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Lilliefors Corrected

Appendix 4

One sample T-test, difference between announced monetary values and actual energy.

One-Sample Test

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Mon, *B, €	17,261	39	,000	,57750	,5098	,6452
Mon, B, kcal	17,997	39	,000	657,01600	583,1724	730,8596
Mon, *L, €	21,979	39	,000	1,51550	1,3760	1,6550
Mon, L, kcal	20,190	39	,000	723,67875	651,1798	796,1777
Mon, *D, €	21,098	39	,000	1,09625	,9912	1,2013
Mon, D, kcal	21,692	39	,000	857,43225	777,4789	937,3856
Tue, B, €	15,514	39	,000	,67525	,5872	,7633
Tue, B, kcal	17,497	39	,000	534,83175	473,0039	596,6596
Tue, L, €	20,666	39	,000	1,21725	1,0981	1,3364
Tue, L, kcal	19,558	39	,000	714,49775	640,6054	788,3901
Tue, D, €	17,799	39	,000	1,41225	1,2518	1,5727
Tue, D, kcal	20,625	39	,000	797,86425	719,6172	876,1113
Wed, B, €	18,462	39	,000	,87350	,7778	,9692
Wed B, kcal	19,107	39	,000	551,91375	493,4887	610,3388
Wed,L, €	16,543	39	,000	1,61325	1,4160	1,8105
Wed, L, kcal	19,648	39	,000	1020,89000	915,7928	1125,9872
Wed, D, €	21,466	39	,000	2,38910	2,1640	2,6142
Wed D, kcal	21,570	39	,000	773,36350	700,8410	845,8860
Thu, B, €	18,018	39	,000	,55425	,4920	,6165
Thu, B, kcal	19,940	39	,000	512,72600	460,7163	564,7357
Thu, L, €	17,942	39	,000	,82100	,7284	,9136
Thu, L, kcal	23,687	39	,000	966,90200	884,3347	1049,4693
Thu, D, €	22,951	39	,000	1,25650	1,1458	1,3672
Thu, D, kcal	25,636	39	,000	648,44350	597,2804	699,6066
Fri, B, €	11,142	39	,000	,40350	,3302	,4768
Fri, B, kcal	13,234	39	,000	438,17150	371,2018	505,1412
Fri, L, €	19,585	39	,000	,96650	,8667	1,0663
Fri, L, kcal	25,705	39	,000	812,39028	748,4633	876,3173
Fri, D, €	22,184	39	,000	1,53500	1,3950	1,6750
Fri, D, kcal	21,861	39	,000	1405,30650	1275,2831	1535,3299

*B – breakfast, L – lunch, D – dinner.

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A Comprehensive Assessment Model for Critical Infrastructure Protection

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Abstract

International business demands seamless service and IT-infrastructure throughout the entire supply chain. However, dependencies between different parts of this vulnerable ecosystem form a fragile web. Assessment of the financial effects of any abnormalities in any part of the network is demanded in order to protect this network in a financially viable way. Contractual environment between the actors in a supply chain, different business domains and functions requires a management model, which enables a network wide protection for critical infrastructure. In this paper authors introduce such a model. It can be used to assess financial differences between centralized and decentralized protection of critical infrastructure. As an end result of this assessment business resilience to unknown threats can be improved across the entire supply chain.

Keywords: Critical infrastructure, supply chains, capability management, risk management, cyber, service

1 Introduction

The history of international trade is long. The role of globalization has steered development toward increasing global alignment of activities across countries, operations and market offerings [1]. Importance of international trade is tremendous for modern economies. A study conducted by the Bertelsmann Foundation's Global Economic Dynamics program [2] reveals the fact that one of the largest beneficiaries of the global trade was Finland with the annual gain in the income per capita of about € 1500,-.

Despite the fact that international trade has deep roots, its significance has never been as great as it is now. Clear, positive effects of globalization as a mechanism to spread wealth cross borders have made it possible to create a web of enterprises that work closely together across the globe. But there is a downside to this: a global network of organizations working together increases the possibility of risks due to their dependency on inter-discipline information.

Protection of the critical components of the supply chain has to cover critical, recognized nods and most important production systems and their sub-systems. Then again, as Lewis [3] points out, actors participating in supply chain management are commercial companies whose main purpose is to run commercially viable operations. Therefore Critical Infrastructure Protection (CIP) is not their first priority, but still an essential part of business due to its financial importance. Also, international trade expands its web so widely, that regional conflicts or crises are seldom a concern for other countries from any other point-of-view than commercial. These actors have streamlined their operations to the point that no back-up systems exist [3].

The supply chain systems' operations' four functions have to be analyzed across organizations. According to Beer [4], these four functions are implementation, coordination, control and intelligence.

In detail, these functions consist of:

1) Implementation consists of daily operations, which enable production of physical products and services.

2) The coordination function consists of the regulating system (task, authority, responsibilities), which is used to manage production operations.

3) The control function consists of supervision and management of the operations related to the implementation and coordination of production of physical goods and services.

4) Intelligence consists of functions relating to the adaptation of environmental changes.

Each one of these functions is built and run as a set of predefined processes. These processes are vulnerable to both uncertainties and risks. The protection of critical infrastructure requires thorough assessment of vulnerabilities and risks at process and individual component levels. Additionally, cross-functional operations require a set of abilities, which enable efficient management of operations and minimization of vulnerabilities and risks. As stated earlier, there is a need to assess all the parts of the business domain's supply chain and reflect the results to the pre-determined outcomes. Capability management as a management tool gives a clear structure for the definition process of risks. This provides a general picture and helps to concentrate on the relevant risks [5].

There are 2 research questions the authors are trying to answer in this paper:

1) What are the potential financial benefits of concentrating on prevention compared to the protection of the total supply chain?

2) Which capability indicators affect supply chain CIP operations?

The functionality of the model is assessed by collecting information from the actualized attacks against a recognized component, assessing and analyzing the time this attack was effective and analyzing its effects on the component's functionality.

A significant element in the analysis is the attack vector. The purpose of attack vector analysis is to assess how increased observation capability could minimize the attacker's effect on the target component, and compare the costs between centralized observation and systems wide observation. This enables cost benefit analysis between centralized and out-sourced service provision.

One has to notice that even though the attacker is stopped in time 0, there is the possibility of severe reputation loss, which has possible negative financial effects, even though the threat did not become a reality.

All the elements affecting CIP are illustrated in the appendix 1.

The paper proceeds as follows. First, we will examine the uncertainty in the service networks and describe the elements of domain assessment in CIP. Next, we address the problem of unknown threat that exists in contractual environment of CIP. Lastly, we propose an approach for improving business resilience to overcome the problems described. We will conclude with key findings and a proposition of the future research.

2 Uncertainty in the service networks

Uncertainty is defined as "the difference between the amount of information required to perform the task and the amount of information already possessed by that organization." [6, p.5.] With risk we refer to the possible outcomes of an action, specifically to the loss that might be incurred if a given action is not taken [7]. A risk combines two attributes i.e. probability and impact. Probability is a measure of how often a detrimental event, which results in a loss, occurs. Impact refers to the significance of that loss to the organization. The level of risk is then perceived as the likelihood of occurrence of a detrimental event and the significance (impact) of that event [8, p.397). Time should be considered as a variable in each analysis, and the effect time has on vulnerability and risks should be analyzed thoroughly.

There are a few assumptions we have to make in order to discuss the matter. The first assumption is that a structure of network organizations and processes is referred to as a service ecosystem. It describes the inter-functional and multidiscipline nature of service oriented industries and operations. The second assumption is that supply chain management is a part of the service industry. In their widely

cited article, Vargo and Lush [9] introduce a theory of service dominant logic, the main point of which is a transition from goods based exchange to an economy based on more specialized skills and knowledge. The authors follow the approach of the Nordic School of Marketing [10] and Service-Dominant Logic (S-D logic) [9]. This approach was selected due to its emphasis on end-user preferences, which is a widely accepted method of developing and researching services.

At the core of the S-D logic is the shift from an emphasis on the traditional goods based, tangible resources to dynamic resources, which act together with other resources. Vargo and Lusch [9] refer to these resources as operand and operant resources, respectively. Because supply chain management is highly dependent on the IT-infrastructure, there is an obvious need to manage the capabilities for running the whole system of supply chain value creation. As Vargo and Lusch state, these arrangements need coordination and co-creation.

One of the foundational premises (FPs) of service dominant logic (S-D) is:

> "Value co-creation is coordinated through actor-generated institutions and institutional arrangements"
> [9, p.7]

Thus, the third assumption the authors make, is that much of the supply chain management is run and managed through automated systems without social interaction. Despite this fact, these automated systems are created by humans, whose approach to the system is connected to the social environment it is developed in. This approach, which is widely used among the social sciences, is interested in the relationships between individuals and larger groups.

Social networks have significant importance to the success of supply chain operations. Uncertainty is defined, managed and accepted within the boundaries of a specific social network. Therefore every organization can reduce uncertainty by obtaining possession of critical assets and forming ties with stakeholders who are more specialized in a specific operation within their social network. [11].

A systems based approach to one's identity introduced by [12] has been a topic influencing both educational and social sciences. This topic cannot be ignored when researching an area as complex as supply chain management, since we are not immune to the effects of either the cultural or social environments surrounding us.

Risk management strategies are not as straightforward as they may seem to be at first sight. Firstly, because supply chains are, as stated earlier, dependent on several systems, there is a need to analyze each system thoroughly in order to assess the correct approach to the risks and vulnerabilities of each of the systems. Secondly, time should be considered as a variable in each analysis, and the effect time has on vulnerability and risks should be analyzed thoroughly.

3 Domain assessment

Critical infrastructure is divided into three levels. The most important level consists of the information technology industry, energy sector and water supply industry. The second level consists of the banking and finance sector, and the chemical industry sector. The third level is formed by the armaments industry, postal- and distribution services, agriculture and food supply chains, health care, and search and rescue services. [3;13] Domain assessment should be divided into three time-related phases: observation, comprehension and prediction [14].

The four functions of the supply chain systems' operations have to be analyzed across the domains the organizations operate in. Our approach has been adapted from the principles introduced by Skyttner [15].

The first and the most important assessment covers the way capabilities are managed within recognized, critical management areas. During the assessment work, the organization's ability to create valid input information, which enables necessary vulnerability analysis, has to be covered. Secondly, there has to be the capability to store that valid information in a way that meets the requirements for the protection of critical infrastructure. Thirdly, the capability to manage the organ, which uses the valid information, has to be assessed. Fourthly, an organization has to have the capability to predict and create scenarios, which require valid information. And lastly an organization has to have the capability to manage feedback information, and most of all, manage the pre-determined operations based on the scenarios

In the second domain, an organization's capability to manage the contractual

environment by using the methods, which take in to account the needs of end-user and the needs of the whole of the supply chain as a system, has to be assessed.

In the third domain, an organization's capability to manage the carrying capacity and capability to secure the alternative methods of transportation and suppliers of vital goods and services for the organization has to be assessed.

In the fourth domain, an organization's capability to manage the alternative and existing data transportation methods under all conditions has to be assessed.

In the last domain, the enhancement of the capability to react to rapidly changing political, social, environmental, legal and technological changes has to be assessed. This relates more to the first domain. The connections between functions and domain are illustrated in appendix 2.

But how do we define a relevant risk in each of the domains? How do we decide which part of the supply chain creates a critical node? How do we divide a system and its sub-systems into manageable components, without sacrificing the overall purpose of the system? How do we define the capabilities, which need to be met? How do we prevent a situation in which the "tail wags the dog", meaning that the risk preventing process defines the outcome and not vice versa? There has to be a managerial approach, a methodology, which sets a framework for capability management.

The initial goal of domain assessment is to define and create capabilities, which enable recognition of an attack and reduce the attacker's ability to operate in the target component. Observation and protection are reactive functions, which affect the overall costs.

4 Contractual environment

The capability to manage contractual environment processes requires a set of pre-defined capabilities. As Anteroinen [16, p.13] states:

> "…capability is the ability or power to achieve a desired operational effect in a selected environment and to sustain this effect for a designated period".

This definition does not determine how the objective should be achieved. The definition also takes into account how domain operations are run.

In the assessment of relationships between the domains and functions the authors limited their scope. During the research the scope was limited to domain 2 ("capability to manage contractual environment") and to function 2, which defines the management and supervision of the production process.

In the modern network based service chains, the commercial co-operation between the actors in the service supply chain is regulated with contracts. Contract management is divided into two major approaches. The first one concentrates on the structural design of the agreed transaction. The main focus of this approach is on the written contracts between different participating parties. These agreements are legally binding by nature [17, p.241].

The second approach is more concerned with the relationships between the actors participating in the commercial co-operation. The main factor, participating parties rely on, is trust, which works as a safeguard for coordination and control functions. The upside of participants in this approach is the positive outcome of the transaction in spite of the existing and possible vulnerability [18, p. 395).

There are existing studies, which combine these two approaches, but their results are not clear-cut. One of the main reasons behind these results is the complexity of the contracts in the framework of trust. Even though one of the basic principles of S-D logic emphasizes institutional arrangements, it does not define which one of the approaches should be used for contractual management.

As the authors stated, the supply chain for a service ecosystem consists of several systems and sub-systems. The capability to manage all the inter-relating contracts within an ecosystem can become extremely expensive if the structural approach is used. Also, just a trust-based approach is hardly acceptable. We are after all researching the critical infrastructure, whose vulnerability cannot be protected only with the element of trust.

There are also examples of reciprocal-trust relationships which are based on the mutually positive out-comes, based on the actions active parties make [19]. This model does not take into account the possible role of third parties

trying to take advantage of the two parties, who have created a reciprocal-trust relationship. Also, the reciprocal altruism introduced, among others by Trivers, [20] already in 1971 demands several and repeated interactions with known actors.

These contractual choices are obviously linked to the industry in question, which affects the criticality of the industry and possibly the already existing relationships between the actors within the industry. Contractual management should also consider the time-related phase observation, comprehension and prediction the critical process is related to. The four organizational functions – implementation, coordination, control and intelligence – need a thorough assessment from the contractual management point of view as well. These decisions are affected by the cultural, political and economic factors, as the main theories of international trade illustrate.

5 Contractual environment and an unknown threat

We approach the challenges in a contractual environment by observing two real life cases. In both cases we present partially successful cyber-attacks and discuss the deficiencies of situational awareness in a business ecosystem. The described sophisticated attacks were successful because of their unidentified nature and development resources behind new technology. Since there is always the possibility for an unknown threat, we endeavor to present a model managing the risk it produces.
The chapter is organized as follows. First we define the concept of an unknown threat. After that we present the two cyber-attack cases, and finally we analyze the cases in relation to contractual environment.

5.1 Unknown threat

An unknown threat is defined as a threat, which is not previously known, there is a theoretical background for the existence of this threat, there are no previously known counter measures against the threat or there are no known identification methods for the threat.

These threats include:
- 0-day vulnerabilities
- Tailored, effective based malicious operations
- Complex attacks against the targeted physical part of the component/system
-APTs, Advanced Persistent Threats that combine all of the above and include significant resources for transforming the behavior of malicious activity

5.2 Case of Industrial Espionage

Our first case contains a modern industrial espionage. The target of the attack was the immaterial capital of a large enterprise in the manufacturing sector that operates in the Nordic geo region. The details of the attack are classified. The information used here is retrieved through an interview with Jan Mickos [21], Vice-president, CGI Finland Security Advisory (May 23, 2017), and can also be viewed in public sources.

5.2.1 Attack description

The perpetrators of the attack campaigns are referred to as ”APT 10” and “APT 29”, which are explained in more detail [22] and [23]. The technical methodology used in the attack was fairly common. Previously known malware was slightly altered so it would not be exposed by normal antivirus scanners nor would it be blocked by technical security protection solutions. The adversary used a lot of time, resources and effort to cover the tracks of their actions and hide from defensive scanners and monitors. One particular feature of the attack was the ability to change the maneuvers, which ensured the stable progression of the attack towards its goal.

The attack was also special in its tactical dimension. It was aimed indirectly at the target via a common ICT service provider. This enabled two advantages. First, it is nearly impossible for an ICT service provider to identify malicious actions, since the traffic in the command and control (CnC) channel was hidden under the normal noise of enterprise activity. Second, even if the targeted enterprise would have noticed any abnormalities, it has no visibility or jurisdiction to the technical environment of the ICT service provider. As a side effect to the primary target, the attacker was able to create an entry point into other customers’ systems through the same ICT service provider.

5.2.2 Time Dimension of the Attack

The attack was exposed in the target environment in 2016. In a forensic investigation, the first traces of CnC were found to be from 2013. Any information from

before this could not be reconstructed. It took around four months to block the attacker from the targeted system after exposure. That time was used for identifying the coverage of the attack, creating sufficient counter measures and collecting enough information for forensic analysis.

During the four years of attack, the attacker gradually collected information from the target environment, increased the compromised systems and components and proceeded towards the target. It is assumed that the attacker did not reach the ultimate target.

After successful coordination of counter measures and blocking the vulnerabilities of the systems it has been noticed, that the attacker has resumed a similar campaign towards the target enterprise via another service provider. This implies two results. First, the unknown threat has changed into a known threat and exposing new attempts are significantly faster. Secondly, a motivated attacker does not quit trying to reach the ultimate goal after the first obstacle. Instead, the attacker searches for another vulnerable component to continue the original campaign.

Speculating on the possible consequences of an attacker reaching the goal of immaterial capital, we can take the famous Nortel case as an example. The attack on Nortel proceeded unobserved for ten years [24]. In practice, the attacker was in control of the whole ICT environment of Nortel. As an indirect consequence of losing the immaterial capital and exposing business plans to competitors, the market value of Nortel dropped 98 % in only two years, ending up in Canada's greatest bankruptcy of all time [25].

5.3 Case WannaCry Campaign

Quite a recent example of a cyber-attack is from May 2017; the case is called WannaCry ransom ware [26].

This campaign had several unprofessional features and because to them, direct damages were relatively small. However, indirect damages were notable. It disrupted normal functions of several critical infrastructure systems all over the world, including hospitals and traffic. It was fortunate for the societies that the attackers' goal was only to deploy ransom ware and collect ransom instead of destroying the compromised ICT systems or stealing the information that was accessed.

In the scope of this paper, WannaCry campaign had two interesting features. The first interesting feature was the speed of contamination of the systems. The previous example campaign was active for several years. This campaign was only active for days. The progress speed was so rapid that the analysis and counter measures of a single system took too much time to be effective. The blocking actions were only successful because of information exchange between security specialists across organizational and geological boundaries, and centralized blocking actions.

The second interesting feature was the methodology used in the campaign. It utilized the technology developed by the National Security Agency, USA (NSA), which was leaked to the public earlier. Despite that the mechanisms were known before the attack, there was a large amount of compromised systems worldwide. As a consequence, one can never trust or assume that the supply chain or the subcontractor has implemented the full preventive toolset for known threats. Furthermore, it is evident that the unknown threats are even less likely being monitored.

5.4 Analysis of the case

In both cases, the attack was blocked by centralized and coordinated actions. To obligate the supply chain node or the subcontractor to monitor systems preventing advanced and persistent type campaigns is nearly an impossible task. Only the one, that manages the environment as a whole and understands the possible goals of an attacker and also carries the business risk, can evaluate the differences and abnormalities of actions in a complex system environment.

We have also observed from empirical data of less public campaigns that the value of damage changes with time as follows [21]:

- The financial/business damage development follows a time-based logarithmic formula
    - Time 0 is the attacker's penetration into the component/system
    - Time 1 is the time the actual damage driven action begins
    - Between 0 and 1 the attacker prepares the actual damage enabling action, such as intelligence and creation of

necessary command functions
    - Onward from time 1 there is increasing damage to the component in relation to the maximum value of the component to the whole business value of the operations

- The value of damage increases exponentially in the relation to time
    - Effects in the individual component reflect to the whole system and increase the overall damage and financial loss

6 Improving business resilience to unknown threats

Inspired by the case example presented in the previous chapters, the purpose of the improvement of resilience to unknown threats is to create a model, which tries to take into account the previously unrecognized threat to the specific business. The approximation in the model is based on the previous work by Zaerens [27] ,which showed the necessity to analyze financial impacts of threat prevention.

In this assessment, the authors are limiting their research to the main owner of the business. Also, an individual component under the research is not necessarily a technical phenomenon or a part of the IT-system. Depending on the business environment, the component can be a technical phenomenon, a business concept or a business driven phenomenon such as customer value creation. The main owner in the model is a company/function, which offers the final product to the end-user.

The observations in the model are based on either the sensor-based observation or on the log-based observation. Based on this definition, the only restriction to observation is the components ability to create material for analyzing purposes. This material is produced by the sensor and it can be technical, automatic or based on human interaction.

Each system component has to have a sensor, which collects information for observation purposes. This is illustrated in formula 1, a cluster of components in the system $sens_j$ in which $j \in [\ 1, S\ ]$ and S equal the amount of components in the system.

The sensor's ability to observe the threat can be assessed by using relative probability $1/w$, where w equals the coverage of information relating to the unknown threat.

In the worst case scenario, information is not collected at all and the possibility to react to the threat is non-existent. Threat observation is divided into ten operations within four previously introduced functions; the operations are managed as a part of operations management, using recognized capabilities.

The sensor's capability to reduce the unknown threat is presented in formula 2 developed by Zaerens in his previous research (Zaerens, 2015)

$$R_n = f(\mathrm{P}\ (threat\ i_1 * (1/w_{sens[1]})), \ldots, \mathrm{P}\ (threat\ n_s * (1/w_{sens[s]})))$$

In order to clarify the topic, the authors defined the attack vector as a function, whose purpose is to fulfil the threat. The assumption is that the attack vector has a linear relationship with the threat. This excludes surveillance activities, whose purpose is to define possible existing vulnerabilities in the target component.

Sensor activity is a constant, on-going function, which requires continuous sensor development in order to manage threat observation. This demands investments from the sensor throughout its lifecycle. This life-cycle cost is usually estimated to be 10 % of the initial investment. This enables life-cycle estimation as follows:

$$c_{sens} = d(1+0{,}1tw)$$, in which

d = initial investment
t = time
w = a relative data collection ability in a specific sensor

Even though these formulae increase a sensor's effectiveness against the threat, they do not take the costs, which are related to data analysis, into account. Obviously threat reduction is possible only, if the collected data collected from the sensor is analyzed. To simplify our approach we assume that the collected data contains sufficient data for exposing the attack.

Decentralized component based analysis can be described as a system where a real-time function of some predefined rule catches an anomaly or an exception. Component based cost analysis can be calculated using the following formula 4

$$h_{sens[w]}, \text{ in which}$$

h = cost of the analysis by individual component *w* used.

We assume that the size of the rule set in component analysis does not affect the actual cost of the analysis. The effectiveness of component based analysis is reduced, if the area under observation is not restricted and its interphases to business processes are not defined adequately. Moreover, the real time observation significantly decreases the possibility for detecting attacks that have been going on for a long duration (e.g. APT type of campaigns).

Financial effects of the centralized approach can be calculated using the following formula 5. This concentrated analysis estimates information from several sensors and their interdependencies. The cost of the analysis is not solely based on the amount of sensors; it is based on average threat coverage.

$$C_{analysis} = h\left(\left(\sum_{i=1}^{sens[n]} w_{sens[i]}\right) /n + \sum_{i=1}^{sens[n]} i \right), \text{ in which}$$

h = cost of the analysis
n = amount of sensors

The effectiveness of the analysis increases when the amount of information from sensors increases.

Instead of centralized monitoring, having each component implemented with its own monitoring capability, the total cost of analysis of the system is the sum of all sensor and analysis costs from each partial component in the system. It is evident that even if the amount of sensors would be greater in some of the outsourced components, the overall effectivity of analysis significantly lacks business related information. Therefore the cost-effectivity ratio is better for centralized systems rather than distributed systems.

7 Discussion

Dialogue between the supply chain stakeholders does not jeopardize the risk management procedures of a supply chain, quite the opposite. It creates a solid base for understanding the system's stakeholders and their needs throughout the different life cycles of a supply chain. Maglio, Srinivasan, Kreulen, and Spohrer [28] envision that service scientists could begin to understand service systems by identifying stakeholders and their needs, opportunities and problems in the environment. Theories behind the service science need to be analyzed during development work. It should be done due to the fact that capability management requires open multidiscipline dialogue between different disciplines and functions.

Looking at the five operational domains, it becomes evident, that the assessment of an individual domain, process or a single actor's CIP capability is not adequate. There is a need to find those processes, which have the largest number of interfaces with each of the domains and the whole ecosystem. This should be the end result of an effective, centrally controlled surveillance activity.

As our research indicates, comprehensive, systems-wide protection can become extremely expensive. There are two questions, which arise from this conclusion. The first question is: who is responsible for the investments holistic protection demands? Secondly, what is the alternative cost for ecosystem-wide protection? One can ask if a main company should invest in tracking and control functions, instead of a "bullet proofed", ecosystem-wide active protection.

The role of a contractual agreement should be seen as an assumption of the future state of the CIP, not as a boundary between the actors participating in the service supply chain. Contractual agreements should be formed following the principles used in the performance based logistics (PBL).

In the PBL, responsibility of the product / service system management is on the supplier of the system, unlike in the traditional end-user – supplier relationship [29]. PBL is in use in military context and it is "a contractual mechanism"

Berkowitz explains that

> *"…[a] contractual mechanisms will include long-term relationships and appropriately structured incentives with service providers…, to support the end user's (warfighter's) objectives."*
> [30, p.5].

This approach does not contradict with the idea of the centralized surveillance and monitoring system. Centralized monitoring and surveillance activities should be used to secure both adequate CIP and a source for the PBL incentives. Also, requirements based PBL emphasizes the positive sides of the structural and trust based contractual management. The existing incentives encourage a service provider to fulfil pre-determined service goals, as research by Doerr, Lewis and Eaton [31] has shown, because these benefits are accountable and reliably measurable.

7.1. Limitations of the study

As mentioned before, this paper is limited according the public information available. Attacked organizations are reluctant to comment the success rates or the damage impact of attacks even if they are known. This ensures the preservation of their reputation and trust relations in the economic systems they participate in. The damages of successful attacks, that are publicly known, are underrated without exception [32,33]. It is notable that attacks are not made public, unless a third party brings the information to attention.

7.2. Recommendation for future research

An interesting research area would be to model the progression of an attack in relation to time. This enables the analysis of the timeframe in which the attacker could theoretically reach the business's critical information after entering the system. This kind of a model would assist in estimating the available time for countermeasures or the collection of forensic information and analysis of attack progression.

8 Conclusions

Combining the systems wide approach and explaining the theoretical background behind the various models creates a comprehensive model, which assists in critical infrastructure protection. It shows that individual supply chains are a collection of extremely complex systems and subsystems backed up with sometimes contradicting theories and practices.

Current global trading operates in an environment, which is highly vulnerable to abnormalities in all parts of the supply chain. During a value creation process, an IT-infrastructure (a cyber-system) is dependent on five basic components:

1) Input information, which reflects the reality of the surrounding world

2) Stored data of the existing reality to help decision making processes

3) Information stimulating the "organ" (human, machine), which in turn affects and stimulates the system

4) Data referring to the desired future state of the system

5) Feedback information regarding the desired outcome of the system or parts of the subsystem [34, p.11.]

All of the organizational functions – implementation, coordination, control and intelligence – across the system and relating subsystems are dependent upon the five components presented above. Each of the five components is subject to vulnerability and risk. This requires a description of the capabilities, which are needed to manage both functions and basic components of system wide vulnerability and risk management. Without these descriptions there is no possibility to calculate the financial effects of CIP.

Because a supply chain consists of a large number of multinational actors, each one of these players is potentially a critical node due to efficiency requirements defined by financial requirements. But unless an individual node affects pre-determined critical processes in the critical domain, a total collapse of the supply chain is not foreseeable. But there is a need for a systematic method, which enables the assessment of entire systems and their subsystems.

The authors have come to the conclusion, that the principles of cyber protection illustrated by i.a. Kuusisto [34], can be followed in commercial supply chain management. The following IT-infrastructure capability areas should be monitored, protected and secured thoroughly only if the benefits are on a financially acceptable level:

1) The capability to create valid input information, which enables necessary vulnerability analysis

2) The capability to store said valid information in a way that it meets the requirements for the protection of the supply chain

3) The capability to manage the organ, which uses the valid information

4) The capability to predict and create scenarios, which require valid information

5) The capability to manage feedback information and most of all, manage the pre-determined operations based on the scenarios

In this paper we examined the domain assessment within the critical infrastructure protection. We stated that business ecosystem environment that contains supply chains or subcontracting is vulnerable for unknown threat. Yet we noted that distributed ecosystem can increase the resilience in operation with careful contractual management. We described the model that quantifies the key elements that are used in observing the malicious intrusions to business system. We also proposed what needs to be taken into consideration in enhancing more resilient business ecosystem.

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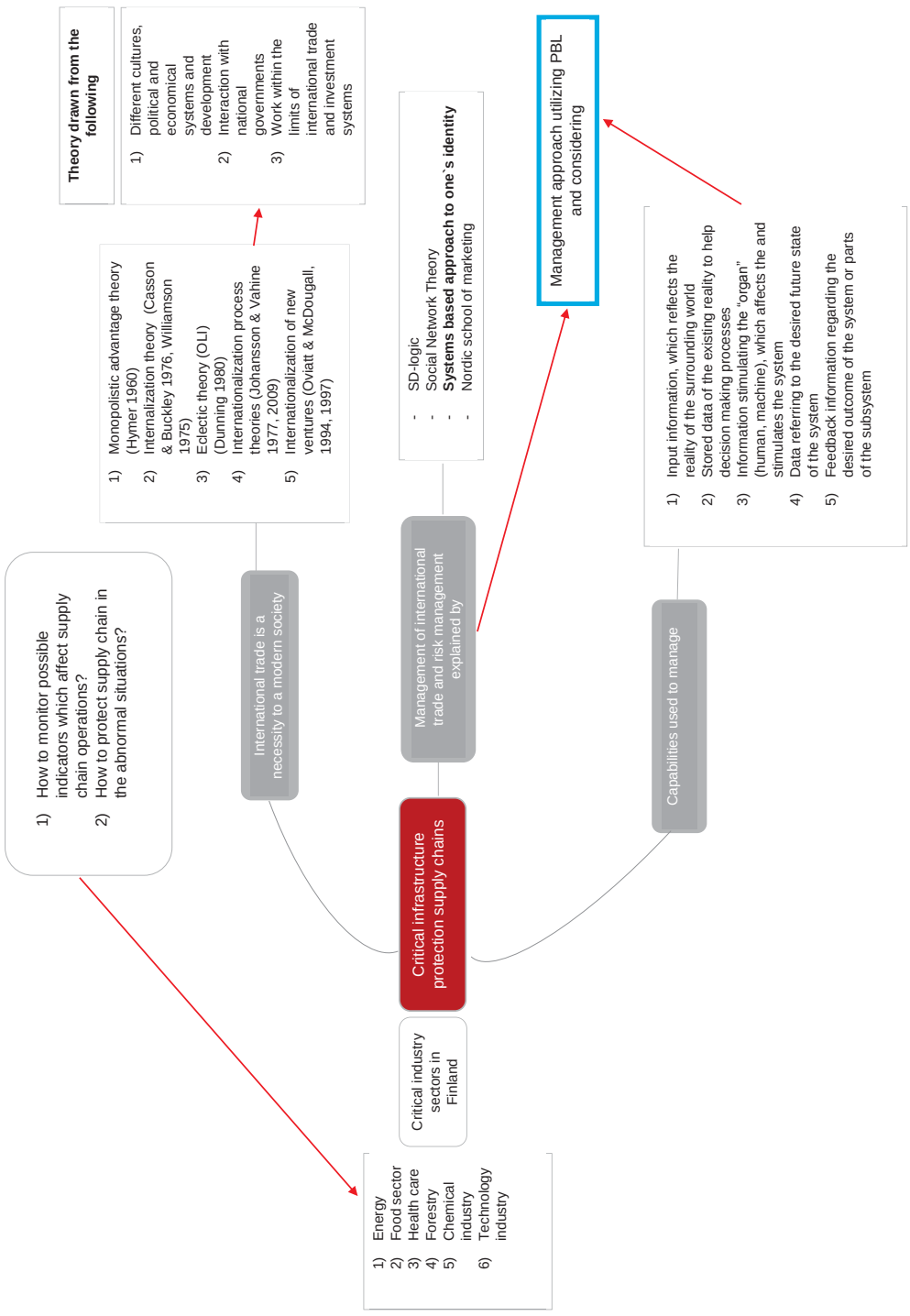
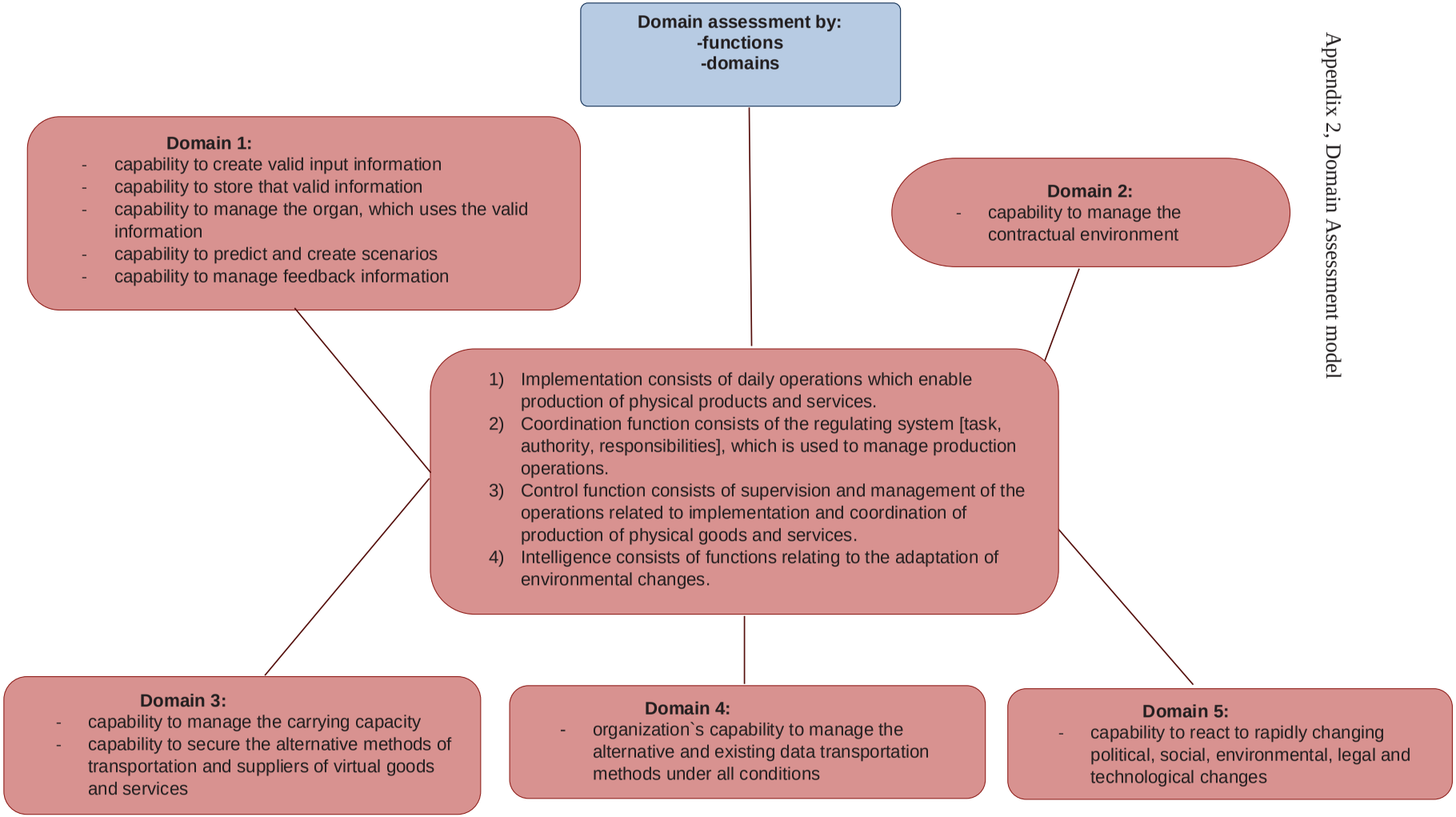
Appendix 1, Framework for Critical Infrastructure Protection




Domain assessment by:
-functions
-domains
Domain 1:
- capability to create valid input information
- capability to store that valid information
- capability to manage the organ, which uses the valid information
- capability to predict and create scenarios
- capability to manage feedback information
Domain 2:
- capability to manage the contractual environment
1) Implementation consists of daily operations which enable production of physical products and services.
2) Coordination function consists of the regulating system [task, authority, responsibilities], which is used to manage production operations.
3) Control function consists of supervision and management of the operations related to implementation and coordination of production of physical goods and services.
4) Intelligence consists of functions relating to the adaptation of environmental changes.
Domain 3:
- capability to manage the carrying capacity
- capability to secure the alternative methods of transportation and suppliers of virtual goods and services
Domain 4:
- organization`s capability to manage the alternative and existing data transportation methods under all conditions
Domain 5:
- capability to react to rapidly changing political, social, environmental, legal and technological changes

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