Hella Abidi

Performance Management in Supply Chains

Applications to humanitarian and commercial supply chains

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Performance Management in Supply Chains - Applications to humanitarian and commercial supply chains

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Performance Management in Supply Chains
Applications to humanitarian and commercial supply chains

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Dedication

I dedicate this work to my beloved Parents, Mustapha and Safia Abidi. My dear father, my dear mom (in memory); the best and wisest parents I ever knew, who taught me many lessons and showed me many things as we went together along the country (life) by ways. Dad, Mom your wisdom words were always in my mind when I was working on my research. Your words: “Do not go where the path may lead, go instead where there is no path and leave a trail.” *(in German: Gehe nicht auf ausgetretenen Pfaden, sondern bahne dir selbst einen Weg und hinterlasse eine Spur) Ralph Waldo Emerson.*

Preface

"It does not matter how slowly you go as long as you do not stop." (Confucius)

First and foremost, I thank Allah swt. and his messenger Mohammed sas. for having provided me with courage, faith, strength, and diligence to reach my goals. Without the help of the Almighty Allah swt. and his messenger Mohammed sas. nothing is possible.

After 12 years of business practice at Dachser SE and the achievement of my Master Degree in Business Management Science at the FOM University of Applied Sciences Essen, I decided in 2011 that I would like to do scientific research. Shortly afterwards, I obtained a research associate project management position at the Institute for Logistics and Service Management within the FOM University of Applied Sciences Essen. Following, in 2012, I met prof. dr. ir. Sander de Leeuw at the POMS conference in Chicago. Together, the idea arose to do a PhD on the applications of performance management to both humanitarian and commercial supply chains. This led to me starting my PhD at the Vrije Universiteit Amsterdam on a part-time basis in 2013.

Finishing and compiling this PhD thesis would not have been possible without the support and concerted efforts of a number of dedicated people.

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1 PERFORMANCE MANAGEMENT AND MEASUREMENT

"If you cannot measure it, you cannot improve it"

1.1 INTRODUCTION

Performance management support top management achieving strategic business objectives (Brudan, 2010). Performance management is a complex approach that has received much attention in the operations management literature (Radnor and Barnes, 2007). Since, the end of the 1950s, performance management has been designed and implemented in business, public and military organizations and more recently in the humanitarian sector to improve productivity, accountability and service delivery. Performance management is defined as use of performance management information to affect positive change in organizational culture, systems and processes, defining performance goals, allocating resources, policy and target setting, and sharing performance results in pursuing goals (Amaratunga et al., 2001). Organizations that apply performance management outperform those that do not measure and manage performance (de Leeuw and Van den Berg, 2011).

To apply performance management effectively, organizations may coordinate key activities and initiate related performance management practices by using performance measurement systems (De Waal, 2003). Performance management practices are defined as managerial processes (Bititci et al., 2011). Performance management practices are the formal and informal practices applied by managers to specify goals, methods, procedures, controls and to allocate decision rights within a particular system that facilitate the delivery of organizational performance for management use (de Leeuw and Van den Berg, 2011). Moreover, performance management practices include the selection of performance indicators and their periodic monitoring and evaluation in order to communicate direction, providing feedback on current performance, influencing behavior and stimulating improvement action (Bourne and Bourne 2011). de Leeuw and Van den Berg (2011) distinguish between strategic and operational performance management practices. They indicate that little attention in research has been paid to operational performance management practices. Operational performance management practices are essential to uncover why and how performance management practices impact performance improvement. de Leeuw and van den Berg (2011) explain operational performance management practices as the definition, implementation and use of performance indicators on the level- of day-to-day operations executed by shop-floor employees in organizations.

Performance management is of growing importance to many organizations. It has been implemented by many organizations to gain competitive advantage and to continuously react and adapt to external changes (de Waal, 2013). The performance management process consists of selecting performance variables, defining metrics, setting targets, measuring and analyzing processes. (Forslund and Jonsson, 2007). Consequently, organizations apply performance management to generate a consistent understanding of the business strategy using a set of performance indicators (Brewer and Speh, 2000) providing qualitative and quantitative information of important elements of the business strategies in which firms have to outperform in order to be successful (Melkers and Willoughby, 2005).

This dissertation uses the performance and operations management literatures, as well as some publications of interest from the broader field of management.

1.2 MEASURING PERFORMANCE

In the past decades the topic performance measurement has attracted much attention among academics and practitioners (Franco-Santos et al., 2012). Performance measurement encompasses the processes for setting targets, designing indicators and collecting and analyzing supply chain performance data. Alignment of performance measurement and strategy of the organization are important for various groups in order to be competitive and to promote business performance (Dossi and Patelli, 2008). Therefore, establishment of a performance measurement framework in an organization promote the communication and synergies between headquarters and subsidiaries and business units (Dossi and Patelli, 2008) and the use of financial and non-financial information hamper misanalysis of subsidiary performance (Chung et al., 2006).

In modern business management, performance measurement goes beyond quantification and accounting. Because of the limitations of the use of traditional financial measures, together with intense competitive pressures and changing external demands (Neely, 1999), both academics and practitioners have advocated the use of multidimensional performance measures (i.e. financial and non-financial measures) because are supposed to contribute much more to business management and performance improvement in the diversified industries (Chan and Qi, 2003, Van der Stede et al., 2006). In academia as well as practice an excess of performance measurement frameworks exist (Kennerly and Neely 2002) such as the results-determinants framework (Fitzgerald et al., 1991), the Strategic Measurement and Reporting Technique (SMART) pyramid (Lynch and Cross 1991), the balanced scorecard (Kaplan and Norton, 1992)

and the performance prism by Neely and Adams (2000). These performance measurement frameworks include a mix of financial and non-financial indicators that effectively translate strategic plans into actions (Lee et al., 2009). The number and type of measures included in these performance measurement frameworks are considered to be consistent with the strategic management style of the organization (Kennerly and Neely 2002). The common characteristics of contemporary performance measurement frameworks include the linking of strategies, objectives and measures and provide accurate information to enable managers to track their own performance and current position in the market and evaluate employees' performance in an effective and efficient manner and assist them in developing future strategies and operations (Lee et al., 2009). Using a performance measurement framework allows to convert data into information that facilitates an effective control and correction by reporting actual level of supply chain performance and comparing it with the desired level of supply chain performance (Melnyk et al., 2014).

To manage and improve logistics and supply chain performance, supply chain managers used performance measures that have been stand-alone measures, and focusing on measuring cost, time and accuracy over the last few decades. The literature review of Gunasekaran and Kobu (2007) has shown that 38 per cent (in total 90 measures and metrics) of the most widely used metrics between 1995 and 2004 have been financial. However, researcher and supply chain managers believe that such supply chain measures are inadequate to improve and manage supply chains as they rely too heavily on cost as a primary measure that may lead supply chain managers to incomplete conclusions (Srimai et al. 2011). Moreover, these measures do not show visibility over supply chain areas that are not directly within the control of supply chain managers because global supply chains are complex structures managed in many management domains (Shaw et al., 2010). Consequently, researchers have designed more sophisticated performance indicators to plan and control the supply chain by quantifying the efficiency and the effectiveness of past action and to measure supply chain performance in balanced ways (Bititci et al., 2005). Nowadays, the most common supply chain performance frameworks that are used in practice are the BSC (Kaplan and Norton 1992, 2001; Manville and Broad 2013) and the SCOR model (Supply Chain Council 2008; Theeranuphattana and Tang 2008). The application of both frameworks simplify communication among supply chain actors and lead to an increased transparency of supply chain and logistics processes (Gunasekaran and Kobu 2007).

1.3 MANAGING AND IMPROVING PERFORMANCE IN SUPPLY CHAINS

Managing and improving performance in a supply chain has emerged as one of the major business areas because instead of organization, supply chains compete with one another (Christopher, 2005). Management of performance in supply chains is no longer based on functional hierarchies, ownership, or intra-organization power but rather on cross-organization relationships (Forslund, 2012). Within a supply chain, organizations can improve performance of different tasks (e.g. customer service, warehousing, supplier relationship management, inventory management, warehousing, logistics and transportation) through the effective use of resources and capabilities (Ketchen and Hult, 2007; Hult et al., 2007). Supply chain performance management is a key driver for obtaining a competitive advantage, increasing organizational effectiveness and for better realization of organizational goals such as enhanced competitiveness, better customer care and profitability (Gunasekaran et al., 2001).

Through cooperation in supply chains, organizations are able to manage and improve the supply chain performance. Supply chain actors can create innovative supply chain strategies or logistics capabilities to meet global supply chain requirements, and to redesign the supply chain. The redesigned supply chain include: warehouse network structures, tasks between tiers, inventory distribution between tiers, transportation network, modes and consolidation centers inside the logistics distribution systems (Reaidy et al., 2015). LSPs within a horizontal cooperation among LSPs can position these operations downstream or upstream in a global supply chain to meet the needs of the customers and to improve performance. LSPs are becoming important actors for developing logistics performance in supply chains (Forslund, 2012). However, the complex structure of supply chains has changed the role of LSPs (Bolumole, 2003) according to the level of outsourcing. This varies from only transportation services to value-added services or from global management of the company's logistical needs to complete and integrated-logistics services (Stefansson, 2005). As a consequence of the changing role of LSPs from traditional, functional to a broader supply chain management (Bolumole, 2003), LSPs have simultaneously developed logistics and distribution networks and cover different geographical areas. For example, in the airline industry, cooperation between airlines in the form of a strategic alliance is increasingly being perceived as an essential element of business networks (Liou, 2012). Networks among airlines like Star alliance, Sky Team and One World are made to attract more passengers, to expand networks, to provide cost reductions, to take advantage of product and service complementarities such as joint luggage handling, code sharing and gates and check-in counters (Liou et al., 2011). In the

maritime industry, networks of ocean liner shipping companies are also well known (often referred to as the liner conference system (cf. Shashi Kumar, 1999). They can focus on specific aspects, e.g. route specific ventures, vessels sharing and slot sharing agreements (Midoro and Pitto, 2000; Panayides and Wiedmer, 2011). In the road transportation and logistics industry leading logistics service providers (LSPs) such as Schenker, Dachser, UPS, DHL and Kühne & Nagel also recognized the benefit of forming networks. Similar to other transportation sectors, LSPs active in road transport and logistics more and more engage in forming networks with partner LSPs.

1.4 HUMANITARIAN VS BUSINESS SUPPLY CHAINS

One area where performance management has witnessed considerable growth in attention is humanitarian supply chain management. This type of supply chain management deals with the coordination and integration of external stakeholders in a relief chain to rapidly provide humanitarian assistance to areas affected by large-scale emergencies (Cozzolino, 2012).

The humanitarian sector differs from the business sector in several important aspects. To summarize these, we build upon an existing framework of Beamon (2004). The first feature of this framework focuses on demand patterns. In business supply chains, demand patterns for goods are typically relatively stable and predictable as the demand occurs from fixed warehouses in relatively regular set of quantities (Balcik and Beamon, 2008). Demand patterns in humanitarian supply chains are typically unpredictable in terms of timing, location, type and size because the demand often vary from the type and impact of the disaster occurrence, and economic conditions of the affected country which has to be assessed first (Beamon and Kotleba, 2006; Pateman et al., 2013). The second feature is related to response time. Response time in the business supply chains is defined as the time between the customer placing an order and the time of delivery of the shipment to the customer. Typically, retailers and manufacturers have agreed-upon response times (Beamon and Balcik, 2008). In humanitarian supply chains, organizations need to react to quick-onset emergencies, where there is usually little to no time between the time a demand occurs (disaster strikes) and the time the supplies are needed (Beamon and Balcik, 2008, p. 11). The third feature is the distribution network configuration. In business supply chains it is common practice to determine and to select the required number and the most efficient locations of central and decentral distribution centers in terms of achieving a given service level at minimum costs (Balcik et al., 2010). Humanitarian supply chains are challenged in determining and selecting the required number and the most efficient central and decentral distribution centers due to the variety in magnitude, location and types of

disasters occurring (Gatignon et al., 2010). A fourth feature relates to inventory control. In business supply chains, the inventory is controlled and monitored based on a lead time and a customer service level agreed with customers (Bottani et al., 2017). Humanitarian supply chains are more project-oriented and short-lived (Cozzolino, 2012), therefore controlling and monitoring the inventory is more challenging due to large variations in lead times, demands and locations (i.e., the affected area; Balcik et al., 2016). A fifth feature is related to information flow and associated systems. In business supply chains the information flow is often supported by advanced technology (Pettit and Beresford, 2009). In humanitarian supply chains, the information flow is often inaccurate or non-existent due to the destructed infrastructure (Kovacz and Spens, 2011), even though accurate information flow and associated systems which impact response efficiency are crucial in humanitarian supply chains (Pettit and Beresford, 2009). The sixth feature relates to the strategic goals of both supply chains. Typically, business supply chains aim to produce high-quality goods at low cost to increase customer satisfaction, to generate maximum profit and to promote sustainability (Bals and Tate, 2018). Humanitarian supply chains aim to minimize human suffering and target to distribute critical and elementary relief items to beneficiaries in a way that the greatest social good is achieved (Oloruntoba and Gray, 2006; Holguin-Veras, 2013).

Feature seven relates to performance management, which is common practice in business supply chains (Bititci et al., 2012). In contrast, performance management in humanitarian supply chains is lagging behind the business sector (Beamon and Balcik, 2008; Abidi et al., 2014). Performance management in humanitarian supply chains is particularly difficult due to the intangibility of services, immeasurability of the mission, unknown outcomes and the variety, interests and standards of stakeholders (Beamon and Balcik 2008).

In terms of supply chain type (feature 8) humanitarian and business supply chains can both be characterized as dynamic and agile supply chains (Oloruntoba and Gray, 2006). Both supply chains operate in a constantly changing unpredictable demands and require a transparent supply chain, enabling timely and accurate information exchange (Scholten et al., 2010); in particular business supply chains are also efficient, e.g. for functional products (Jin-Hai et al., 2003).

Humanitarian and business supply chains share a common view about the definition of supply chain management (9). Both define supply chain management as the planning and coordination of all activities involved in sourcing and procurement, conversion, and all logistics management activities; it also includes cooperation and collaboration with channel partners,

which can be suppliers, intermediaries, LSPs, and customers (beneficiaries) (Beamon and Balcik, 2008; Kovacz and Spens, 2009; CSCMP, 2019).

An overview of the differences and similarities between humanitarian and business supply chains are presented in Table 1.1.

Table 1.1: *Humaniatrian vs. business supply chains*

No.	Area	Humanitarian Supply Chains	Source	Business Supply Chains	Source
1	Demand pattern	Unpredictable, irregular	Beamon and Kotleba, (2006) Pateman et al. (2013)	Predictable, planned in advance and known	Balcik and Beamon (2008)
2	Lead time	Lead time is determined by the chain of material flow and the capacity of stored items in prepositioned warehouses	Balcik et al. (2010)	Lead time determined by supply chains actors and agreed	Pettit and Beresford (2009)
3	Distribution network configuration	The number of central and decentralized warehouses is difficult to identify due to the unknown location and size of disaster occurrence	Gatignon et al. (2010)	The number and profitability of central and decentralized warehouses are identified	Balcik et al. (2010)
4	Inventory control	The high variation of response times and demands hamper controlling the inventory in an accurate way	Balick et al. (2016)	Monitoring inventory level is determined based on customer demands and customer service level	Bottani, et al.(2017)
5	Information system	Inaccurate information or even non-existent due to destroyed information and communication network systems	Kovacz and Spens (2011)	Using advanced technology, information flow is available	Pettit and Beresford (2009)
6	Strategic goal/objective	Aiming non-profit objectives and reducing human suffering	Holguin-Veras et al. (2013)	Minimizing costs and generating economic profit	Bals and Tate (2018)
7	Performance management	Performance management in a structured and standardized approach is not common practice in the humanitarian supply chains	Abidi et al. (2014)	Performance management design and implementation is common practice.	Bititci et al. (2012)
8	Supply chain type	Agile, flexible	Oloruntoba and Gray, (2006); (Scholten et al. (2010)	Agile, flexible and/or efficient e.g. for functional products	Hai et al., (2003); (Scholten et al. (2010)
9	Definition of supply chain management	The process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods and materials, as well as related information, from point of origin to point of consumption to meet the **end beneficiary´s** requirements	Beamon and Balcik, (2008); Kovacz and Spens, (2009)	The process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods and materials , as well as related information, from point of origin to point of consumption to meet the **end customer´s** requirements	CSCMP (2019)

1.5 RESEARCH GAP

It is a well-known statement that one needs to measure before one can improve. de Leeuw and Van den Berg (2011) stated that organizations that apply performance management outperform those that do not measure and manage their performance. Understanding performance

management design and implementation is thus pivotal for a company's success. Performance management in a structured and standardized approach is not common practice in the humanitarian supply chains (HSCs) and is less strategic in focus (Van der Laan et al., 2009; Abidi et al., 2014). Compared to the humanitarian supply chains, the business sector has an extensive history in performance management. In fact, the business sector already has addressed the issue of performance management, linking supply chain strategy with operational performance (i.e. Kaplan and Norton, 1992, 1996).

A significant amount of research on performance management in the business sector has focused on the design and implementation of performance management. Examples are Gunasekaran et al. (2004) who focus on assembling key metrics using literature and results of an empirical study of selected British companies. Lai et al. (2002) as well as Huang et al. (2005) present performance indicators that are based on reliability, responsiveness, costs and assets (Lai et al., 2002; Huang et al. 2005). Defining metrics is a key step in managing performance, but successful performance management entails more than defining metrics. In fact, Santos et al. (2008); Wouters and Wilderom (2008) define the implementation phase as a further crucial step in performance management. Only a few studies examined the actual implementation of performance management in the supply chain (Shepherd and Günter, 2010). Examples of work on implementation of performance management in organizations are Bourne et al. (2000); Neely et al. (2000); Kennerly and Neely (2002); Bittici et al. (2005); Nudurupati et al. (2011); Hacker and Lang (2000); Bullinger et al. (2002).

Since supply chain performance management is not yet commonplace in the humanitarian sector (Abidi et al., 2014) and the literature contains several concepts and techniques that can be applied to the humanitarian sector, this thesis focuses on how performance management techniques can be applied in the humanitarian sector. The first research gap that this thesis thus aims to address is to examine supply chain performance practices in HOs and how humanitarian supply chain performance management can be improved.

Once organizations have processes and procedures for performance management in place, the supply chain can be further optimized. One key lever in the optimization of global supply chains, these days, is collaboration between partners in the supply chain (Kim and Chai, 2017). One such type of collaboration is vertical collaboration, which takes place between customers and their suppliers. The emergence of vertical cooperation in supply chains has changed the

role of LSPs (Bolumole, 2003). The role of LSPs, for example, depends on what has been outsourced by shippers. The level of outsourcing may range from only transportation services to value-added services or from global management of the company's logistical needs to complete and integrated-logistics services (Stefansson and Russel, 2008). As a consequence of the changing role of LSPs from traditional functional service providers to broader support of supply chain management (Bolumole, 2003), LSPs have developed logistics and distribution networks covering a variety geographical areas. Because of this geographic spread of coverage, LSPs have started to engage in horizontal cooperation to reduce activity costs through load consolidation, joint-route planning, and group purchasing (Pérez-Bernabeu et al., 2014, p. 586). Such cooperation enables LSPs to offer more comprehensive service packages, to reach more customers, to obtain more cargo, to use facilities more efficiently, and to develop and provide more effective logistics solutions (Cruijssen, et al. 2007b; Carbone and Stone, 2005; Cruijssen et al., 2010) compared to what could be achieved individually (Pomponi et al., 2015). Therefore, it becomes crucial to select the right LSP partner, to evaluate LSPs within horizontal cooperation and to identify the associated selection and evaluation criteria Cruijssen et al., (2007a). Selecting and evaluating partners in horizontal cooperation among LSPs has witnessed a fairly limited amount of research attention. The second research gap that we aim to cover in this thesis thus relates aim to the development of an approach for selecting and evaluating LSP partners involved in horizontal cooperation that results in managing and improving supply chain performance.

1.6 AIM AND STRUCTURE OF THE THESIS

In this section, we provide how qualitative and quantitative methods assist HOs and LSPs in developing performance management in six chapters. This research is structured as follows. After the general introduction of measuring and managing performance topic in Chapter 1, Chapter 2 is focusing on a systematic review of literature on performance management in humanitarian supply chains. Chapter 3 deals with the application of supply chain performance management practices in business at a HO. Chapter 4 provides criteria for developing a 4PL concept for the humanitarian supply chains. Chapters 5 and 6 examine whether vertical logistics cooperation criteria for partner selection and evaluation hold for horizontal partnerships among LSPs. In addition, we develop an approach for evaluating horizontal LSP partners. A brief outline of the content of the next chapters is presented to serve as a comprehensive framework.

In Chapter 2 we present the state-of-the art on performance measurement in humanitarian supply chains and discuss the challenges that need to be overcome in designing and disseminating performance measurement in a humanitarian supply chain. Performance measurement is defined as the process of quantifying the efficiency and effectiveness of an operation using a set of measures (Neely et al., 1995). Performance measurement facilitates effective control and correction by reporting the current level of performance and comparing it with the desired level of performance (i.e. the standard) (Melnyk et al., 2014). Over the years HO´s have encountered challenges in developing suitable and common performance indicators. Research published in 2010 showed that in practice 55% of HO´s do not monitor and report any performance measurement indicators, 25% state they control only a few indicators and only 20% measure performance consistently (Blecken, 2010). The lack of performance indicators has been a standing problem in humanitarian supply chain management (Davidson, 2006) and still is a challenge today (Anjomshoae et al., 2017). To support the development of measuring performance in HOs, we first systematically analyze the literature on humanitarian supply chain performance management following the structured method of Denyer and Tranfield (2009) and Rousseau et al. (2008). Initially 1,163 articles were identified and screened of which 52 articles met all inclusion and exclusion criteria to be analyzed, categorized and synthesized. This chapter provides two separate analyses: a descriptive and a thematic analysis. The descriptive analysis identifies the research scope, methodologies and characteristics of performance measurement in humanitarian supply chains. The thematic analysis provides a synthesis of the main outcomes from the extracted literature and gives an overview of future research and practice as well as gaps in the field of performance measurement in humanitarian supply chains. Findings reveal that performance measurement in humanitarian supply chains is still an open area of research, especially compared to the commercial sector. The findings also provide a first classification of 94 performance measurement indicators in humanitarian supply chains. Our systematic literature review furthermore provides directions for further research.

Next, we focus in Chapter 3 on whether successful supply chain performance measurement practices from the industry are applicable in HOs. Performance measurement allows HOs to quantify the efficiency and effectiveness of operations (cf. Neely et al., 1995) and to optimize both the development and execution of business strategy (Ariyachandra and Frolick 2008). In the literature, we find that different approaches on performance measurement in the humanitarian supply chain have been suggested by amongst others Beamon and Balcik (2008);

Van der Laan (2009); de Leeuw (2010); Schiffling and Piecyk (2014); Abidi and Scholten (2015); D'Haene et al. (2015); Santarelli et al. (2015); Acimovic and Goentzel (2016); and Anjomshoae et al. (2017). However, insights on how to design and to implement performance measurement by HOs in the humanitarian supply chain is an area that needs further research compared to business supply chains (Abidi et al. 2014; Abidi and Scholten, 2015). Thereby, the contribution of this third chapter is to our opinion the first to provide an in-depth case-based understanding of the design and implementation of supply chain performance measurement at HOs and of how performance measurement practices from industry might be used by HOs to design and implement humanitarian supply chain performance measurement. Using action research at Médecins sans Frontières, 10 supply chain performance measurement practices from industry are applied to design, test and implement supply chain performance indicators using relief project data.

The findings indicate the following. Firstly, tools and techniques such as workshops or technical sheets are essential for the design and implementation of performance measurement projects at HOs. Secondly, connecting performance management to an IT- project is crucial to implement performance measurement at HOs. Thirdly, performance management practices from business also apply to and are relevant for humanitarian supply chains. The findings in this chapter confirm the relevance of performance measurement practices from industry at HOs and the application of those practices in humanitarian context, albeit with adjustments. In addition, the findings illuminate that the application of performance measurement practices from industry are a useful approach for designing and implementing performance measurement because of the relative simplicity of adjusting these practices, tools and techniques to the specifics of humanitarian supply chains.

Building further on the future research suggestions of Chapter 3, in Chapter 4, we discuss the value of fourth-party logistics (4PL) services in humanitarian supply chains. A 4PL provider is defined as an independent, singularly accountable, non-asset-based logistics service provider that integrates its client's supply and demand chains (Win, 2008, p. 677). Using 4PL services organizations ensure transparency, process re-engineering, strategy development and better management of resources across supply chains and focus their efforts on core competencies (Jensen, 2010; Hingerly et al., 2011). As a result, 4PL services have received considerable attention in the business literature (see Mukhopadhyay and Setaputra, 2006; Win, 2008; Fulconis and Paché, 2018 for a recent literature review).

For humanitarian supply chains, academic attention has been directed towards describing general relationships, coordination, strategic alliances, collaboration and cooperation between the actors of humanitarian supply chains (i.e. Jahre and Jensen, 2010; Jensen, 2012). However, 4PL in humanitarian supply chains has received minimal academic attention. We believe to be the first to study the value of 4PL services in a humanitarian supply chain and to present a framework for managing its performance. To this end, performance criteria are identified by an Analytical Hierachy Process (AHP) analysis involving academics and practitioners from HOs located in Germany and Netherlands. The findings indicate that 4PL services can help to optimize supply chain processes and improve coordination of humanitarian logistics if the 4PL provider acts as 'architect/integrator', 'resource provider', 'supply chain infomediary' and 'decision maker as proposed by Christopher (2005).

At this stage, we identify that literature and practices are predominantly oriented towards selection and evaluation of partners in business vertical logistics cooperation rather on business horizontal cooperation among Logistics Service Providers (LSPs) or in humanitarian context. As there is no research on partner selection and evaluation in horizontal cooperation among LSPs neither on humanitarian nor in business, in Chapter 5, we discuss how to select the LSP partners for a horizontal cooperation network. Horizontal cooperation among LSPs aims to achieve decreasing cost, improving service and protecting market position in a dynamic and strong competitive logistics market (Cruijissen et al., 2007 a). To achieve these benefits, horizontal cooperation bundles transport of LSPs operating at the same level of the supply chain, having similar or complementary transportation and logistics needs (Vanovermiere et al., 2014). Therefore, choosing the right LSP partner for horizontal cooperation is crucial for a logistics network to achieve high levels of performance (Lee and Cavusgil, 2006; de Leeuw and Fransoo, 2009). Literature provides little to no insights on partner selection criteria for horizontal cooperation among LSPs.

To identify partner selection criteria for horizontal cooperation in LSP networks, we examine the literature on vertical cooperation to identify possible criteria and verify those using interviews with practitioners. Using AHP, the relevance of these criteria for horizontal LSP partner selection is assessed at a medium-sized family-owned Dutch LSP and a large family-owned German LSP. With this study, we are the first to identify and validate partner selection criteria for horizontal cooperation in LSP networks. The empirical data analysis indicates that the main criteria for selecting a partner in horizontal cooperation LSP networks are information exchange, long-term engagement, and security. In vertical cooperation, the most important

criteria for partner selection are known to be delivery, quality, and price (Soosay et al., 2008; Yang et al., 2009; Golmohammadi and Mellat-Parast, 2012). The difference in rankings of selection criteria between the two types of cooperation is explained based on the characteristics of vertical and horizontal cooperation.

Buidling further on the outcome of Chapter 5, we examines strategic partner evaluation criteria for LSP networks in Chapter 6. Horizontal cooperation enables partners to offer wider service packages, reach more customers, use facilities more efficiently, increase effectiveness and develop and provide more innovative solutions (Cruijssen, et al. 2007b; Carbone and Stone, 2005; Cruijssen et al., 2009) than what could be achieved individually (Pomponi et al., 2015). Evaluation of LSPs within a horizontal cooperation is essential because it has a positive effect on the participating LSPs' position in the market (Kannan and Tan, 2002) and performance of the logistics services they offer (Daim et al., 2012). However, clear insights on how to evaluate the performance of partners in collaborative LSP networks are still missing (Raue and Wallenburg, 2013). There is substantially less literature on horizontal cooperation in transport and logistics than on vertical and lateral cooperation (Knemeyer and Murphy, 2005; Cruijssen et al., 2009). The literature on vertical cooperation explores, e.g. how to select and evaluate LSPs that already cooperate with manufacturers (Jharkharia and Shankar, 2007), what kind of criteria are applied (Dickson, 1966; Weber et al., 1991; Büyüközkan et al., 2008; Wu and Barnes, 2011) or which mathematical decision-support models can be used (Luo et al., 2009; Bayazit and Karpak, 2013).

These studies present evaluation models and criteria for vertical cooperation. To the best of our knowledge, no partner evaluation criteria nor models have been proposed in the literature. We believe to be the first takeing this challenge by firstly reviewing the literature on partner evaluation in vertical cooperation and to compose an overview of possible criteria for the evaluation of partners in a network of LSPs. Secondly, an Analytical Network Process (ANP) model is developed to validate the criteria, to identify weights for these criteria, and to validate model outcomes at an LSP involved in a European transport and distribution network (LSP1). Thirdly, the ANP model developed for LSP1 is applied to another LSP with similar characteristics (LSP2) to validate whether the ANP model, its criteria and criteria weights can be directly transferred. In-depth interviews with industry professionals are used to draw conclusions on the modeling approach and the model outcomes. We believe to be the first to establish criteria for evaluating strategic partners in a network of logistics service providers, to show how an ANP model can be used to identify the weights of these criteria on a case-specific

basis and to investigate whether a base ANP model can be developed for evaluating strategic partners in a network of LSPs. The findings show that evaluation criteria for partners in vertical partnerships between shippers and LSPs are applicable to LSP partners in horizontal partnership networks. The ANP model with criteria weights provides a good starting point for LSPs to customize the evaluation framework according to their specific needs or operating environments.

1.7 THESIS RESEARCH OUTPUT

Table 1.2 provides an overview of the research output from this dissertation. Table 1 indicates for each chapter (Chapter 2 through 6): title of the chapter, the research question that is addressed and data source, research approach that have been applied. Table 1.2 also shows the journal publication status of the studies on which the chapter is based (i.e. published, in preparation for journal submission or submitted).

Table 1.2: *Overview of thesis research output*

Chapter	Title	Data Source	Research Questions/objective	Research approach	Journal publication status
2	Humanitarian Supply chain performance management: a systematic literature review	EBSCOHOST, ABI/Informs, Elsevier and Google Scholar	What is needed for developing a performance measurement system for the humanitarian supply chain field?	a structured method based on Denyer and Tranfield (2009) and Rousseau et al. (2008)	Published in Supply Chain Management: An International Journal "Hella Abidi, Sander de Leeuw, Matthias Klumpp, (2014) "Humanitarian supply chain performance management: a systematic literature review", Supply Chain Management: An International Journal, Vol. 19 Issue: 5/6, pp.592-608"
3	Performance management practices in humanitarian organizations	HOs owned data	Whether supply chain performance management practices in business are applicable to Humanitarian Organizations (HOs) because many factors of business supply chains might be similar to humanitarian supply chains.	Action research Coughlan and Brannick (2014)	Under Review in Supply Chain Management: An International Journal
4	The value of fourth-party logistics services in the humanitarian supply chain	Empirical data	Which decisive criteria support a 4PL as an innovative logistics concept for humanitarian supply chains?	Analytical Hierarchy Process (AHP) based on Saaty (1986)	Published in Journal of Humanitarian Logistics and Supply Chain Management "Hella Abidi, Sander de Leeuw, Matthias Klumpp, (2015) "The value of fourth-party logistics services in the humanitarian supply chain", Journal of Humanitarian Logistics and Supply Chain Management, Vol. 5 Issue: 1, pp.35-60"
5	Strategic Partner Selection Criteria for Building a Network of Logistics Service Providers	Company owned data	What extent the criteria for partner selection in vertical cooperation could be used to support horizontal cooperation among LSPs.	Analytical Hierarchy Process (AHP) based on Saaty (1986)	Submission process Journal of Business Logistics
6	Strategic Partner Evaluation for an LSP Network	Company owned data	The aim of this study is to establish criteria for evaluating strategic partners in a network of logistics service providers, to show how a n Analytical Network Process (ANP) can be used to identify the weights of these criteria on a case specific basis and to investigate whether a base ANP model can be developed for evaluating strategic partners in a network of logistics service providers	Analytical Network Process (ANP) based on Saaty (1990)	Accepted and in publication process in International Journal of Logistics Management

2 HUMANITARIAN SUPPLY CHAIN PERFORMANCE MANAGEMENT

2.1 BACKGROUND

Over the years the number of natural and man-made disasters has increased significantly. Due to climate change it is expected there will be more disasters (Olortunba, 2005; Dupont and Pearman, 2006); Thomas and Kopczak even expect a steady increase in the number of natural disasters for the next fifty years (Thomas and Kopczak, 2007). In 2006 the United Nations confirmed the expectation that the natural disasters over the next years become more severe, more often and more destructive (UN, 2006). In 2011, natural disasters killed 30,773 people and caused 244.7 million victims worldwide (Guha-Sapir et al., 2012). Economic damages from natural disasters were estimated at US$ 366.1 billion worldwide in 2011 (Guha-Sapir et al., 2012). The increasing number of natural disasters and the resulting humanitarian emergencies put pressure on humanitarian organizations to deliver humanitarian aid in an appropriate and cost effective way (Thomas and Kopzcak, 2005; Van Wassenhove, 2006a; Oloruntoba and Gray, 2006; Kovacs and Spens, 2007). Humanitarian organizations (abbreviated as HOs) are faced with logistics complexity, destabilized infrastructure and environment and the HO´s staff works in an extremely chaotic environment (Cassidy, 2003). Logistics is essential for disaster relief operations because effectiveness and speed in supplying beneficiaries with health services, food, shelter, water, medicines and sanitation is essential in case of a disaster (Thomas and Kopczak, 2005). Tomasini and Van Wassenhove (2009a) state that around 80% of the costs for relief operations consist of logistics costs in the form of procurement and transportation function.

Nevertheless, the significant increase of natural disasters, complex and cost intensive humanitarian logistics operations, responsibility, and reporting towards donors and beneficiaries but also the financial crisis which is limiting availability of donor money are reasons for HO´s to become more efficient in their operations. For an efficient humanitarian supply chain, performance measurement is crucial. It facilitates effective control and correction by reporting the current level of performance and comparing it with the desired level of performance (i.e. the standard) (Melnyk et al., 2014). Over the years HO´s have encountered challenges in developing suitable and common performance indicators. The lack of performance indicators has been a standing problem in humanitarian supply chain management (Davidson, 2006). This is because it is simply too difficult and too expensive to establish direct

linkages between an organization's annual efforts and the impact of those efforts on the organization's mission (Sawhill and Williamson, 2001). Even though performance indicators must be tailored to the missions and goals of individual institutions, neither a generic scorecard nor any universal set of indicators will work in all cases for all non-profits (Sawhill and Williamson, 2001).

The commercial domain has an extensive history in performance measurement. The added value of measuring performance in the supply chain is beyond discussion in the commercial domain and many companies have been able to reap tangible benefits from this. In fact the humanitarian sector is lagging behind when it comes to obtain benefits from measuring performance in the supply chain. However, when comparing commercial and humanitarian supply chains several factors that complicate measuring performance have to be taken into account.

There are various critical elements that complicate measuring performance in humanitarian supply chains, including (Blecken et al., 2009; Davidson, 2006; Widera and Hellingrath, 2011; Tatham and Hughes, 2011; Jahre and Heigh, 2008):

- Nonexistence of centrally captured data from operations,
- Limited information technology capacity and infrastructure,
- Chaotic environment,
- Lack of motivation for measurement in non-profit sector,
- Potentially negative media exposure,
- Human resource issues,
- General reluctance of performance measurement,
- Long-term versus short term goals of disaster response,
- Increasing complexity of performance measurement in this sector,
- The inability of fieldworkers to capture accurate data while working under significant time pressure,
- No recognizing the key role of the logistic community as an essential part of the NGO´s and humanitarian relief operations
- No linking between funding and humanitarian logistics performance measurement indicators

The main purpose of this study is therefore threefold. First, we aim to identify the state of the art of performance measurement and management in humanitarian supply chains. Second, we aim to define the implementation, gaps as well as the challenges in this field and give insights for future research in this domain. Third, we aim categorize the performance measurement

indicators to the five supply chain phases (Gunasekaran and Kobu, 2007) and evaluate them based on the evaluation criteria of Caplice and Sheffi (1995).

This chapter comprises six sections and is structured as follows. Below we first discuss the importance of measuring performance. We then investigate performance management in humanitarian supply chains by conducting a systematic literature review. In section 2.4 we discuss the performance measurement in humanitarian supply chains. Hereby we compare the key findings from humanitarian literature with those in the commercial world and asses the performance measurement indicators. Furthermore, we discuss the implementation and the challenges. In section 2.5 we identify research agenda that includes four key drivers namely for an efficient performance management and measurement in humanitarian supply chains. In section 2.6 conclusions are presented.

2.2 THE IMPORTANCE OF PERFORMANCE MANAGEMENT AND MEASUREMENT

Neely et al. (1995) define performance measurement as the process of quantifying the efficiency and effectiveness of an operation; this entails using a set of measures to quantify two central goals of a firm or organization the efficiency and effectiveness of an operation (Neely et al., 1995). A key objective of performance measurement and suitable financial and non-financial indicators is to inform decision makers at the strategic, tactical and operational level in producing of high quality goods, processes and services (Gunasekaran and Kobu, 2007). Performance measurement is fundamental for improvement (Kaplan, 1990), for making decision (Gunasekaran and Kobu, 2007; Long, 1997), for simplifying communication between supply chain actors and increase transparency of the supply chain and logistics processes (Gunasekaran and Kobu, 2007). There is furthermore an extensive research base in the strategy and accounting domains that shows a positive connection between using non-financial performance indicators (such as logistics indicators) and organizational results (Ahn 2001; Braam and Nijssen 2004; Ittner et al. 2003; Ittner 2008), hence the importance to measure performance in supply chains. Parker (2000) and Gunasekaran and Kobu (2007) identified criteria for commercial logistics to show the purpose of performance measurement:

- Identify success,
- Identify whether customer needs are met,
- Help the organization to understand its processes and to confirm what they know or reveal what they do not know,

- Identify where problems, bottlenecks, waste exist and where improvements are necessary,
- Ensure decision are based on facts, not on supposition, emotion, faith or institution,
- Tracking progress (show if improvements planned actually happened), and
- Facilitating a more open and transparent communication and co-operation.

Chow et al. (1994) indicates that logistics performance may be viewed as a subsection of the larger conception of a firm or organizational performance (Chow et al., 1994). It is multi-dimensional by default because one indicator is not sufficient for measuring logistics performance. A simple way of looking at the diversity of logistics activities is to differentiate between efficiency and effectiveness (Gleason and Barnum, 1986). Generally, efficiency is "doing the things right" and effectiveness is defined as "doing the right thing" (Gleason and Barnum, 1986). Logistics effectiveness has to be viewed as the extent to which the logistics function's goals, e.g. fulfillment time or in-stock availability are accomplished (Mentzer and Konrad´s, 1991). Logistics efficiency is the ratio of resources utilized against the results achieved and therefore identifies how well resources are utilized (Mentzer and Konrad´s, 1991). Other approaches use a larger diversity of indicators. Sink et al. (1984) for example defined and extend the meaning of performance; they illustrate seven dimensions': effectiveness, efficiency, quality, productivity, quality of work life, innovation and profitability.

It is generally believed that companies applying performance management outperform those that do not, although many studies are mainly anecdotic in nature lacking more rigorous research methods (Adams et al., 2004; Neely, 2005).

2.3 PERFORMANCE MANAGEMENT IN HUMANITARIAN SUPPLY CHAINS

2.3.1 A systematic review

Literature review is a major contribution to research progress (Colicchia and Strozzi, 2012) and it provides the best evidence for informing policy and practice in any discipline. Furthermore it is a key research objective for the respective academic and practitioner communities (Tranfield et al., 2003). A literature review is defined as a content analysis for analyzing, e.g. documents and identifying the conceptual content of the field by conducting a clear and systematic procedure (Mayring, 2003). In this research, we apply a systematic literature review method (Denyer and Tranfield, 2009; Tranfield et al., 2003; Leseure et al., 2004). A systematic review follows a list of specific steps to guarantee that relevant studies with regard to a specific topic are obtained and to avoid bias (Denyer and Tranfield, 2009).

This ensures the fidelity, completeness and rigorous nature of the review (Kitchenmann and Charters, 2007; Gonzales et al., 2010). To gain an in-depth insight of research in performance measurement as well as management in humanitarian supply chain, 10 steps that can be grouped in four stages are followed as presented in following table according to Tranfield et al. (2003).

Table 2.1: *A systematic literature review method (Tranfield et al. 2003)*

Stage	Phase
Planning	Identification for the need for a review
	Preparation of a proposal for a review
	Development of a review protocol
Searching	Identification of research
Screening	Selection of studies
	Study quality assessment
Extraction, synthesis and reporting	Data extraction and monitoring progress
	Data synthesis
	The report and recommendations
	Getting evidence into practice

2.3.2 Planning

In the beginning of the review we constructed a review panel that consists of researcher that are considered academic experts in the fields of humanitarian logistics, commercial logistics and performance measurement. We set manifold meetings to discuss the research questions and to analyze the gaps as well as the needs of humanitarian logistics sector about the area of performance measurement. In September 2012, a Humanitarian Logistics Workshop about performance measurement in humanitarian logistics was organized. 27 persons from other academic institutes, e.g. Hanken HumLog Institute, University Duisburg Essen, Cardiff Business School etc. and from the humanitarian practice, e.g. UN OCHA, UNICEF etc. had participated and the gaps as well as our research questions were discussed. Following research question is defined that guides the review:

RQ. *What is needed for developing a performance measurement system for the humanitarian supply chain field?*

2.3.3 Searching

Based on our research question we developed key terms to identify and evaluate the literature and to avoid biased research. We collected material from November 2012-December 2012 focusing on the following keywords: “performance” OR “performance measurement” OR “performance model” OR “performance system” OR “KPIs” OR “indicators in humanitarian logistics, humanitarian supply chains as well as emergency operation". Different academic journal, textbooks and doctoral dissertations articles were analyzed. The collected articles were defined and delimited. Hereby we achieved a low outcome of papers. Therefore we decided to extend the research keywords and not only to collect articles dealing with performance measurement. In June 2013 we started the second process and extended the keywords as followed. We recollected the materials and we analyzed them based on the inclusion and exclusion criteria in 2.3.4.

Based on these criteria we defined new areas to extract and analyze data in the systematic literature review. The following subject terms those address our research question were searched for within four research databases (EBSCOHOST, ABI/Informs, Elsevier and Google Scholar): ‘humanitarian logistics’, ‘humanitarian supply chains’, ‘performance’, ‘performance measure’, ‘performance measurement’, ‘performance evaluation’, ‘emergency logistics’, ‘emergency operations’, ‘disaster relief operations’, ‘performance model’, ‘performance system’, ‘KPIs’, ‘Indicators’. Further, as articles were reviewed other cited articles were added. The mentioned keywords from those new articles were then used to create search strings with Boolean connectors (AND, OR, AND NOT). The strings were used to search for titles, abstracts and keywords. We determined the time period of publications from 1970 until 2012 because since 1970 the total number of natural and technological disasters increased, a high increase of six-fold is to be recognized especially for natural disasters (Schulz, 2009). Furthermore, we observed that the number of publications and research interest in this field increased after the disastrous execution of the logistics after the Indian Ocean tsunami in 2004 (Kovacs, 2011). Table 2.2 shows the protocol for database search.

Table 2.2: *Protocol for database research*

Database	Scope	Date of search	Number of publications
EBSCOHOST	Title, abstract and keyword	11.-13.06.2013	354
ABI/Informs	Title, abstract and keyword	17.-18.06.2013	218
Elsevier	Title, abstract and keyword	18.-20.06.2013	452
Google Scholar	Title, abstract and keyword	20.06.2013	139
Total			**1,163**

2.3.4 Screening

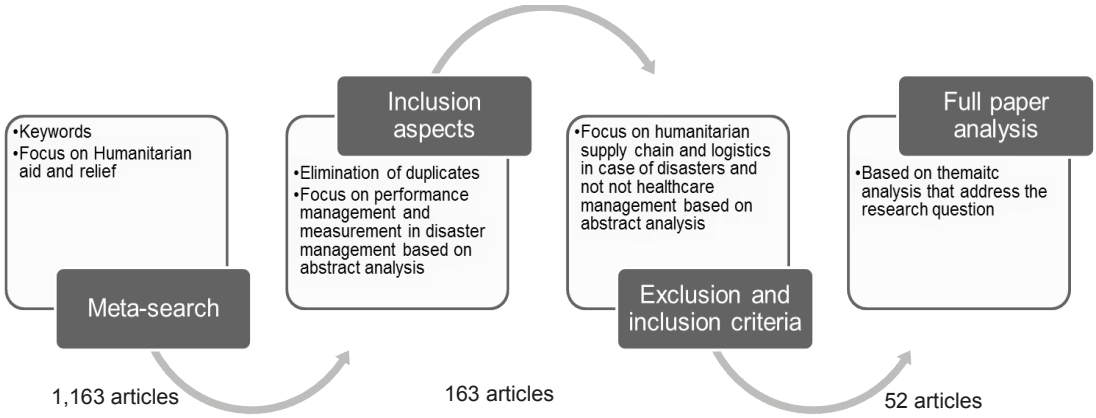
In order to ensure the fidelity and completeness and to protect the objectivity we determined criteria for inclusion or exclusion of articles as illustrated:

- Inclusion aspects: Analytical and empirical peer reviewed research articles as well as research related to performance measurement in humanitarian logistics, performance measurement in disaster management, performance measurement indicators, period time from 1970 to 2012, disaster relief operations, emergency logistics and emergency operations as well as performance management of operations relief in humanitarian supply chains. Furthermore, we included one book chapter and one mater thesis because of the popularity and impact in the practice as well as in the academia.
- Exclusion aspects: research that is out of the scope of our research, e.g. healthcare management, emergency management in hospitals etc., poor data quality, editorial opinion and non-english articles. Conference proceeding are excluded because a peer review is not often considered by the conference committee and due to the limited access to the conference proceeding.

As presented in Figure 2.1, in the searching phase we identified 1,163 articles that address our subject terms. In the second step, we eliminated duplicates based on titles and authors of the articles. Furthermore, we deleted articles that are not peer reviewed. Based on abstract reading we concentrated on performance management as well as measurement in disaster management excluded papers that address the research area like healthcare management. In the last step, we read the full articles and collected data for our descriptive analysis. Finally, we have categorized the articles in two main categories namely performance management and measurement. To address our research questions we have subcategorized the findings in: definition and measurement of success in humanitarian supply chains, approaches to measure actual performance in humanitarian supply chains and challenges in humanitarian performance management (Table 2.3).

Finally 163 articles have manifested all our inclusion criteria and only 52 articles (Appendix A) have met all our inclusion and our exclusion criteria that are specified after reviewing the full papers (Figure 2.1). Totally we rejected 1,111 papers because they were focused on different subjects of the humanitarian field.

Figure 2.1: *Modified screening methodology by Gimenez and Tachizawa (2012)*



2.3.5 Extraction, synthesis and reporting

We categorized and synthesized the 52 articles based on the aspects mentioned in Table 2.3. Hereby we conducted two separate analyses namely a descriptive and thematic analysis. The descriptive analysis explains the research scope, methodologies and characteristics of performance management in humanitarian supply chains. The thematic analysis highlights the

synthesis of the main outcomes from the extracted literature and gives us an overview about future research and practice as well as gaps in this field. The thematic structure considers following themes that address our research question (see also table 2.3).

- Definition and measurement of success in humanitarian supply chains
- Approaches to measuring actual performance in humanitarian supply chains (managing performance)
- Challenges in humanitarian performance management

Table 2.3: *Categories used in extracting and analyzing data in the systematic review (modified based on Pilbeam et al. 2012)*

Area	Category	Information
Descriptive	Year	Year of publication
	Journal/book	Journal/book in which it was published or indication of book section
	Title	Complete title of the paper
Methodology	Paper type	Identify if the paper is conceptual, mathematical, case study, literature review and/or survey
	Theoretical lens	Identify the theoretical paradigm presented in the study and from which the analysis of the data has been executed
	Sampling	If samples were used, this categorie identifies: sample size, size of network, local, regional or global
Thematic	Purpose	Shared objectives
	Context	NGO, GO, non-profit organization, performance measurement indicators, performance measurement framework, process, technology, at which level
	Definition and measurement of success	Performance measurement frameworks and indicators
	Managing performance	Describing and analyzing actual practice of managing performance
	Challenges	Challenges and issues in development of a performance management system, performance measurement indicators and systems.

2.4 ANALYSIS

2.4.1 Literature review - descriptive analysis

The objective of the analysis was to position this research in the body of the literature. Hereby this step is used to categorize the articles. The main criteria were the number of publications and their distribution per year from 1970 to 2004 and 2005 to 2012 after the disastrous logistics

execution after the Indian Ocean tsunami in 2004, e.g. to evaluate the relevance of the topic performance management and measurement in the humanitarian supply chain (Figure 2.2).

Figure 2.2: *Allocation of the articles across the period 1970-2012*

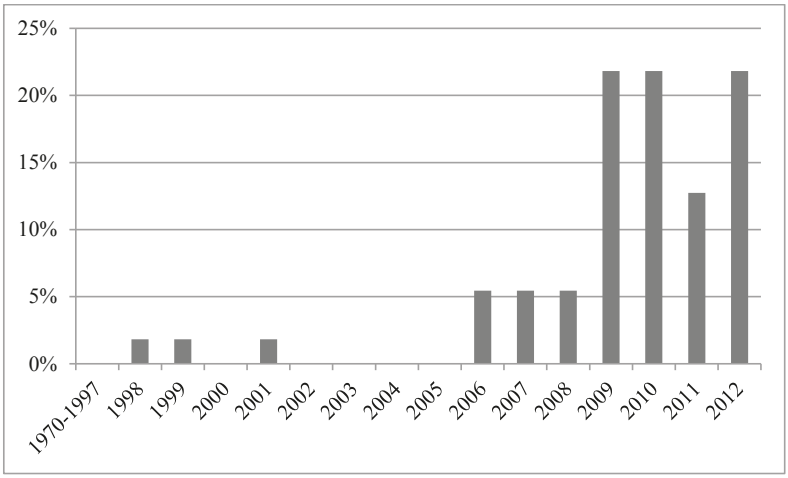
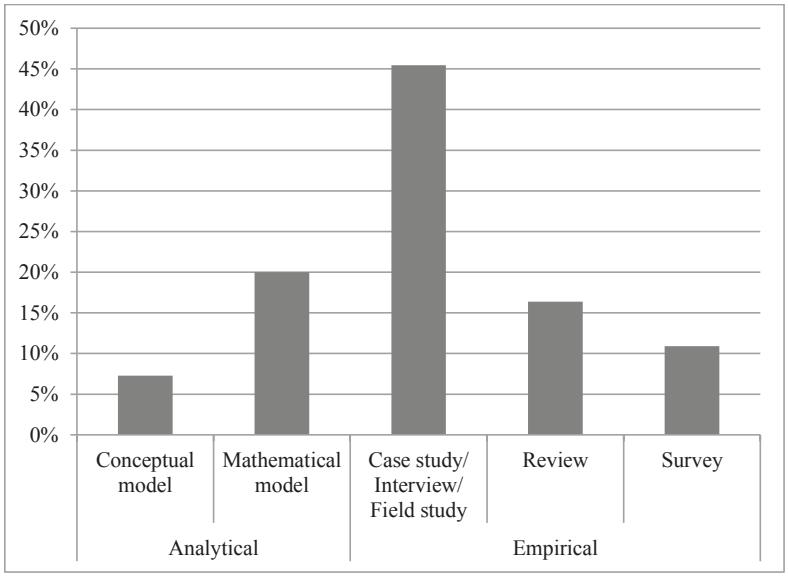


Figure 2.2 shows that the importance in performance management and measurement in humanitarian supply chains increased significantly after the Indian Ocean Tsunami in 2004, and specifically in the last four years. Figure 2.3 presents a classification of the papers based on methodology. Figure 2.4 illustrates the thematic focus of this study namely definition and measurement of success in humanitarian supply chains, approaches to measuring actual performance in humanitarian supply chains, challenges in humanitarian performance management

Details of the 52 articles are provided in Table 2.4 in Appendix A. Figure 2.3 shows that the most used method to investigate the topic performance management and measurement in humanitarian supply chain and logistics is the case study (46.2%) followed by mathematical models (21.2%). Reviews (13.5%) and Surveys (11.5%) are less used due to limited time of the humanitarian supply chain and logistics community. Only one survey and one review exist to define key performance indicators for the humanitarian supply chain and humanitarian logistics field.

Figure 2.3: *Allocation of the articles based on approaches*

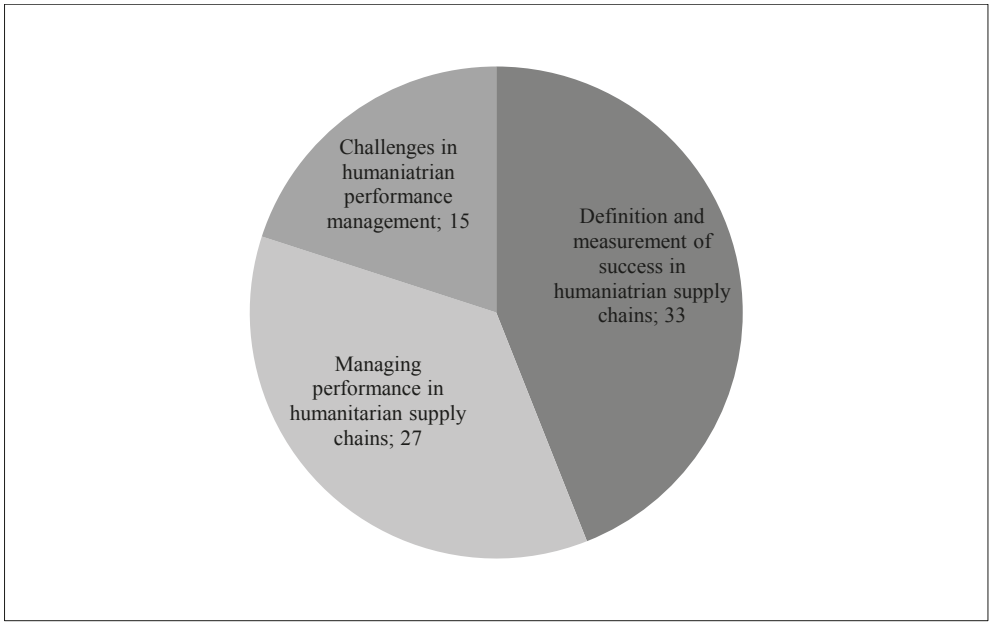


Altogether 52 empirical and analytical articles have been found. 30.8% have a specific focus on performance measurement indicators. Nevertheless, these papers indicate just sporadic performance measurement indicators. Furthermore, the scope is difficult to compare, resulting in indicators that are only applicable in specific logistics processes and to specific humanitarian supply chain structures. 59.6% of the articles are targeting improvement-oriented approaches. These articles deal with improving and promoting efficiency and effectiveness in the humanitarian supply chain and logistics sector, developing performance management frameworks and exploring manifold logistics concepts to achieve the best logistics performance. Only 9.6% of the articles illustrate the use of performance measurement frameworks to support indicator development. Most likely access to real data is hindered in such cases due to the HOs structure, the chaotic environment as well as the complexity of the humanitarian logistics structure (e.g. Pettit and Beresford, 2005; Thomas and Kopczak, 2005; Tufingki, 2006).

Figure 2.4 shows that most of the articles (in number 33) defined critical success aspects to provide an effective and an efficient humanitarian supply chain relief, i.e. minimizing overhead costs, developing strategies, utilizing strength and evaluating efficacy.

27 articles deal with performance management systems. Less attention is paid to the development of indicators and frameworks. Furthermore, 15 articles introduce the different challenges that humanitarian supply chain actors are faced with

Figure 2.4: *Allocation of the articles by the themes of this study*



2.4.2 LITERATURE REVIEW - THEMATIC ANALYSIS

As a next step the articles were coded, analyzed and sorted according to three categories, namely definition and measurement of success in humanitarian supply chains, managing performance in humanitarian supply chains and challenges in humanitarian performance management. The complete article was read for this purpose because a judgment and categorization of the articles based on reading the abstracts, title, keywords and conclusion was considered insufficient (Figure 2.1 methodology of screening the articles). In the following an exemplary overview of the articles is given.

Table 2.4: *Overview of the articles from the systematic literature review*

Year	Article	Definition and measurement of success in humanitarian supply chains	Managing performance in humanitarian supply chains	Challenges in humanitarian performance management
1998	Worm et al.	x	x	
1999	Ghafory-Ashtiany	x		
2001	Chang and Nojima	x		
2006	Davidson	x		x
2006	Beamon and Kotleba	x	x	x
2006	Van Wassenhove	x		
2007	Wei and Kumar		x	
2007	Medina-Borja et al.	x	x	x
2007	Moe et al.	x	x	
2008	Beamon and Balcik	x	x	x
2008	Balcik and Beamon		x	x
2008	Lutz and Lindell		x	
2009	Kumar et al.	x	x	x
2009	Kovacs and Tatham	x	x	x
2009	Blecken et al.		x	
2009	Schulz and Heigh		x	
2009	Van der Laan et al.	x		x
2009	McLachlin et al.	x		
2009	Oloruntoba and Gray	x		x
2009	Whiting and Ayal-Öström	x		
2009	Maon et al.	x		x
2009	Pettit and Beresford	x		
2010	de Leeuw	x		
2010	Blecken			
2010	Chandes and Pache	x		x
2010	Scholten et al.	x	x	
2010	Salmeron and Apte		x	
2010	Gatignon et al.	x		
2010	Kovacs and Tatham	x	x	
2010	Rongier et al.	x		
2010	Egan	x	x	
2010	Abrahmsson et al.			x
2010	Ertem et al.	x		
2010	Oloruntoba			
2011	Wild and Zhou	x	x	
2011	Tatham and Hughes	x		x
2011	Rietjens et al.		x	x
2011	Yang et al.		x	
2011	Nikbakhsh and Zanjirani Farahani	x		x
2011	Vitoriano et al.		x	
2011	Medina-Borja and Triantis	x	x	
2012	Quiang and Nagurney		x	
2012	Liang et al.		x	
2012	Holguin-Veras et al.	x		
2012	Heaslip et al.		x	
2012	Nagurney and Quiang	x		
2012	Lin et al.	x		
2012	Lodree Jr. Et al.		x	
2012	Leow et al.			
2012	Parlak et al.		x	
2012	Huang et al.	x		
2012	Cozzolino et al.		x	

Definition and measurement of success

The first category, definition and measurement of success, focuses at a definition of measurement approaches and frameworks as well as the associated indicators.

Cozzolino et al. (2012) considered the agile and lean concept to ensure effectiveness. Yang et al. (2011) suggested the adoption of RFID, sensor and network technologies in humanitarian logistics to optimize humanitarian operations relief. Other authors like Balcik and Beamon (2008) developed a simulation and modeling tool about facility location and stock pre-positioning decisions in a humanitarian relief chain responding to quick -onset disasters. Medina-Borja et al. (2007) defined input and output criteria and measured the performance by applying the Data Envelopment Analysis (DEA) or Beamon and Balcik (2008) used a performance measurement framework that was developed for the commercial counterpart (in 1999) for measuring the performance of humanitarian operations relief. Another approach like Balance Scorecard (BSC) was modified by Moe et al. (2007) to evaluate the natural disaster projects. Furthermore de Leeuw (2010) defined new indicators that can be adopted in the BSC to measure the humanitarian supply chain performance. Generally the approaches used to manage, improve, evaluate and measure the performance of humanitarian supply chains are manifold. These are retrieved from operations research and economics that are applied in the commercial supply chains such as Data Envelopment Analysis (DEA), Process Reference Model and Balance Scorecard (BSC), furthermore methods from business science and practice from the commercial environment such as SWOT analysis, Incident Command System (ICS), agility concepts and RFID technologies are applied.

Managing performance in humanitarian supply chains

The second category focuses at the practice of managing performance in humanitarian supply chains. In this category actual humanitarian supply chain performance is evaluated and discussed. Recently, Holguin-Veras et al. for example evaluated the performance of humanitarian logistics structure after the Port-au-Prince earthquake and define three structure types for comparative purposes (Holguin-Veras et al., 2012). Worm et al. (1998) analyzed the rapid response capabilities of tactical forces and tactical commands teams. They applied the mission efficiency analysis (MEA) that supported this investigation in an effective manner. Chang and Nojima (1999) developed post-disaster system performance indicators and evaluated the network coverage and highway transportation accessibility after the Hyogoke-Nanbu Earthquake in 1995. Most of the other papers in this category are OR related. For

example Yi and Kumar (2007) used a meta-heuristic of ant colony optimization (ACO) to solve logistics cases in disaster relief activities, i.e. vehicle route construction and multi-commodity dispatch. Kumar et al. (2009) conducted an analysis to assess the performance of non-profit organizations specifically how they managed their operation with limited resources and unlimited demand; furthermore they developed a framework that can be used by non-profit organizations to educate their staff in form of how they can use the resources more efficiently. Another work of Ertem et al. (2009) focused on resource allocation and to avoid inefficiencies in procurement of relief items. They proposed an auction based framework where bidders (suppliers) and auctioneers (HOs) compete amongst each other in multiple rounds of the procurement auction. Blecken et al. (2009) work presented a process reference model to support non-profit organizations that are involved in humanitarian relief in designing and visualizing supply chain processes. In addition to that, they discussed how non-profit organizations improve communication and coordination as well to measure performance. Rongier et al. (2010) illustrated a method that assist stakeholders in their decisions while carrying out a performance evaluation of the activities run during the crisis response operation.

Challenges in humanitarian performance management

Third, we have a category focusing at challenges that humanitarian supply chains are faced with. The given challenges are manifold and critical exemplary: characteristics of humanitarian logistics system are unique, organizational performance is a very complex problem, performance indicators and measurement systems have not been widely developed and systematically implemented in the relief chain as well as data accuracy (Beamon and Balcik, 2008). There are 4 challenging aspects are related to analyse and evaluate the performance of an emergency response system 1) value judgment 2) complexity of emergency response systems of the context in which they operate 3) validity of information 4) limiting conditions under which the system operated in that specific situation (Abrahmsson et al., 2010). Determining the best way to evaluate organizational performance is generally a very complex problem due to the diversity of criteria and dimensions of performance. Several performance models presented in the literature argue for introducing a selected number of key performance areas in order to obtain a valid holistic overview of the organization (Medina-Borja et al., 2007). For example Beamon and Kotleba (2006) determine that various performance indicators exist for traditional commercial supply chains but the distinct characteristics of the humanitarian relief environment may cause many of these to be inappropriate or irrelevant (e.g. customer indicators is irrelevant in a relief setting). Van der Laan et al. (2009) explored that

the biggest challenges lie in data accuracy and the fact that the current set of performance indicators is not geared towards future improvement. HOs often monitor and evaluate the supply chain for operational improvement. Furthermore, the staffs have not a proper qualification for tracking performance. However the key problem is the poor data accuracy and availability. And in many countries consumption data are inaccurate, not reflecting real demand because the supply pipeline has not always been full. Maon et al. (2009) saw the challenges more in cultural differences of relief agencies and disaster area.

2.5 DISCUSSION

2.5.1 Frameworks and indicators

The review of literature provides insides into the frameworks and key performance indicators for humanitarian supply chains. The difficulties of performance measurement in humanitarian supply chain are that they tend to be input-oriented rather that output-oriented in measuring the performance (Beamon and Balcik, 2008). In 1999, Beamon developed a three-part performance measurement framework for the commercial supply chain that consist of resource indicators, i.e. total cost of resources used, overhead costs, inventory investment, cost of supplies, annual costs etc., output indicators, i.e. total amount of disaster supplies and total amount of disaster supplies of each type that are delivered to recipients, target fill rate etc. and flexibility indicators, i.e. minimum response time, maximum proportion of emergency orders cycle and is applicable to humanitarian logistics. The presented indicators of Beamon and Balcik are clear in itself but they were not empirically tested, only three indicators (annual cost, response time and maximum proportion of emergency orders cycle) were used in mathematical modeling of inventory in relief operation. Another framework based on the idea of the balanced scorecard with the perspectives of the humanitarian supply chain shows four perspectives namely customer (i.e. speed of delivery, quantity etc.), internal (environmental and compliance issues, the use of pledged donation etc.), learning and growth (required knowledge, staff development etc.), financial (efficiency, flow of donations, track budget etc.); are tested based on case studies (de Leeuw, 2010). A second Balanced Scorecard and the presented set of performance indicators in percent that are found in the article of Schulz and Heigh indicate four perspectives namely customer service, i.e. delivery performance, stocks managed by service agreements etc., financial control, i.e. deviation from unit budget, service turnover versus plan, cost recovery etc.,), process adherence, i.e. available stock capacity to supply 5,000 families in 48 hours, relief stock turnover rate etc. and innovation and learning, i.e. staff development, on time reporting etc. (Schulz and Heigh, 2009).

The supply chain and the goals of a HO have to be understood and structured (Davidson, 2006). Davidson had examined the procurement and distribution of relief items data of the south Asia earthquake in 2005 from the Humanitarian Logistics Software. Based on these data Davidson had developed four performance measurement indicators such as appeal coverage (percent of appeal coverage, percent of items delivered) that determine how well the HO is meeting its appeal for an operation; donation-to-delivery time indicates the delivery time of relief items in the destination country after a donor has assured to donate it; financial efficiency consist of three indicators, two indicators measure the budgeted prices compared to the actual prices paid for delivered items, the third incorporates the transportation cost of delivering the goods to the beneficiaries and the ratio of total transportation costs to total relief items costs for delivered goods at destination in time; assessment accuracy expresses the speed and the accuracy of pledged donation and delivered relief items to beneficiaries and how accurate the field staff have assessed the need of beneficiaries, therefore the measure is how much the operations' final budget changed over time from the operations' original budget (Davidson, 2006). Davidson (2006) had not only developed the indicators, she investigated and evaluated the scorecard at different point in time after a relief operation and indicated the relevance of an information system to capture data timely (Davidson, 2006). Other set of performance indicators are accuracy of stock records that gives information about what to order when; realized service level is categorized in monitoring responsiveness and indicated the percentage of relief items that were delivered in the promised time and with stock efficacy a calculation of the expected inventory turnover rates can be conducted based on the chosen policy parameters because different product types require different order policies and/or different parameter settings regarding order size and safety stock (Van der Laan et al., 2009).

There are several excellent literature reviews of performance measurement systems and indicators, predominantly in commercial settings (Chan et al., 2006; Franco-Santos et al., 2007; Gunasekaran et al., 2001; Gunasekaran et al., 2004; Gunasekaran and Kobu, 2007; Neely, 2005; Shepherd and Günter, 2006). These papers show a diversity of approaches to evaluation of the performance of a supply chain. Gunasekaran et al. classified the performance measures on strategic, tactical and operational level to clarify the appropriate level of management authority and responsibility for performance (Gunasekaran et al., 2004); Lai et al. (2002) as well as Huang et al. (2005) present performance indicators that are based on reliability, responsiveness, costs and assets (Lai et al., 2002; Huang et al., 2005); the work of Beamon shows three different indicator categories like resources, output and flexibility (Beamon, 1999).

Otto and Kotzab focus on the performance measure towards the goals of supply chains (Otto and Kotzab, 2003); Giannakis, Simatupang and Sridharan determine performance measures to evaluate the collaboration within a supply chain (Giannakis, 2007; Simatupang and Sridharan, 2005); a performance management process for delivery services is set by Forslund and Jonsson (Forslund and Jonsson, 2007). Furthermore, there are general methodologies developed to measure supply chain and logistics performance, namely the balance scorecard (Kaplan and Norton, 1992), supply chain council´s SCOR model, logistics scoreboard, activity-based costing and economic value added (EVA) (Lapide, 2000).

In this chapter, we focus on the literature reviews of performance measurement systems and indicators of Gunasekaran and Kobu (2007). Table 2.5 indicates performance measurement indicators that focus on the supply chain environment by considering four different phases namely plan, source, make and deliver. Gunasekaran and Kobu (2007) did not consider the phase 'return' in their research.

Table 2.5: *Key performance indicators in logistics and SC environment (Gunasekaran and Kobu, 2007)*

Phases in supply chain	Performance indicators	
	Financial	**Nonfinancial**
Plan	Return on investment	Labour efficiency
	Selling price	perceived value of product
		development cycle time
		bidding management cycle time
		compliance to regulations
		forecasting accuracy
		supply chain response time
Source	Scrap/obsolescence cost	Labour efficiency
	Inventory cost	product development time
	selling price of goods and service	lead time for procurement including supplier development time
		delivery reliability
		product and service variety
Make	Scrap/obsolescence cost	Labour efficiency
	overhead cost	conformance to specifications
	inventory cost	capacity utilization
	selling price of goods and service	lead-time for manufacturing
	value added	production flexibility
		process cycle time
		accuracy of scheduling
		product and service variety
		value added
Deliver	Overhead cost	Labour efficiency
	value added	delivery reliability
	inventory cost	perceived value of product
	stock-out cost	value added
	transportation and warranty cost	product and service variety
		perceived quality

In the humanitarian supply chain we identified that the most developed key performance measures can be classified to organizational and process level. Performance measures at network and project are rare. The organizational level (e.g. Davidson, 2006; Blecken et al., 2009; Schulz and Heigh, 2009) measures the achievement of the target of an organization, e.g. donations and represents their strategy. The network level (e.g. Quiang and Nagurney, 2012) is characterized by knowing and understanding the strategy of the complete supply chain network. It deals with measuring the common targets of the overall supply chain network by applying a common method. At the project level (e.g. Moe et al., 2007) each process of the project can be measured. The project in the humanitarian logistics can be subdivided in three categories based on the phases for the disaster management preparation, immediate response and reconstruction. The process level (e.g. Van der Laan, 2009; de Leeuw, 2010; Gatignon et al., 2010) measure the logistics process, e.g. transportation, warehouse and inventory. The determining of performance measurement system and indicators in the humanitarian sectors at

organizational level, project level and process level can be developed based on the key success factors, phases for the disaster management (preparation, immediate response and reconstruction) and goals of each HO. In this respect, the network level seems to be a challenging issue for the humanitarian sector due to a lack of collaboration and partnership in this sector. Furthermore, it requires an extensive coordination and communication between the members of the supply chain network. Currently such collaboration and partnership at this dimension does not exist compared to the counterpart commercial supply chain. Common goal of the overall supply chain network is relevant to determine performance indicators and these require that the members of the supply chain network have similar key success factors. However, three articles present the balanced scorecard (McLachlin et al., 2009; Schulz and Heigh, 2009; de Leeuw, 2010) as a managerial tool that can be adopted in the humanitarian logistics setting with determining suitable objectives. Based on the results of the literature review and the different presented performance measurement indicators, it is recognized that the researchers suggest the balanced scorecard for the humanitarian sector as a possible instrument and that have to be tested in a HO by using the real-life data and evaluate the HO´s objectives. For our comparison, we have considered five supply chain phases and we have constructed an exemplary End-to-End humanitarian supply chain.

There are various ways in which performance indicators can be categorized, ranging from a balanced scorecard (Kaplan and Norton, 1992) to a framework results and determinants (Fitzgerald, 1991) for positioning performance indicators in a strategic context (Neely et al., 1995). We have classified the different performance measurement indicators of our systematic literature review in those five phases of an end-to-end humanitarian supply chain at the financial and non-financial level.

The 94 performance measurement indicators can be categorized to three phases plan, source and deliver at financial and non-financial level. Both phases make and return are not considered in the 52 articles. It can be seen that performance measurement indicators in the phase delivery play a dominating role. The most used performance measurement indicators focus on cost and delivery time. It seems to be clear that was the main objectives in relief operations pursued by HOs.

Table 2.6: *Performance measurement indicators used in humanitarian supply chains*

	Performance indicators	
Phases in supply chain	**Financial**	**Nonfinancial**
Plan	Appeal coverage [3]	Total length of highway open [1]
	Financial efficiency [3]	Area distance-based accessibility [1]
	Management expenses per household [4]	Total distance-based accessibility [1]
	Fundraising expenses per household [4]	On time reporting [8]
	Management expenses as % of total expenses [4]	Supply chain adaptability [6]
	Operations management [10]	Staff development [8]
	Donor management [10]	Actual project time versus planned project time[8]
	Financial network performance measure [15]	Image [10]
	Resources [5]	Partner management [10]
	Deviation from unit budget [8]	Innovation [10]
	Deviation from project budget [8]	Network robustness measure [15]
	Service turnover versus plan [8]	Unified network performance measure [15]
	Inventory turns [9]	Supply chain network performance measure [15]
	Income from the community [13]	Dynamic network efficiency [15]
		Synergy measure [15]
		Volunteer hours [9]
		Capacity creation [13]
		Human resources efficiency [6]
Source	Donations per household [4]	Fill rate announcement queue [12]
	Federated income per household [4]	Fill rate allocation share among bidders [12]
	Fund raising expenses per dollar of monetary/public contributions [4]	Demands can be satisfied [14]
	Stocks managed by service agreements [8]	Demands cannot be satisfied [14]
	Available stock capacity to supply 5,000 families in 48 h (segmented by ownership of stock) [8]	Assessment accuracy [3;6]
	Available stock capacity to supply 15,000 families in 14 days [8]	OS utilisation [6]
	Relief stock turnover rate [8]	Accuracy of stock records [7]
	Average procurement cost per transaction [8]	Procurement transactions using Humanitarian Logistics Software [8]
	Fundraising (income generating) and development resources [13]	

Deliver	Donation-to-delivery-time [3]	OSOR (order stock out of risk) [2]
	Output [5]	Order fulfilment cycle time [6]
	Flexibility [5]	Order fulfilment rate [6]
	Cost efficiency [6]	On time delivery [6]
	Stock efficacy [7]	Realised service level [7]
	Cost recovery [8]	Delivery performance [8]
	Average warehouse cost per m^2 stored [8]	Orders with agreed delivery time in days [8]
	Average % of transport cost of total order cost for airfreight [8]	Monthly reports to customers on time [8]
	Average % of transport cost of total order cost for other transport mode [8]	Operational vehicles using It software fleet wave [8]
	value of good sent [9]	product/donation velocity [9]
	Donation amounts going directly to the clinics versus the total amount of money donated [9]	customer satisfaction [9]
	% of appeal items mobilized & delivered at 2 months [11]	number of people served in all facilities [9]
	Operations total costs at 2 months [11]	number of people who participate in education programs provided [9]
	% logistics costs at 8 months (items+transport+storage value) [11]	Product and service level [10]
	Cost to deliver relief packages per family at 2 months [11]	Customer relationship (to donors) [10]
	Cost to deliver relief packages per family at 8 months [11]	Customer relationship (to intermediaries) [10]
	Efficiency [16]	Customer relationship (to beneficiaries) [10]
	% goods delivered from the region [11]	Families receiving at least partial packages by 2 months [11]
		Average no. of families served by day [11]
		Days to activate and to end supply chain [11]
		Order lead time (requisition to delivery) in days [11]
		Average distance of relief items (km) to families [11]
		Outputs of the service delivery process [13]
		Outcome Achievement [13]
		Efficacy [16]
		Equity [16]

Source: [1] Chang and Nojima (1999); [2] Beamon and Kotleba (2006); [3] Davidson (2006); [4] Medina-Borja et al. (2007); [5] Beamon and Blacik (2008); [6] Blecken et al. (2009); [7] Van der Laan (2009); [8] Schulz and Heigh (2009); [9] Kumar et al. (2009); [10] de Leeuw (2010); [11] Gatignon (2010); [12] Ertem et al. (2010); [13] Medina-Borja and Triantis (2011); [14] Quiang and Nagurney (2012); [15] Nagurney and Quiang (2012); [16] Huang et al. (2012)

Based on the supply chain performance indicators of Gunasekaran and Kobu, 2007 (Table 2.6) we compared them to the 94 humanitarian supply chain performance indicators that are collected from this conducted systematic literature review. The comparison report that only following supply chain performance indicators based on the work Gunasekaran and Kobu (2007) can be found in the humanitarian sector:

- Bid management cycle time;
- Capacity utilization;
- Delivery reliability;
- Forecasting accuracy;
- Inventory costs;
- Labor efficiency;
- Lead time for procurement;
- Overhead cost;
- Stock out cost;
- Transportation cost.

In fact the performed 94 performance measurement indicators indicate a divergence between each proposed performance measurement indicator from the commercial counterpart. The supply chain performance indicators focus more on the operational level and cover the process level of the humanitarian supply chain. We assume here a further difference between a humanitarian organization and a commercial organization. At the operational level both types of organization have the same target to increase the customer (beneficiary) satisfaction, improve the procurement and delivery performance, decrease the inventory, delivery as well as transportation costs. Many performance indicators exist for traditional commercial supply chains but the distinct characteristics of the humanitarian relief environment may cause many of these to be inappropriate or irrelevant (e.g. customer preference is irrelevant in a relief setting) (Beamon and Kotleba, 2007).

At the next level the performance measurement indicators (Table 2.6) can be analyzed by evaluating and exploring the issues based on evaluation criteria summary of Caplice and Sheffi (1995).

Table 2.7: *Evaluation criteria summary (Caplice and Sheffi, 1995)*

Criterion	Description
Comprehensive	The measurement system captures all relevant constituencies and stakeholders for the process
Causally oriented	The measurement system tracks those activities and indicators that influence future as well as current performance
Vertically integrated	The measurement system translates the overall firm strategy to all decision makers within the organization and is connected to the proper reward system
Horizontally integrated	The measurement system includes all pertinent activities, functions, and departments along the process
Internally comparable	The measurement system recognizes and allows for trade-offs between the different dimensions of performance
Useful	The measurement system is readily understandable by the decision makers and provides a guide for action to be taken

In the phase plan the indicators should indicate the efficiency of a supply chain and deliver value to customers. In the phase source the indicators monitor and improve the relationships between supply chain members. In the phase deliver the indicators report about the movement of products to warehouses or to customers (Jacobs and Chase, 2011; Supply Chain Council, 2008). The weakness of the presented indicators in Table 2.6 as a system is that the system is not comprehensive. First, it does not include all the stakeholders that are involved in the process. Second, it demonstrates that the indicators focus on one dimensional management and it ignores donor perspective and in particular the beneficiaries' perspective to measure the output. Furthermore the lack of this system is that the indicators do not focus on asset management dimension and only two indicators monitor, i.e. voluntary hours and staff development human resources dimension. Asset management and human resources dimension are crucial because these indicate the input. This performance measurement system is not casually oriented because it shows mostly the end results and it does not manifest the long term objectives. All the indicators are internally focused and cover more the internal procurement and distribution processes. This system is more horizontally integrated rather that vertically integrated. The weakness of this system is that it does not translate the overall strategy of the organization to all decision makers among the organization and it is not connected to an appropriate reward system. The advantage of this system is that it is more horizontally

integrated because the indicators capture the activities across different functions but unfortunately they do not balance against each other and even the measurement of carriers as intermediate supply chain members is not considered. In summary, the measurement system as presented is not useful for HOs. It should focus on different performance dimensions, i.e. asset management, human resources, beneficiary and donor perspective, financial and process efficiency. In fact not all elements like internal and external aspects are covered. In fact performance indicators and measurement systems have not been widely developed and systematically implemented in the relief chain. Various factors make performance measurement a challenging task for HOs. Some of the difficulties are associated with common complications observed in organizations operating in the nonprofit sector. Furthermore, the inherently unique characteristics of the disaster relief environment make relief chain performance measurement even more challenging for NGOs (Balcik and Beamon, 2008).

2.5.2 Implementation

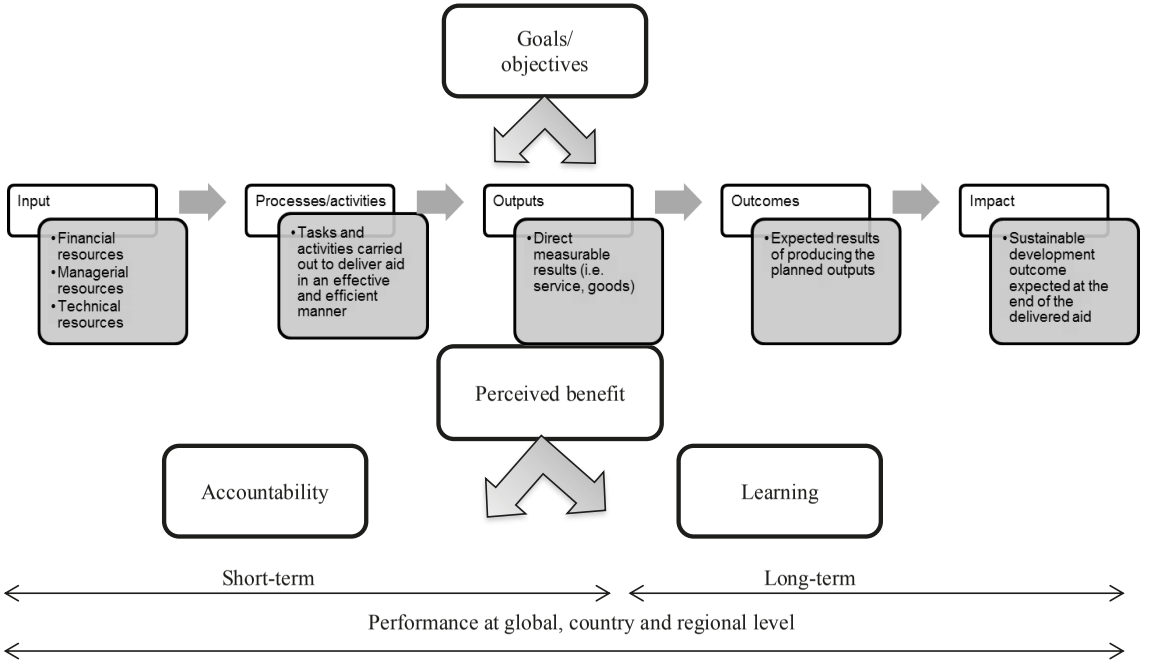
Implementation of performance management is defined as putting the performance management system and procedures in place (Bourne et al., 2000) and should be handled as a part of an organization wide project (Bourne, 2005; Bourne et al., 2005a). In these research studies a very unsystematic approach was found to assess efficiency to undertake impact assessment, to evaluate objectives in outcome term and implementation of processes. Kumar et al. (2009) argue that a successful organization starts with passion for the mission and vision, which is at the heart of the institution, HOs need leaders with strong business management skills and a committed spirit. The leaders must ensure that the right people are hired for the right positions. Furthermore a results-based management is often too complicated and too comprehensive; the second challenge revolves around the relationships among inputs, activities, short term outputs, midterm outcomes and long term outcomes. Moreover a challenge is the overelaboration of techniques. Measurement and indicators only provide a partial contribution to the information managers and decision makers' requirements and needs (Rietjens et al., 2011). The developments and implementations of such systems need supportive network and infrastructure. Just relatively little number of HOs have actively contributed to different researches that have been undertaken in the field performance management and measurement in humanitarian supply chains. Exemplary IFRC in the study of Schulz and Heigh (2009) and Gatignon et al. (2010), MSF in the study of Van der Laan et al. (2009) or Red Crescent of Iran in the study of Ghafory-Ashtiany (1999). In fact performance measurement of humanitarian supply chains is in fact a major issue of the most passionate debates as donors

require accounts of activities, particularly from NGOs, without forgetting that the affected populations run the risk of being the silent victims of a poor output performance of humanitarians supply chains (Chandes and Pache, 2010). Despite this, the challenges to relief chain design and management are: unpredictability of demand in terms of timing, location, type and size; suddenly-occurring demand in very large amounts and short lead times for a wide variety of supplies, high stakes associated with adequate and timely delivery; lack of resources (supply, people, technology, transportation capacity and money) (Balcik and Beamon, 2008). Another centrally driven factor to improve logistics performance in humanitarian supply chain is to overcome the barriers of any gendered access to aid (Kovacs and Tatham, 2009). The distinction between internal and customer-related indicators raises the question of the suitability of adopting such indicators used by for-profit organizations to measure the success of supply networks activities in a post-disaster response situation. HOs must also ensure that appropriate information readily available to meet the demands of the donor community. In such situations the use of standard indicators is often unsatisfactory as they often do not adequately account for all the cultural nuances impacting activities (Tatham and Hughes, 2011). According to the findings from the conducted systematic literature review in this chapter, the criteria are summarized in following performance management framework. This has to be considered at the regional, country and global level. The framework highlights the short-term and long-term perspective of a performance management and measurement (Tatham and Hughes, 2011).

The framework indicates on the top the aspect goals/objectives. This has to be determined and expressed by the strategic management considering the different aspects of disaster management and preparedness strategies. It is a task of the strategic management because they focus on resources, goals as well as strategies. Furthermore, media plays an increasing role and important role in disaster relief because the sudden onset disasters are mostly over financed due to media (Van Wassenhove, 2006b). However, strategic management have the direct control over inputs, processes/activities and influence a part of outputs. The input factor consists of financial (i.e. monetary or in-kind donations), managerial and technical (i.e. warehouse or communication equipment) resources that are needed to have effective activities as well as processes. Processes/activities in humanitarian supply chains include a variety of tasks, i.e. inventory management, distribution of relief items, warehouse management, procurement of relief items, construction of hospitals, fleet management and transportation. These are implemented and carry out humanitarian aid in an efficient way and are essential to report to donors. The outputs illustrate the measurable results of the delivered activities in form

of relief items or services. The outcomes are the expected results of producing the planned output and show the realization of the determined goals and objectives. The impact are crucial in humanitarian aid. Tatham and Hughes (2011) argue the typology 'impact' is described as being either positive or negative, direct or indirect and leading to primary and/or secondary long-term intended or unintended effects. The impact about humanitarian intervention, advocacy, coordination capacity building are difficult to measure. Exemplary, impact indicators is crucial for donors; based on knowing the impact by the donors they can choose what to fund and to develop policy. Impact indicators (i.e. mortality rate, severity and intensity of a disaster situation) play a dominant role in guiding disaster preparedness and planning response by national government (Hofmann et al., 2004). The results of all these mentioned factors lead to transparency and accountability. Accountability towards stakeholder can be demonstrated because of learning from experiences and documentation. Despite the challenges inherent in implementing change programmes, modern organizations need to respond more effectively to changing external and internal environments and organizational learning has become an important strategic focus (Cheng et al., 2006). Learning means learning from past experiences; depends on the capabilities and training of the involved staff; collaboration, operations and process management (e.g. recognizing logistics as a central role in preparedness) effective coordination; cross learning possibilities (learning from business and humanitarian) and corporate social responsibilities (Van Wassenhove, 2006). It must take account that donor has to know where the money is spent because they take the responsibility for that. Perceived benefit does not mean profit in humanitarian supply chains, it focus more on spending donation in an effective way, helping and providing aid to affected people in an efficient manner. Furthermore the perceived benefit is managing the performance in an effective and efficient manner because of control and management of decision making (Beamon and Balcik, 2008).

Figure 2.5: *Performance management framework*



Performance management framework (summarized based on the findings of the systematic literature review (Appendix A) as well as Hofmann et al., 2004, Buckmaster, 1999 and Crawford and Bryce, 2003)

It must take account that implementation factors that are categorized in internal and external factors have to be expressed to ensure the implementation of performance management systems in the humanitarian sector. Effective implementation has to be regarded as on-going and continual learning processes which are characterized by ingrained practices and a resistance to radical change programmes (Cheng et al., 2006). Following implementation factors can be highlighted here based on the finding of the conducted literature review:

- Internal factors are strategic management (Medina-Borja et al., 2007; Pettit and Beresford, 2009; de Leeuw, 2010; Rietjens et al., 2011), training and learning (Van Wassenhove, 2006a; Kovacs and Tatham, 2009; Maon et al. 2009; de Leeuw, 2010), selecting and determining indicators (Kumar et al. 2009; Van der Laan et al., 2009; Chandes and Pache, 2010), information systems (Worms et al., 1998; Davidson, 2006; Balcik and Beamon, 2008; Beamon and Balcik, 2008; Van der Laan et al., 2009;Tatham and Hughes, 2011), social aspects, i.e. ethics and cultural criteria (McLachlin et al., 2009; Wild and Zhou, 2011)
- External factors are security (Maon et al., 2009; Abramsson et al., 2010), coordination of HOs (Ghasfory-Ashtiany, 1999; Maon et al. 2009; Scholten et al., 2010; Nagurney and Quiang, 2012; Holguin-Veras et al., 2012), media (Van Wassenhove, 2006a) and advocacy (Whiting and Ayal-Östrom, 2009)

2.5.3 Challenges

Based on the literature review it became evident that four focal challenges have to be managed. The first is the satisfaction of donor, because the number of HOs increased significantly. Due to this expansion in this sector and competitive environment dynamic, HOs compete for scarce donor resources (Lindenberg, 2001). Compared to the commercial sector, in the industry there were led to improve its performance by benchmarking its performance against other sectors and developing strategic approaches to align organizational and supply chain processes (Egan, 1998). The humanitarian sector that uses performance indicators in the reports for donors frequently focus on financial indicators in order to link activities in the field back to the donor communities or relevant stakeholder groups whose role to ensure transparency and correct stewardship of funds (Tatham and Hughes, 2011). Hereby is to add that in such natural disasters the focus of HOs and generally humanitarian logistics is to alleviate suffering, vulnerability and save lives of affected people that occurred by disasters such as natural or man-made disasters (Moe et al., 2007).

Second is learning and training of employees at every level or organizations to evaluate and monitor process as well as educating managers in knowing how to implement effectively their

strategies into practice. Because due to the high turnover of staff, many are lacking the proper qualifications for tracking performance (Van der Laan, 2009); so learning and training is one of a strategic point to develop humanitarian operations in an efficient and effective way (Maon et al., 2009; Kovacc and Tatham, 2009).

The third investigated challenge is determining meaningful indicators. The tasks to relief chain design and management are: unpredictability of demand in terms of timing, location, type and size; suddenly-occuring demand in very large amounts and short lead times for a wide variety of supplies, high stakes associated with adequate and timely delivery, lack of resources (supply, people, technology, transportation capacity and money) (Balcik and Beamon, 2008). The challenges in humanitarian supply chains about performance management can be seen in the difficulties related to the measurement outcomes and impacts in humanitarian relief. The HOs strive to measure performance on inputs rather than outputs like in the non-profit organizations (Beamon and Balcik, 2008). Furthermore the balanced scorecard was presented as a possible tool, but the HOs cannot implement this tool easily due do the different objectives. The commercial logistics focus on economic objectives and the humanitarian logistics focus on social and economic objectives. For example a peace HO does not measure their performance with a process measure such as tonnes per week, they measured their success of a project by its contribution to the promotion of their main activity, i.e. peace (McLachlin et al., 2009).

The fourth key challenge is the poor data accuracy and availability. Developing the core indicators of profitability is that those non-profit organizations have difficulties to capture robust data in such complex and chaotic environment with destructed information and communication network system (Van der Laan, 2009; Tatham and Hughes, 2011) and in many countries consumption data are inaccurate, not reflecting real demand because the supply pipeline has not always been full (Van der Laan, 2009). Hence, for a better understanding of relief operations outcome or effectiveness indicators have to be developed (Tatham and Hughes, 2011; Beamon and Balcik, 2008). HOs often do, as a matter of priority, monitor and evaluate the supply chain for operational improvement (Thomas and Kopczak, 2005).

2.5.4 A future research agenda for performance management and measurement in humanitarian supply chains

From the discussion above we may conclude that the field of performance management in humanitarian supply chain is still in its infancy: for example, we found many different performance indicators and frameworks and the literature is inconclusive about which ones are best applicable in which situation. A framework and the resulting indicators should be

comprehensive, sufficiently complex to contain all the main features of the organization, but at the same time flexible, enabling modification by those who will work with it (Michelli and Kennerly, 2005).

Our systematic literature review gives insights into the conceptual idea of performance management and leads to new research directions. We summarized a future research agenda around four aspects.

- *Development of a common performance measurement framework*

  Currently several different performance measurement frameworks in the humanitarian supply chain exist (e.g. Beamon and Balcik, 2008; Schulz and Heigh, 2009; de Leeuw, 2010). So far the humanitarian sector has not seen the emergence of one or a few common performance measurement framework similar to the commercial sector has seen (cf. Neely, 2005). Therefore a common performance measurement framework has to be established that is easily understandable and manageable. This performance measurement framework should include standardized, comparable indicators based on common input, and focused on impact. The framework should support the goals of performance measurement and identify directions for organizational change. This leads to the following research question:

  RQ1: what are appropriate performance measurement frameworks and indicators for humanitarian supply chains?

- *Initiating the performance improvement cycle*

  One of the key goals of measuring performance is to induce. Performance indicators are required to establish a culture of improvement and accountability for improvement in humanitarian sector. Performance measurement needs to be part of an integrated improvement cycle within the focal organization as well as focused at its key stakeholders. This will also allow to measure and monitor and improve performance across the network. Attention for implementation aspects is key, for example the influence of performance measurement on the understanding and motivation of individuals in the HOs (Hall, 2008; de Leeuw and Van den Berg, 2011). We need a better understanding of how performance management can support an improvement cycle in HOs. This obviously requires the availability of sufficient data as an enabler. This leads to the following research question:

  RQ2: How to set up and implement a continuous improvement performance cycle in humanitarian supply chains?

- *Developing appropriate information technology (IT) to support performance management*

  Improved information flow in humanitarian organizations is necessary to facilitate performance management. Interesting questions here is how much staff should spent time on collecting data and analyze data; in the heat of an emergency data collection may not be at the top of the priority list of people. However, the access to data for the employees should be ensured frequently and in time (Kennerly and Neely, 2002). Furthermore, the focus of the employees should be supporting the improvement rather than spending a high amount of time in monitoring (Johnston et al., 2002). Preferably performance data should be collected electronically to save time and to establish stability (Gunasekaran and Kobu, 2007). Simple data access as well as providing standardized data analysis instruments are key drivers in performance management (Bourne, 2005; Bourne et al., 2005a), which requires proper training of employees at each level. This is an area where there is an abundance of research in the commercial sector but not in the Humanitarian sector. We derived the following research question:

  RQ3: What should an appropriate IT platform for performance measurement and management in humanitarian supply chains look like?

- *Involving stakeholder performance management*

  There are various actors in the humanitarian supply chain, e.g. government and their donor agencies, international humanitarian NGOs, suppliers, 3PL service provider, governmental agencies of the aid-receiving country, media and corporate donor (Oloruntoba and Gray, 2009). We have to take into account that many HO´s do exactly the same thing, e.g. they apply for the same funds, they use the same media as well as 3PL service provider and they have similar marketing strategies to increase funds and to stay competitive (Oloruntoba and Gray, 2009). Generally, the actors and in particular donors are key in performance management of HOs. Donors want to monitor the extent to which their money is well spent but that does not mean that donors should dictate all performance indicators. This may hamper HOs in developing a common performance measurement framework that present results about the outcomes and impact. An improved supply chain in terms of performance management may provide the bridge between donors and recipients as well as a strategic instrument for survival (Oloruntoba and Gray, 2009). This leads to the fourth research question:

RQ4: How to involve stakeholders in managing performance to ensure an efficient and effective humanitarian supply chain?

2.6 CONCLUSION

In this study we aimed to describe the state of the art of performance measurement and management in humanitarian supply chains using a systematic literature review. We aimed to define the gaps as well as the challenges in this field and give insights for future research in this domain. For this we categorized the performance measurement indicators into the five supply chain phases based on the classification of indicators developed by Gunasekaran and Kobu (2007). We assessed them based on evaluation criteria that have been empirically tested in commercial supply chains by Caplice and Sheffi (1995): comprehensiveness, usefulness, internally comparable, causally oriented and horizontally as well as vertically integrated. In doing so, we found that performance measurement frameworks and indicators are far from complete and that a process perspective seems to be a logical choice as a starting point for developing a performance measurement framework and indicators, similar to the SCOR model which was used as a basis in the Gunasekaran and Kobu (2007) paper.

The following insights were derived from the systematic literature review: the main body of publications regarding performance management and measurement in humanitarian supply chains has emerged after the 2004 Indian Ocean tsunami disaster. The total number of research articles in this specific field of performance measurement and management in humanitarian supply chains is still low compared to the commercial sector. We furthermore observed that the topic has gained more attention among European researchers than among US, Australian or Asian researchers. There are many valuable contributions based on theory and models, but the number of contributions that deal with actual application in humanitarian supply chains are limited. Further work is needed on the application of theory and models, particularly in the area of mathematical and stochastic programming as well as decision theory.

We have summarized the necessary success factors for implementing a performance measurement and management system in humanitarian supply chains from various investigations of researchers from this field and have designed a first guideline for developing an appropriate performance measurement framework. This guideline has not yet been empirically tested. As a first step towards future research in this area, this framework has been presented to two different international HOs who act as global players in disaster relief in more than 29 countries at the strategic, tactical and operational level. They are now in the process of developing a performance measurement framework based on this concept. They have decided

to integrate the topic performance measurement and management in their supply chain strategy and have determined that as a supply chain goal for 2014 in order to align it with their supply chain management concept. An important lesson in this context relies on the identification of the need to focus more on implementation issues of performance measurement and management in humanitarian supply chains and on how to ensure proper data availability. This requires involvement of relevant stakeholders in the supply chain, most notably the donors, but this has consequences for staff training as well.

Another finding based on the systematic literature review is that the topic performance measurement and management is not yet common practice in humanitarian supply chains. This study discussed strengths as well as weaknesses in designing and disseminating a performance measurement and management framework. Such a framework should be implemented as a strategic tool for humanitarian supply chain management that enhances effectiveness, improves the supply chain processes, increases efficiency, enhances donor interaction and satisfaction and makes HOs accountable as well as transparent towards their stakeholders. A process-oriented performance measurement reference model based on SCOR principles could be an appropriate and common framework in humanitarian supply chains where different stakeholders and processes are incorporated. Such a framework should provide information about key indicators such as the service levels and costs for different supply chain activities at the global, country and regional level.

We developed a guideline and categorization since a systematic approach to categorize research output regarding performance measurement and management in humanitarian supply chains does not yet exist. A limitation of this study therefore relates to the general validity and reliability of qualitative literature research. Further research in the area of performance measurement and management is pivotal to not only advance theory but more importantly help improve the supply chains of HOs. The success of HOs these days relies heavily on excellence in supply chain as a core competence and functionality of their missions and that requires appropriate performance measurement and management.

3 PERFORMANCE MANAGEMENT PRACTICES IN HOs

3.1 INTRODUCTION

To date, supply chain performance measurement at Humanitarian Organisations (HOs) has not been as systematically designed and implemented as it is in business companies or the military (Abidi et al., 2014). Once HOs began to address performance measurement and management, several key issues emerged (e.g. Beamon and Balcik, 2008). One such issue was how, in response to donor requests, to design and implement a supply chain performance measurement system that goes beyond financial indicators. The design and implementation of a supply chain performance measurement system is a particularly complicated task at HOs due to the intangibility of the services offered, immeasurability of their projects, unknown outcomes and the variety in the interests and standards of stakeholders (Beamon and Balcik, 2008). In addition, HOs need a process in place to ensure the evolution of performance management as the HO's circumstances change (Abidi et al., 2014). Another issue is the lack of employee training, weak management commitment and unsupportive organisational culture, limiting supply chain performance measurement and management at HOs (Tatham and Hughes, 2011).

When it comes to performance measurement and management the humanitarian sector stands in stark contrast with the business sector, where supply chain performance measurement and management has been commonplace for quite some time and there is abundant literature on performance measurement design models and their implementation (e.g. Gutierrez et al., 2015). As such, performance measurement and management is seen as a fairly well researched topic in the business domain (Melnyk, 2014). A similar depth of research is still lacking in the humanitarian supply chain literature (i.e. Abidi et al. 2014; Abidi and Scholten, 2015; Anjomshoae et al., 2017) even different approaches on performance measurement and management in the humanitarian supply chain have been suggested by Davidson (2006); Beamon and Balcik (2008); Blecken et al. (2009); Schulz and Heigh (2009); Van der Laan (2009); de Leeuw (2010); Abidi and Scholten (2015); D'Haene et al. (2015); Santarelli et al. (2015); Acimovic and Goentzel (2016); Anjomshoae et al. (2017). In response, this research investigated whether supply chain performance management practices from business can be applied in HOs when designing and implementing humanitarian supply chain performance measurement systems and presenting a process for managing the design and the development of performance management in HOs.

Our study focusses on two critical phases of performance measurement: its design and its implementation (e.g. de Leeuw and Van den Berg, 2011). . The study was conducted over a four-year period at Médecins Sans Frontières (MSF) Belgium with the aim of designing and implementing a performance measurement system for their supply chain. MSF's supply chain strategy is to be flexible and to adapt effectively and rapidly to beneficiary (patient) demands. The (emergency) relief programs that MSF is active in, such as responding to cholera outbreaks, focus on response operations in the immediate aftermath of a disaster and are therefore typically characterized by a considerable uncertainty in needs (Saputra et al., 2012). To deal with these circumstances, the key supply chain objectives of MSF Belgium are flexibility and service, while maintaining focus on cost reduction and quality. Already in 2014, before the start of our study, MSF Belgium had created a new department responsible for the so-called End-to-End supply chain for all countries. The End-to-End supply chain encompasses all activities of a project starting from the assessment of relief needs, procurement from international and national suppliers, warehousing, distribution up to providing services to beneficiaries. Moreover, the staff of the new department responsible for the End-to-End supply chain were responsible for managing the associated human resources, material and financial demands and information flows.

In this study at MSF Belgium, we focused on two main phases of performance management, design and implementation. The design phase at MSF Belgium consisted of an assessment of performance measurement methods and indicators in use, the identification of supply chain objectives, and the design of end-to-end key performance indicators. The implementation phase then involved collecting, analysing and disseminating the performance indicator data.

We used action research to evaluate the applicability of ten supply chain performance management practices for the design and implementation of performance management, identified in the business literature. We derived these practices from research presented by de Leeuw and Van den Berg (2011). We used various sources to back up our findings and to evaluate the applicability of the performance management practices. These included monthly reports, internal documents, observations, discussions, interviews, workshops and meetings at MSF Belgium, a visit to and interviews at three relief projects in Zimbabwe. Finally, in order to examine whether the performance management practices had been applied as intended, we validated their applicability during interviews.

We aimed to make theoretical and practical contributions. Firstly, we wanted to contribute to a deeper understanding of the design and implementation of supply chain performance

management at HOs. Secondly, we sought to show how performance management practices from business might be used by HOs to design and implement humanitarian supply chain performance measurement systems.

The remainder of the paper is structured as follows. The next section presents the theoretical background and a description of key performance management practices. Section 3.3 describes the research approach and execution and section 3.4 details its application and analysis of these performance management practices in the design and implementation of supply chain performance management at MSF Belgium. Section 3.5 provides the main findings and discussion of design and implementation phases of performance management. Section 3.6 provides the conclusions, limitations and future research directions.

3.2 PERFORMANCE MANAGEMENT PRACTICES

It has long been recognised that performance measurement and management is crucial for the effective and efficient management of logistics networks (Melnyk et al., 2014). Performance measurement and management contributes to the continuous improvement of performance (Neely et al, 1997), to the deployment of strategy (Kaplan and Norton, 2001), to organisational learning (Kueng et al., 2001), to managerial development (Garengo et al., 2005) and to aligning operations with strategic objectives (Taticchi et al., 2010). Performance measurement and management in humanitarian supply chains is still in its early stages compared to that in business supply chains. Measuring and managing performance in the humanitarian supply chain is a concern and a challenge for academics and practitioners because it is considered too difficult and too expensive to establish direct linkages between an organisation's annual efforts and the impact of those efforts on the organisation's mission (Sawhill and Williamson, 2001 Abidi et al., 2014; Santarelli et al. (2015); Anjomshoae et al. (2017). A plethora of performance measurement and management frameworks have been developed for business supply chains (Atkinson, 2012) including the Balance Scorecard (Kaplan and Norton, 2001) and the SCOR model (Supply Chain Council, 2007). Such frameworks are undoubtedly valuable, but their adoption is often constrained by the fact that they offer little guidance on how to select appropriate organisation-specific indicators and how to practically implement the designed indicators within organisations (de Waal and Kourtit, 2013). Examples are Gunasekaran et al. (2004) who focus on assembling key metrics using literature and results of an empirical study of selected British companies. Lai et al. (2002) as well as Huang et al. (2005) present performance indicators that are based on reliability, responsiveness, costs and assets (Lai et al., 2002; Huang et al. 2005); the work of Beamon shows three different indicator categories like

resources, output and flexibility (Beamon, 1999). Nevertheless, mostly they appears to be a general view (Rantanen et al., 2007). To support humanitarian organisations in designing and implementing performance measurement systems, we conducted a literature review upon used an existing framework of performance management practices (focused on designing and selecting performance measurement indicators and on implementation of performance management), as identified by De Leeuw and Van den Berg (2011) to define practices that focus on designing and selecting performance measurement indicators and on implementing performance measurement and management.

3.2.1 Designing performance measurement systems

The designing phase focuses on identifying an organisation's objectives and success factors in order to develop performance indicators (Bourne et al., 2000). In the business sector, it is common practice to design and develop indicators using a standard performance measurement framework rather than a custom-made model (Najmi et al., 2012) (ID 1 in Table 3.1). The most commonly used performance measurement frameworks in supply chain management practice are the Balance Scorecard (BSC) (Kaplan and Norton 2001) and the SCOR model (Supply Chain Council, 2007). The BSC assists decision-makers in evaluating business activities from financial, customer, learning and growth, and internal processes perspectives (Kaplan and Norton 1992). The SCOR model distinguishes five supply chain processes and proposes associated performance indicators on four levels (Supply Chain Council, 2007). Both performance measurement frameworks are relevant to supply chain management as they help to derive indicators that link the environment and the strategy of an organisation. Linking environment and strategy is essential (Melnyk et al., 2014) for delivering appropriate and cost-effective supply chain performance. Operational performance indicators should be derived from strategic and tactical organisational objectives (Melnyk et al., 2014) (ID 2 in Table 3.1) as presented by. Performance indicators should assess performance by measuring both quantitative and qualitative objective criteria (Gutierrez et al, 2015). Objective criteria should be applied in identifying standards and targets: either customer requirements, benchmarks or market standards, or time studies or historical data rather than estimates by management or operators (Taticci et al., 2010) (ID 3 in Table 3.1).

Performance measurement can have a valuable role in creating a dialogue between the top management of an organisation and its divisions/subsidiaries and avoiding any misinterpretation of divisions/subsidiaries performance (Gutierrez et al, 2015). As such, operational performance indicators should be defined jointly with all the departments involved,

rather than by each department separately, (Micheli et al., 2011) (ID 4 in Table 3.1) to achieve effective performance management (Tung et al., 2011). It has long been recognised that performance measurement and management are critical for the effective and efficient management of any business (Melnyk et al., 2014). However, flexibility should also be considered in metrics to ensure an ability to quickly react to changes (Ferreira and Otley, 2009) (ID 5 in Table 3.1).

Table 3.1 summarises the best practices discussed above which have been supported by the empirical work of de Leeuw and Van den Berg (2011).

Table 3.1: *Best practices in designing performance measurement indicators*

	Practices	**Sources**
ID 1	Define performance indicators according to a standard model, e.g. BSC or SCOR, or a corporate standard model rather than a custom-made model	Bourne et al. (2002); Ittner et al. (2003); Tangen (2004); Najmi et al. (2012)
ID 2	Derive operational performance indicators from the company's strategic and tactical objectives	Bourne et al. (2005a); Ferreira and Otley (2009); Melnyk et al. (2014)
ID 3	Use objective criteria for defining standards and targets, either external (customer requirements, benchmarks or market standards) or internal (time studies or historical data), rather than estimates by management or operators	De Waal (2007); Tatticci et al., (2010); Melnyk et al. (2014); Gutierrez et al. (2015)
ID 4	Define operational performance indicators jointly with all the departments involved, rather than by each department separately	Hardjono and Bakker (2006) Chung et al. (2006); Tung et al. (2011); Michelli et al. (2011)
ID 5	Cover three aspects – efficiency, effectiveness and flexibility – in the performance indicators	Ferreira and Otley (2009); Broadbent and Laughlin (2009); Melnyk et al. (2014)

3.2.2 Implementing performance measurement

The implementation phase puts the performance measurement system and procedures into place (Bourne et al., 2000). Initiating and sustaining a performance management initiative is crucial for improving business performance (Nudurupati et al., 2011) (ID 6 in Table 3.2). Implementing performance measurement is primarily a mechanistic exercise (Bourne et al., 2000) and should be managed by team leaders and/or operators who are part of the implementation team (ID 7 in Table 3.2). The team leaders and/or operators should possess good business management skills and demonstrate a committed spirit (Franco-Santos et al., 2007).

Performance measurement implementation should be handled as a part of an organisation-wide project (Ukko et al., 2007) because this will enhance implementation success (Nudurupati et al., 2011) (ID 8 in Table 3.2). In order to fully understand the design and implementation of performance measurement, and to ensure the success of an implementation, the involvement of an external expert in performance management projects is recommended (Marchand and Raymond, 2008) (ID 9 in Table 3.2). Moreover, the successful implementation of performance measurement systems relies on top management commitment (Cavalluzzo and Ittner, 2004). Top management should ensure that people apply performance measurement systems at all levels of their decision making (Kennerley and Neely, 2002) since these systems not only deliver performance improvement but also become a vehicle for cultural change, which helps in liberating the power of the organisation (Meekings, 1995). During implementation, explicit attention should be paid to cultural change and/or to operator training in the new way of working (Franco-Santos et al., 2012) (ID 10 in Table 3.2). Here, training by officials and managers can reduce the resistance to using performance measurement (Battista and Verhun, 2000) and enhance the skills and knowledge on analysing the results obtained from a performance measurement system and then making improvements (National Performance Management Advisory Commission, 2010).

Table 3.2 lists the best practices discussed above which have been further supported by the empirical work of de Leeuw and Van den Berg (2011).

Table 3.2: *Best practices in implementing performance measurement indicators*

	Practices	**Sources**
ID 6	Initiate a performance management initiative to improve business performance, i.e. cutting costs or improving customer service, rather than non-business reasons such as complying with legislation or assessing/rewarding operators	Bourne et al. (2003); Nudurupati et al. (2011)
ID 7	Pay explicit attention to cultural change and/or operator training in the new way of working during implementation	Bourne et al. (2002); Franco-Santos et al. (2007); De Waal and Counet (2009); Franco-Santos et al. (2012)
ID 8	Make team leaders and/or operators part of the implementation team	Franco-Santos and Bourne (2005); Ukko et al. (2007); Franco-Santos et al. (2012)
ID 9	Involve an external expert in performance measurement or in organisational change in the implementation	Bourne et al. (2002; 2003); Bourne (2005); Marchand and Raymond (2008)
ID 10	Implement performance indicators as part of a company-wide project	Bourne (2005); Bourne et al. (2005b); Nudurupati and Bititci (2005); Hardjono and Bakker, (2006); Ukko et al. (2007)

3.3 RESEARCH APPROACH AND EXECUTION

3.3.1 Research approach

The design and implementation of performance measurement systems in an organisation involves a change process that usually takes considerable time to develop (e.g. De Waal and Counet, 2009). For empirical and longitudinal research into this type of change, methods such as interviews, participant observations and action research are often recommended (e.g. Gutierrez et al., 2015). Compared to the interviews or observations used in a traditional case study, action research requires participative action and critical reflection and yields a deeper understanding of, in this case, performance measurement (Gutierrez et al., 2015). Action research can be characterized as a specific form of case study with the dual objective to contribute to the practical concerns of an organization while simultaneously accommodating the goals of science (Eltantawy et al., 2015). Action research is appropriate when seeking to take actions, to solve problems and to develop knowledge and theory about that action (e.g. Coughlan and Coghlan, 2002). Action research takes place simultaneously with the action and is a sequence of activities than can be used to solve problems at an organisation (Coughlan and Coghlan, 2002). Moreover, action research is based “on a collaborative problem-solving relationship between the researcher and practitioners which aims at both solving a problem and generating new knowledge” (Coghlan and Brannick, 2010, p.35).

Action research was adopted for our study because knowledge on performance measurement design and implementation needed to be produced in close collaboration between researchers and practitioners (Bourne et al., 2005). This study is conducted over a period of four years at Médecins Sans Frontières (MSF) Belgium. MSF in Belgium asked the authors to design and to implement a performance measurement system, to take actions and to participate in the performance management project because of the complexity of developing performance measurement at HOs. The action research method is essentially longitudinal and empirical and consists of a problem and solution formulation phase and a solution implementation phase (Lang et al., 2012). Working through such phases is one aspect of "rigor" in action research (Johnson et al., 2014). Each phase is composed of five stages: diagnosing, action planning, action taking, evaluation and specify learning Bernardo et al., 2017; Fagundes et al., 2017). The main action research phases in our study were as follows: (1) researchers involved in designing and in implementing performance measurement, and in understanding the processes of change or the improvements of the processes; (2) tracking changes in performance measurement development in a real setting (participatory) (Coughlan and Coghlan, 2002); (3) determining objectives and designing performance indicators; and (4) implementing, and testing the designed performance indicators and providing a reflection on the results.

It is also significant to add that for action research, access to data and information about the topic being studied is relevant (Alex da Mota et al., 2012). In addition, gaining trust in action research is also key criteria in order to obtain information from employees. This information is a key advantage of applying action research study as "academic researchers cannot get direct access to this know-how through questionnaire surveys" (Ballantyne, 2004, p. 328). In our performance management project at MSF in Belgium we had access to both data and staff.

We established a performance management working group at MSF Belgium consisting of practitioners (six supply chain officers and one supply chain director) and academic staff (one senior researcher and a PhD candidate (the main researcher)) to implement the design and implementation of a performance measurement system. The practitioners' presence was crucial to obtain support for the design and implementation of the measurement system in the organisation. This presence ensures the involvement of key actors and the necessary resources and was recommended by Gutierrez et al. (2015). The academic staff provided the theoretical foundations to develop the conceptual procedural framework and could give insights into the development, opportunities and challenges of performance measurement at an HO. The senior researcher acted as a facilitator in developing an agreement among the performance

management working group members. The main researcher acted as a coordinator and process enabler to provide training sessions, to ensure the involvement and participation of all actors, to organise workshops, to achieve a consensual validation of the performance measurement development (e.g. Gutierrez et al., 2015) and to design and test the developed indicators using real project data.

3.3.2 Design of performance measurement

The design phase started with a kick-off meeting, with employees from different departments at the headquarters of MSF Belgium, which was organised by the supply chain director and the main researcher. After the meeting, we first reviewed and assessed the performance indicators used by MSF Belgium. The review and assessment of the existing performance measurement was based on internal documents, semi-structured interviews (Appendices 1 and 3) and monthly reports as recommended by Braz et al. (2011). We furthermore identified the key objectives linked to MSF Belgium's supply chain based on 14 semi-structured interviews (Appendices 1 and 3). These interviews were conducted with the medical staff, finance officers and director, supply chain officers and director, back-office staff (warehouse management), technicians, logisticians and supply managers who were involved in various projects worldwide (Table 3.3). The interview process used to assess performance measurement were based on questions developed by, Neely et al. (1997) and Kennerley and Neely (2002), and consisted of five main parts: (1) the introduction of the interviewer and interviewee, the scope of the research project and assurance of confidentiality; (2) the role of the interviewee at MSF Belgium; (3) definition of a successful humanitarian supply chain and the supply chain at MSF Belgium, key objectives, key processes, the structure and strategy linked to the agile humanitarian supply chain of MSF Belgium, service level required by donors and beneficiaries; (4) bottlenecks and gaps in the supply chain as well as software used and data collection capabilities; and (5) specific questions on performance management (i.e. existing KPI frameworks, implementing performance management) (Appendices B).

Table 3.3: *The employees interviewed*

Job Position	Experience in humanitarian aid (years)	Experience in supply chain management (years)
Back office	9	11
Medical Cell	13	0
Finance Director Supply Unit	0.5	0
Chief Supply Chain	25	0
Middle Manager OPS Logistics	23	20
Back office	23	30
Supply Chain Officer 1	18	8
Supply Chain Officer 2	8	11
MSF Supply Site Director	16	6.5
Middle-Manager Finance	16	0
Supply Chain Director	11	9
Supply Polyvalent Technician	11	11
Logistics Coordinator	5.5	4
Project Supply Coordinator	11	12

Following this, the main researcher made an inventory of existing performance indicators at MSF Belgium and mapped the extent to which these indicators covered the supply chain processes at MSF Belgium. In addition, we used the SCOR model and BSC to identify gaps in the supply chain processes that were not well covered by existing metrics at MSF Belgium. This also enabled us to ensure that the designed performance indicators covered efficiency, effectiveness and flexibility.

Third, the availability of data was checked to identify whether the complete set of performance indicators (existing plus newly suggested ones) could be measured as executed in Gutierrez et al. (2015). For some performance indicators, data sources were not accessible because some data were not entered into the systems but rather held on paper or in spreadsheet documents. To avoid manual data collection and potentially conflicting data, an IT project was created in parallel by IT experts at MSF Belgium to enable data entry in an electronic format. These IT experts were also involved in the performance management project to provide opportunities and explain limitations of data entry in using the designed performance measurement indicators, a process in line with suggestions by Bourne et al. (2000).

Fourth, the performance indicators identified were ranked by the members of the performance management working group during a workshop using scoring sheets. The outcomes of this workshop were used as input for an Analytical Hierarchy Process (AHP) analysis. The AHP

analysis was used to determine the most important performance indicators in evaluating supply chain performance at MSF Belgium (Appendix E). However, the resulting indicators did not fully match the supply chain objectives of MSF Belgium. Therefore, we used a technical sheet based on Neely et al. (1997) (Appendix C) to evaluate the most important performance indicators and to ensure the appropriateness of the performance indicators for each supply chain process and for each organisational supply chain level, an approach in line with the suggestions of Braz et al. (2011).

Finally, the main researcher organised a follow-up workshop with the members of the performance management working group (supply chain officers, supply chain managing director, head of supply and supply chain director) to identify an appropriate measurement procedure, a step again suggested by Gutierrez et al. (2015). In doing so, we asked the members of the performance management working group the following questions (Appendix G): (1) How can we operationalise these performance indicators? (2) Can we establish a target for each indicator? (3) What is an appropriate data gathering method? (4) Are the indicators effective? In practice, it took the working group 12 hours to achieve consensus on the indicators and their measurement. The final version was presented to the advisory board by the supply director and supply chain director in order to gain approval for its implementation.

3.3.3 Performance measurement implementation

We structured the implementation phase in two main steps. The first step dealt with the organisational implementation of performance management at MSF Belgium. Weekly meetings were organised with the members of the performance management working group. We discussed the performance indicators, the data collection, we reviewed performance management procedures and we analysed the performance management culture at MSF Belgium.

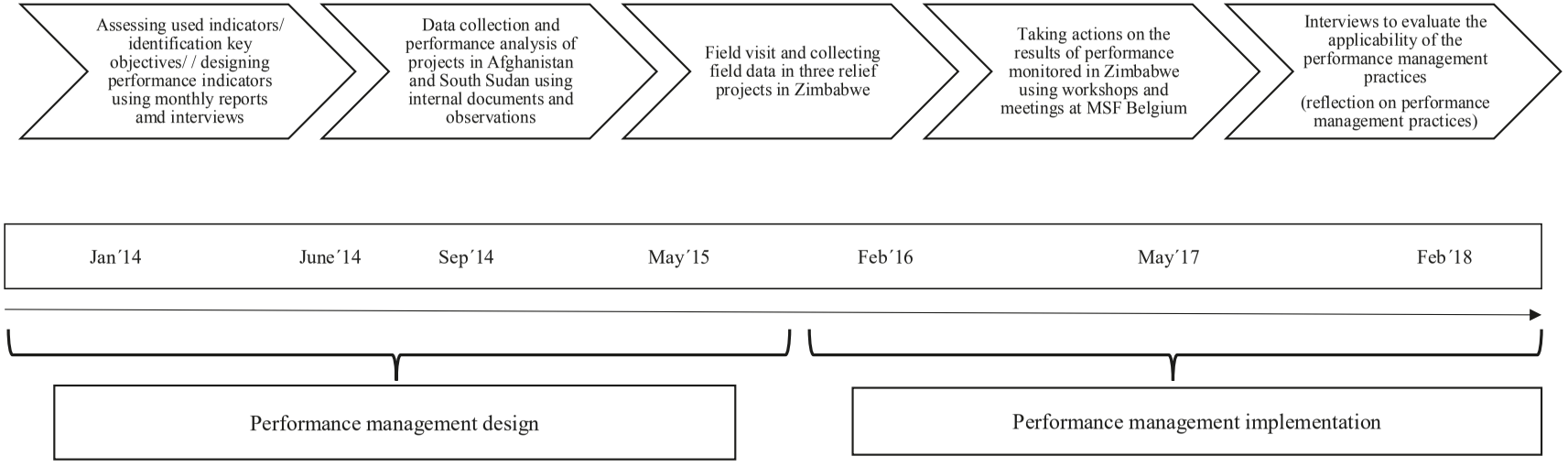
The second step focused on actually measuring the supply chain performance of MSF projects using the key performance indicators determined in the design phase. Through this second step, involving an MSF supply seminar in Belgium, we aimed to obtain the commitment of managers in relief projects worldwide by showing them how to analyse the supply chain performance of projects (Appendices F and G). We furthermore provided training sessions and seminars to the managers and operating groups. Additionally, we visited three relief projects in Zimbabwe. For each project we discussed the performance measurement implementation strategy (Appendix G; some details are omitted for reasons of confidentiality). In Zimbabwe, we had daily meetings, organised by the supply manager and the main researcher, with MSF employees: the

supply manager, warehouse manager, logistics officer, medical coordinator, pharmacists and the project heads of the relief projects. During each meeting, we analysed the performance of the selected projects in Zimbabwe. Performance indicators were discussed, criticised and adjusted.

Upon return to Europe, the main researcher set up new weekly meetings at MSF Belgium with the support of the supply chain director. The objective of the weekly meetings was to adjust the key performance indicators and to establish a data collection system based on inputs obtained. The main researcher acted as a reviewer in these meetings. Furthermore, the main researcher provided a supply chain performance analysis of the three relief projects in Zimbabwe as examples for the advisory board of MSF Belgium. Finally, the supply director and the supply chain director at MSF Belgium presented this supply chain performance analysis to the top management at MSF Belgium (the advisory board).

The related timeline including the major steps is presented in Figure 3.1.

Figure 3.1: *Timeline of performance management design*



3.4 DESIGN AND IMPLEMENTATION OF PERFORMANCE MEASUREMENT AT MSF

This section presents and analyses the application of the 10 selected performance management practices at MSF Belgium. These management practices, their operationalisation and tools are summarised in Tables 3.4 (design) and 3.5 (implementation).

3.4.1 Performance measurement design

3.4.1.1 Action research and analysis at MSF Belgium

To start the project, two members of the performance management working group organised a kick-off meeting. In line with practice ID 4 (see Table 4 – we use the same ID number identified from the literature review section 2), the members of the performance management working group invited employees from a variety of departments. During this kick-off meeting, we discovered that there had already been several initiatives to set up supply chain performance indicators, initiated by different departments.

During the kick-off meeting, all the existing indicators at MSF Belgium were discussed. It transpired that the indicators did not fully cover supply chain performance, were input-oriented (e.g. expiry date of products, incoming donation, transportation and warehouse costs, workload, fuel consumption, total stock value) rather than output-oriented (e.g., service level, delivery quality, customs clearance time, productivity of delivery vehicles) and did not allow performance to be compared across projects because virtually every project had its own indicators. Furthermore, we saw that the performance indicators used in these projects did not fully match MSF Belgium's supply chain objectives. It was identified that different departments had different expectations with regards to supply chain objectives: (1) the financial department aimed at reducing supply chain costs and improving supply chain cost transparency and visibility; (2) the medical department sought a more rapid response to changes in demand by beneficiaries (patients) by increasing flexibility; and (3) the supply chain department targeted cost efficiencies and quality as well as service level enhancement. This led, for example, to medical staff preferring to have an abundance of stock, whereas the stock manager from the supply chain department focused on limiting stocks to reduce warehouse costs and to avoid product expiry and damage. Participants at the kick-off meeting argued that this was due to communications about the supply chain performance objectives and the agile supply chain strategy of MSF having been unclear and only implicit.

Next, we aimed to establish objective criteria for defining standards and targets (practice ID 3). For this purpose, we carried out interviews with the supply chain's top management, supply

chain officers, the financial director and officers from the relief projects and, further, evaluated internal documents with regards to the mission of the End-to-End supply chain. The outcomes of the interviews were documented in a mind-map that helped to identify the key objectives of the supply chain and how they related to the supply chain strategy of MSF. This mind-map was discussed in a meeting with the interviewees that was facilitated by the main researcher. Although some specific project and country differences arose during the meeting, there was general agreement about the core objectives reflected in the mind-map (included in Appendix H).

The team used two standard models (the SCOR model and the BSC) as well as an overview of existing indicators to develop a long list of 75 performance indicators (practice ID 1). We then organised a meeting with the members of the performance management working group to develop, using a scoring sheet, a shortlist of indicators. This reduced the long list of 75 indicators to a more manageable 25 performance indicators. Using standard models, such as BSC and SCOR, helped to ensure that future and output-oriented indicators (such as upside supply chain flexibility[1] or donation-to-delivery time) were also included along with indicators that consider outcome, adaptability, accountability and impact (as also noted by Abidi and Scholten, 2015). The use of a standard model also helped ensure the indicators comply with MSF's agile supply chain strategy (practice ID 2).

Following this, a four-hour workshop with members of the performance management working group was organised. In this meeting, the shortlist of 25 performance indicators was matched with the mind-map to verify the extent to which key performance objectives were well covered. This workshop was aimed at sharing the views of the members of the performance management working group (consisting of both operational staff and management) and establishing a common understanding of the selected performance indicators. The advisory board wanted to have a maximum of five performance indicators at the strategic level (there were no limitations on the number of indicators at the operational and tactical levels). For this purpose, an Analytical Hierarchy Process (AHP) model[2] was developed to identify the performance

[1] Upside supply chain flexibility is included in the SCOR model and is a discrete measurement defined as the amount of time it takes a supply chain to respond to an unplanned 20% increase in demand without service or cost penalty. It shows the ability of a company or supply chain to respond quickly to an increase in order volume for a product.

[2] The AHP model was discussed by a group of researchers and practitioners in several meetings. A pre-test was conducted with the supply chain director and one of the authors. The final AHP survey was sent out to the performance management group members from the organisation (n=6) (Appendix 4). The six experts had a timeframe of two weeks to compare and to assess the relevance of each key performance indicator for each project level at MSF Belgium (headquarters (international), coordination, project site and project base levels) and for each key supply chain process determined (procurement, warehouse, distribution and supply chain planning).

indicators that could best provide a picture of supply chain performance at strategic, tactical and operational levels.[3] AHP is a standard method used to evaluate trade-offs between alternatives. It is commonly used in supplier evaluation, and also in KPI selection (Stricker et al., 2017). After completing the AHP, it was presented to the members of the performance management working group who were critical of the outcome, in part because they believed completing the pairwise comparison survey would require too much effort. The results of the AHP analysis also failed to match the key supply chain objectives. For example, the performance indicator 'invoice accuracy' scored higher than 'percentage of shipments received with missing quantity or with damaged or incorrect goods' despite the latter being more beneficiary-focused and thereby more in line with MSF supply chain objectives. Deriving performance indicators from strategic, tactical and operational organisational objectives helped the participants to understand that certain performance indicators were necessary, such as 'percentage of non-planned donation value' or 'percentage of order created vs. order responded' (output-oriented indicator) compared to 'number of average order (incoming) lines per day (workload)' (input-oriented indicator).

During a further attempt to create a shortlist of appropriate performance indicators, the research team changed the approach and asked the members of the performance management working group to complete a performance indicator technical sheet (Appendix C) based on Neely et al. (1997). Schreyer (2008) and Sousa et al. (2010) recommended using this technical sheet as its use ensured that measures were clearly defined and contributed directly to the associated continuous improvement programme. This technical sheet (Appendix C) includes information on each performance indicator in terms of its purpose, format, target, responsibility, data source and frequency of reporting, and on the use of these performance indicators. In completing the technical sheet, we also asked the members of the performance management working group to match each performance indicator with an operational, tactical or strategic objective of the agile supply chain of MSF Belgium. While completing this sheet, participants noted that some performance indicators overlapped. They realised that performance indicators such as 'demand forecast accuracy' provide more valuable insights than 'demand accuracy'. In order to reach a team consensus, we used the technical sheet and discussed each performance indicator during a workshop. Using the technical sheets, the 25 performance indicators were first sorted into operational, tactical and strategic indicators in a project meeting. The members of the

[3] Strategic level: headquarters (international), tactical level: Coordination level, operational level: Project site and project base level. The four organisational supply chain levels involved in MSF's ordering and delivery process are described in detail in Saputra et al. (2015, p. 117).

performance management working group then reviewed the indicators by category and looked for overlap between the three categories. The strategic indicators were reduced to five, as requested by the advisory board, while ensuring a good balance between performance indicators (this approach was also suggested by Braz et al. (2011)).

The focus on covering the key supply chain objectives in choosing indicators ensured coverage of efficiency, effectiveness and flexibility (ID 5). During a workshop with the members of the performance management working group, we used the technical sheet to identify performance indicators that would cover the categories of efficiency (i.e. indicators focused on costs), effectiveness (focused on time) and flexibility (in resources). For this purpose, we used the technical sheet to detail the content of each performance indicator. The efficiency category, for example, contained total delivery cost; the effectiveness category included on-time delivery and the flexibility category included stock level (to enable a rapid reaction when necessary).

Table 3.4: *Performance management practices in the design phase*

	Performance management practice	**Operationalisation and tools used**
ID 4	Jointly define operational performance indicators with all departments involved, rather than by each department separately	Organisation of a kick-off meeting of the performance management group at the headquarters of MSF Belgium to clarify MSF Belgium's supply chain strategy (Appendices B and D)
ID 3	Use objective criteria, either external or internal, in defining standards and targets rather than estimates by management or operators	Identification of the key objectives linked to MSF Belgium's strategy and its supply chain strategy using interviews (Appendix D) and a mind-map (Appendix H)
ID 1	Define performance indicators according to a standard model, e.g. BSC, SCOR	Identification of whether, and if so to what extent, these performance indicators are also relevant when evaluating the supply chain performance at MSF Belgium and to reduce the number of performance indicators through on-site meetings with employees from different divisions (Appendix D), application of the Analytical Hierarchy Process (Appendix E) and a workshop
ID 2	Derive operational performance indicators from strategic and tactical company objectives	Ensuring the appropriateness of the performance indicators for each supply chain process and for each organisational supply chain level through a workshop and a technical sheet (Appendix C)
ID 5	Cover all three aspects – efficiency, effectiveness and flexibility – in the performance indicators	Agreement over the design of performance indicators that cover all three aspects (efficiency, effectiveness and flexibility), establishment of a measurement procedure and enhancement of the performance management culture within the operating group at MSF Belgium through a workshop and a technical sheet (Appendices C and G)

These five steps (ID 1 to ID 5) are summarised in Table 3.4 below. In the next section, we reflect on the performance management design practices that we identified from interviews with

the supply chain director, a project leader and the supply director of MSF Belgium. We discuss the practices in order of application in the project, which is not always equal to the order discussed in the tables above. This reflection addresses whether the performance management practices work as intended.

3.4.1.2 Reflection on performance management design practices

The interviewees confirmed the usefulness of having a kick-off meeting with all departments involved (practice ID 4). Here, the interviewees argued that applying practice ID 4 has led employees to reflect on their own activities using inputs from different perspectives and to think about indicators that encompass the supply chain rather than a single node or leg in that supply chain. In addition, it was indicated that the meeting resulted in attendees promising to provide the data and information necessary for designing and testing performance indicators.

As a second step in the design phase, we used a mind-map to identify objectives and targets that are required for designing performance indicators (ID 3). Practice ID 3 was considered effective for designing performance measurements with the interviewees asserting that the objectives and targets should be the starting point for designing performance indicators when addressing a complex supply chain such as at MSF Belgium. According to the interviewees, this also contributes to gaining an understanding of the purpose and use of indicators in the performance management working group (i.e. as an indication of how far you are away from your objectives).

Third, we defined additional performance indicators based on a standard model (ID 1). The interviewees appreciated practice ID 1 because it enabled the performance management working group to combine indicators from standard models (slightly adjusted to accommodate the specifics of MSF) with existing indicators during the design phase. The interviewees argued that the combination of different indicators (from standard models and in current use) is necessary because existing standard models are not directly applicable when evaluating humanitarian supply chains. Nevertheless, drawing ideas from standard models, such as SCOR and BSC, proved useful. Using standard models was also a way to ensure that the focus when designing indicators went beyond existing operational indicators and included tactical and strategic indicators. Furthermore, the interviewees recommended using only the technical sheet when selecting performance indicators since the AHP model was considered as too time-consuming and overly complex. They indicated that they viewed the application of the technical sheet as a pragmatic tool to achieve a consensus on performance indicators.

We designed performance indicators based on the strategic and tactical supply chain objectives of MSF Belgium during a workshop with the performance management group. The interviewees saw ID 2 as necessary because deriving indicators from the strategic (headquarter) and tactical (coordination) levels enabled links to be created between the strategic, tactical and operational levels. This linking of the three levels is crucial in identifying the impact of one level on the others. Practice ID 2 also helped in clarifying crucial starting points, such as MSF's agile supply chain, to employees. This understanding contributes to data quality because people are then more willing to pay closer attention to entering data in systems correctly. The interviewees argued that, particularly in some African countries, MSF has more problems with data quality than, for example, in some Asian countries. They also indicated that the variety of IT systems used at MSF does not contribute to achieving good data quality (which was one of the reasons for setting up the overall KPI project).

To verify if the designed indicators covered all three aspects (efficiency, effectiveness and flexibility – ID 5) we used the technical sheet during a workshop with the performance management group. The interviewees agreed that practice ID 5 was useful because taking all three aspects into account was helpful in ensuring the right indicator design decisions were taken. All the interviewees indicated that covering all three aspects is relevant in establishing MSF's current performance and in determining whether MSF is on the right track to achieve its supply chain strategy.

We also discussed the relative importance of the practices. Overall, the interviewees argued that ID 3 was the most important because clarifying the supply chain objectives at an HO is crucial if one is to design appropriate supply chain performance indicators. ID 4 was evaluated as the second most useful, ID2 as the third, with ID 1 and ID 5 less important but still valuable.

3.4.2 Implementation of the new performance measurement framework

3.4.2.1 Action research and analysis at MSF Belgium

Not surprisingly, the implementation phase is critical in performance management (De Waal and Counet, 2009). As a structured and standardised performance assessment of the supply chain was not yet common practice at MSF Belgium, the supply chain director decided to involve the authors of this study as an external expert team (ID 9 – we use the same ID number identified from the literature review section 2) with academic and consultancy experience not only for the design but also for the implementation of a performance measurement system at MSF Belgium. Many authors recommend involving an external expert to achieve a full understanding of performance management and to ensure the successful implementation of a

performance measurement system (e.g. Marchand and Raymond, 2008). Not only the project team but also the advisory board at MSF deemed external support in the implementation phase as important in guiding decision-making and preventing commonly made mistakes, and to provide extra capacity and knowledge on the topic of performance measurement.

During the implementation phase, resistance from various managers in relief projects was observed. For example, during the implementation, one supply chain officer did not want to share the information needed for the defined performance indicators on one project in order to advance his own preferred indicators that had already been measured. To overcome this resistance, not only operational-level employees (supply manager, warehouse manager, pharmacists in the projects) but also members of the management team (supply chain officers, supply chain director and supply director at MSF Belgium) were incorporated in the project team (ID 8). More specifically, the supply chain director was appointed as the team leader for implementing strategic indicators at MSF Belgium, and a supply chain officer as the team leader for implementing tactical and operational indicators in relief projects in various countries. The head of relief projects, in cooperation with the supply chain officers, had the authority to make decisions with regards to the implementation. For example, the head of relief projects in Afghanistan and South Sudan and two supply chain officers at the headquarters in Belgium decided to pilot-test the performance indicators. This was possible thanks to the range of people present in the projects that possessed considerable knowledge about local conditions where the projects were running. As a result, the head of relief projects and the supply chain officers in Afghanistan and South Sudan were able to facilitate access to the relief projects in different villages and cities in Afghanistan and South Sudan that exposed the system to different cultures and to different levels of understanding of performance measurement.

Over the course of the performance management project, it grew into a larger, organisation-wide, supply chain improvement initiative (ID 6 and ID 10). After introducing the new performance indicators, we were able to identify heads of relief projects in other countries besides Afghanistan and South Sudan who were interested in measuring the supply chain performance of their relief projects and who were responsible for providing reports on supply chain performance results to the supply chain director. To structure the implementation of performance management in the various relief projects in the different countries, the performance management project working group decided to organise supply chain performance measurement sessions during a one-week supply seminar. This supply seminar was organised by MSF Belgium, with the objective of discussing general supply chain improvements with

supply-related employees representing 29 projects in a range of countries. During this week, the performance management project working group organised three sessions on supply chain performance management. In these, the performance management working group presented the performance indicators developed, demonstrated their application using data from 12 projects in Afghanistan and South Sudan, and showed the reported results (including performance improvements). Having seen the results in these sessions, several supply managers from various countries asked for an implementation-focused visit by the performance management working group to their relief projects. The performance management working group also solicited further inputs on performance indicator adjustments from the supply managers who attended the supply seminar. As a result, new issues concerning supply chain performance measurement arose (e.g. how to apply the system with projects that share stocks since, in that situation, one cannot measure stock levels per project).

The supply chain performance measurement sessions during the supply seminar not only showed the relevance of sharing experiences across the organisation and presenting supply chain performance measurement as part of improvement efforts, it also clarified the contribution of supply chain activities to improving performance in the relief projects. As a result, this motivated the staff to use the new performance measurement approach in their daily work. After the supply week seminar, visits to three relief projects in Zimbabwe were identified, where data were collected to measure the performance indicators. The visit to the relief projects lasted two and a half weeks. During this visit, daily meetings were organised by this study's researcher and the supply manager responsible in Zimbabwe to review the performance measurement implementation and to take actions based on the monitored performance. In each meeting, current performance was analysed, and actions were initiated based on the indicators. For example, after measuring fuel costs, the number of delivery stops and the high delivery frequencies to the same area, it became apparent that freight was often not consolidated due to urgent delivery requirements imposed by the medical department. The head of supply indicated that these performance indicators supported him in discussions with medical and financial departments by providing information on the impact of medical and financial decisions on supply chain performance. Dealing with cultural change and ensuring that employees understand the purpose of measuring performance is therefore essential (ID 7).

As a result of this fieldwork, MSF Belgium decided to set up training sessions and seminars in various projects to achieve a common understanding of performance measurement in order to overcome cultural challenges, to ensure progress in performance measurement, and to promote

proactive behaviour by employees from different hierarchical levels (as also suggested by Nudurupati et al. (2011) and Gutierrez et al. (2015)).

In Table 3.5, the first column summarises the practices involved in implementing performance measurement and the second column describes the use of each practice in our project together with the tools applied. In the next section, we provide a reflection on performance management implementation practices. For this, we conducted interviews with the supply chain director, project leader and supply director of MSF Belgium to evaluate the applicability of the performance management practices. The reflection examines if the performance management practices work as they were intended to work.

Table 3.5: *Performance management practices implementation phase*

	Performance management practice	Operationalisation and tools used
ID 9	Involve an external expert, skilled in performance measurement or organisational change, in the implementation	Academic staff with a background in consultancy and practice were invited to carry out the design and the implementation phases of performance management at MSF Belgium
ID 8	Make team leaders and/or operators part of the implementation team	Two team leaders were involved: one team leader on the strategic level and the second on the tactical and operational levels (Appendices C and F)
ID 6	Introduce a performance management initiative in order to improve business performance, i.e. cutting costs or improving customer service, rather than for non-business reasons such as complying with legislation or assessing operators	A one-week supply seminar was held in Belgium to discuss general supply chain improvements and the performance management project. Supply managers from 29 different projects in various countries attended (Appendix F)
ID 10	Implement performance indicators as part of a companywide project	An implementation strategy was developed with the performance management working group. Further, the designed performance indicators were demonstrated using data from 12 projects in Afghanistan and South Sudan. Results were presented during the one-week supply seminar
ID 7	Give explicit attention to cultural change and/or operator training	A visit to three relief projects in Zimbabwe to collect data and measure performance in these projects (Appendix F and performance measurement matrix – data not presented due to confidentiality reasons) A standard approach determined in conjunction with the team leaders (data again confidential)

3.4.2.2 Reflection on performance management implementation practices

The interviewees argued that involving an external expert (ID 9) in the design and implementation team was crucial in the design and implementation phase of a performance measurement system. The interviewees recognised that implementing performance measurement is a complex business for which they needed to bring in external competence as such experience was not available internally.

In the implementation phase, both management and operational employees were part of the team (ID 8). According to the interviewees, this made it easier to obtain data from the relief projects. Two of the interviewees indicated that this also avoided difficulties in coordinating the resources used across projects (many MSF projects run in parallel).

The interviewees indicated that ID 6 is important in ensuring an ongoing reflection on the activities of MSF Belgium and so determine the gaps between actual and desired performance as well as actions to be taken to close any gap. For this purpose, the members of the performance management working group organised meetings and assignments during the supply seminar (such as the Excel sheet developed during the supply seminar; see Appendix F). The interviewees argued that such activities need to be regularly repeated as such assignments initiate reflection and motivate employees.

The interviewees believed that implementing the performance indicators as a companywide project (ID 10) was a very useful approach that had identified differences between countries and made it possible to design unified indicators. However, it was also indicated that a possible disadvantage of such an approach might be that employees felt additional workload pressures across all countries. The workshop during the supply seminar was instrumental in building consensus among countries. The interviewees supported the view that such workshops should be organised more often for different regions and should involve more people from the relief projects.

As a final step, the main researcher conducted a pilot study in Zimbabwe and applied the performance indicators in three relief projects to compare the performance of these projects, to increase organisational learning about performance measurement and to give explicit attention to cultural change and to operator training (ID 7). Interviewees argued that investing in understanding different cultures and the education levels of people involved in performance measurement simplifies the implementation process and avoids attempts to disrupt it. The interviewees argued that there are differences among country employees in the level of understanding of performance measurement, which affects the ease of implementation and the type of support needed in different countries. A good understanding of this is pivotal to the successful implementation of a performance measurement project.

During the interviews, the supply chain director, project leader and supply director of MSF Belgium evaluated the relative importance of the implementation practices. In general, the interviewees argued that ID 7 is the most important practice, ID 9 was seen as the second most important, ID 8 and ID 10 as the next most important followed, finally, by ID 7. The reason

why ID7 was seen as the most important was because providing training to employees in projects in different countries enhances and improves the skills and knowledge on performance management and reduces the risk of non-usage of performance management tools by the employees.

3.5 MAIN FINDINGS AND DISCUSSION

We conducted action research at MSF Belgium over a period of four years to explore whether supply chain performance management design and implementation practices applied in business organisations are appropriate for humanitarian organisations (HOs). To this end, we conducted a variety of workshops, meetings and interviews, and we conducted pilot tests. This study provided the following findings.

The first finding is that the ten performance management practices we used are not all equally important for successful design and implementation of performance management – although all the practices seemed to be required for the successful design and implementation of supply chain management at MSF Belgium. During the interviews that we held in 2018 to reflect on the performance management design and implementation practices, the interviewees all agreed that all the practices were important and a prerequisite for successful design and implementation of performance management at HOs. However, according to the interviewees two practices (ID 3 and ID 7) stood out in terms of importance. Setting objective criteria (ID 3) was seen as a key prerequisite by all interviewees. One interviewee argued that setting and discussing objective criteria "makes clear what the indicators should be used for because different MSF supply chains have to be considered and it supports MSF employees in learning how to design indicators independently." This result is in line with earlier findings (e.g. Taticci et al., 2010; Melnyk et al., 2014). Paying explicit attention to cultural change (ID 7) was evaluated as most important. Three interviewees indicated cultural acceptance is crucial because they would work in environment where many cultures and competencies and visions come together which influence the results of performance management implementations. This result is in line with Franco-Santos et al. (2012).

The second finding is that tools and techniques developed for designing and implementing supply chain performance measurement systems in and for business organisations are also relevant for managing supply chain performance in a humanitarian context. This is in line with findings from the literature on humanitarian supply chain management (Schulz and Heigh, 2009; Kovacz and Spens, 2011; Heaslip, 2013). During the course of the four-year project, we applied a variety of tools and techniques from businesses such as workshops, the Analytical

Hierarchy Process (AHP) (Saaty, 1980) and the technical sheet (Neely et al., 1997). We used workshops to solicit feedback on ideas and to discuss different perspectives on problems with relevant stakeholders as recommended by Bititci et al., 2000). For example, we presented the usefulness of the 'demand forecast accuracy' performance indicator. We showed how to obtain relevant data and how to measure 'demand forecast accuracy' using data from actual relief projects in Afghanistan. In addition, we presented how to analyse the obtained results and how to take the necessary actions to ensure appropriate stock levels in the relief projects while reducing airfreight costs. We observed that such an approach leads to greater agreement and reduces resistance among the employees in relief projects and at headquarters, similar to what Bititci et al. (2004) observed in the business sector.

We also found that not all the techniques worked as we had anticipated. For example, AHP did not work as expected. Practitioners argued that AHP is difficult to use due to the large number of metrics and measures given in the performance measurement system. The interviewees criticised the AHP survey (Appendix E), which involves pairwise comparisons of performance indicators, as too time-consuming and complex. This criticism is in line with findings in the research by Wakchaure and Jha (2012). Instead, we used an approach involving a technical sheet developed by Neely et al. (1997) to generate the purpose, format, target, responsibility, data source and reporting frequency, and use for each performance indicator. Using a technical sheet for each indicator simplified the selection of a limited number of relevant indicators and provides a structure to support the design process of indicators as indicated by Sousa et al. (2010).

The third finding is the need to connect the design and implementation of a performance management procedure to an IT project. Wouters and Wilderom (2008) have previously highlighted that data availability and related IT systems are essential for an effective design and implementation of a performance measurement system. MSF Belgium had recognised at an early stage that relying on data captured in a chaotic environment with unusable and incomplete data information is problematic when attempting to design and implement performance management because the actual performance levels may be depicted incorrectly. Therefore, four months before starting the performance management project, a parallel IT project had been started at MSF Belgium to develop a unified supply chain IT system across the globe. During the implementation of the performance management project at MSF Belgium, the supply chain director also got involved in the IT project and became the liaison between the two projects.

The fourth finding concerns the applicability of performance management practices used in business organisations to HOs. It is often stressed that business and humanitarian supply chains are very different (Abidi et al., 2014). However, the MSF performance management project as well as the interviews with key stakeholders about the practices applied showed that many of the design and implementation practices commonly found in business environments can also be applied in a humanitarian context, albeit with some adjustments. This finding is in line with Singh et al. (2018) who explained that the fundamental structure of the humanitarian supply chain is not so different from the business supply chain. For example, several metrics from the BSC and SCOR models can be used, but need adjustment to fit humanitarian supply chains (e.g. demand/supply planning costs obtained from the SCOR model has been replaced by purchasing items under the control of MSF Belgium)[4], a finding supported by Abidi and Scholten (2015). The applicability of these practices may help the design and implementation process of performance management that is aligned to HO´s strategies, philosophies and incentive schemes similar as in the business sector. In a similar vein, Abidi et al. (2014) showed that the concept of fourth-party logistics service providers, which is well known in the commercial sector, may also apply to humanitarian organisations. The performance management practices presented provide a structured guide to ensure that design and implementation of performance management at HOs stays manageable.

The fifth finding focuses on cultural change during performance management implementation in an organization. During the reflection interviews, the interviewees put emphasis on paying attention to cultural change (ID7). The interviewees pointed out that considering cultural change and providing training to MSF employees in the field is necessary and a new way of working for MSF during the implementation of performance management. The performance management project initiative led to a cultural change in the supply chain department at MSF Belgium. We observed that employees became less resistant to implementing performance management, and that the training sessions raised awareness of the importance of assessing supply chain performance, among others. One interviewee indicated that “cultural acceptance is crucial because we work in environment where many cultures, competencies and visions come together. For example, in some countries employees did not pay much attention to the topic of performance management, which results in inputting inaccurate supply chain data to the system.” In addition, employees from various departments at MSF Belgium realised that

[4] Costs associated with forecasting, developing finished goods or end-item inventory plans, and coordinating the demand/supply process across the entire supply chain. This performance indicator includes the financial volume of items purchased under the control of MSF in place of total purchased amount

supply chain performance management can support them in monitoring efficiency, in comparing results with expectations, in encouraging discussions in meetings between executives and employees and between colleagues and donors, in providing accurate and timely information to decision makers and in improving global performance.

Last, the study at MSF showed that there may be a logic to the order of applying the performance management design and implementation practices. Already during the ex-ante project approval we noticed that the understanding on performance management objectives and design of the indicators have to be unified among all actors involved in the performance management working group at MSF in Belgium. Starting with ID 4 and ID 3 allowed us to reach consensus among all actors. In contrast, the literature stated that negotiating goals is an approach that is not preferred (cf. de Leeuw and Van den Berg, 2011). We then focused the design phase on practices ID 1 and ID 2 to structure indicators according to standard frameworks such as the BSC or a SCOR model.

In the implementation phase of a performance management the order of the performance management practices retrieved from the literature has been changed as well. To implement performance management at MSF in Belgium, the supply chain director decided before starting the project to implement an external expert and a project team leader (ID 9 and ID 8) who is capable to guide organizational change as supported by literature (Marchand and Raymond, 2008; de Leeuw and Van den Berg, 2011). Then, ID 6 and ID 10 was recognized as a crucial step in the implementation phase of performance management at MSF in Belgium. The implementation of a performance management as a part of a company-wide project (ID 10) and creating a performance management initiative (ID 6) is advisable as these can facilitate the change process within an organization (de Leeuw and Van den Berg, 2011). ID 7 was regarded as a last step in order to avoid resistance among all actors involved in performance management implementation. Such resistance might lead to a lack of motivation of staff to induce improvement (de Leeuw and Van den Berg, 2011).

3.6 CONCLUSIONS

Research on how to design and then implement supply chain performance management measures in humanitarian supply chains is limited (Abidi et al., 2014). Indicators used by HOs do not cover all the relevant aspects of the humanitarian supply chain, with for example reports for donors frequently focussing only on financial indicators (Beamon and Balcik, 2008). In essence, there is no common understanding of performance management and there are no tools

and insights available in the literature on how an HO can design and implement supply chain performance management.

The existing literature often claims that humanitarian and business supply chain performances should be measured differently (e.g. D'Haene et al., 2015; Dubey et al., 2018). To the best of our knowledge, this paper is the first to provide an in-depth understanding of designing and implementing supply chain performance management procedures at an HO. In our research, we applied 10 supply chain performance management practices identified in the business literature to a humanitarian supply chain. We found that tools and techniques, such as workshops and technical sheets, used in a business environment are also essential in designing and implementing performance management projects at HOs. Likewise, connecting performance management to an IT project is crucial in successfully implementing performance management at HOs. Overall, our case study indicates that performance management practices used in business organisations apply to and are relevant for humanitarian supply chains and that not all the best practices are equally relevant when developing a performance management in HOs.

However, as with any study, our study has its limitations. First, the key issue regarding validity in action research using one specific case is the questionable transferability of findings to other contexts (Thompson and Perry, 2004). Therefore, in future research, we suggest undertaking multiple case studies to extend our findings to other organisations with different funding structures (MSF is known for its independence, with a large proportion of funds provided by individual donors) or different supply chain structures. Second, we have judged the applicability of business-based supply chain performance practices in humanitarian organisations using qualitative approaches. Providing stronger evidence for this applicability may require large-scale investigations such as a wider survey of performance management practices. Further, it would be interesting to study a range of humanitarian organisations that are entirely different from each other and for example to compare these with relatively stable business supply chains.

In terms of the wider research agenda, there are two conclusions and recommendations for further research. First, we identified that the availability of reliable, timely and accurate information is key in managing humanitarian supply chain performance. Recently, HOs have started to invest in sophisticated information technology in the hope that this will improve information sharing, provide accurate forecasts or mitigate inventory fluctuations. Although technologies are available, it is not clear which information it is that managers require to manage processes in relief operations and to make the best possible decisions. As a result, it is difficult for volunteers, technology developers and logisticians to collect and analyse data that

result in information that is accessible, reliable and relevant for decision makers (Gralla et al., 2015). This research also demonstrated that there is a lot of unusable and unstructured data in relief projects. Wamba et al. (2015) indicated that, once IT systems are in place, big data analytics will allow one to go beyond financial performance indicators and add value to customer, process and innovation perspectives that can promote and improve performance management and decision-making. Future research could therefore focus on examining the impact of big data and predictive analytics assimilation on humanitarian supply chains and humanitarian organisational performance in a similar way to the research by Gunasekaran et al. (2017) has addressed the business environment.

4 THE VALUE OF 4PL SERVICES IN THE HUMANITARIAN SUPPLY CHAIN

4.1 INTRODUCTION

In recent years, the broader topics of humanitarian supply chain management and more specifically collaboration and coordination among humanitarian organizations (HOs) have received significant attention in academia and practice (e.g. Altay and Green, 2006; Van Wassenhove, 2006b; Jahre and Jensen, 2010; Kovács , 2011; Blecken et al., 2009; Akhtar et al., 2012; Schulz and Blecken, 2010; Jensen 2012). However, in the face of diminishing income due to the financial crisis (Dang et al., 2010; EFA Global Monitoring Report, 2011) humanitarian supply chain actors are seeking to increase the benefits of their organizations and services to save more lives and to supply beneficiaries with aid in the shortest time possible (Cozzolino et al., 2012). Specialized logistics knowledge is needed considering the complexity of logistics infrastructure during humanitarian action, the need for efficient processes as well as the sometimes-problematic collaboration between actors in the humanitarian supply chain (Overstreet et al., 2011). Furthermore, donors more and more put HOs under pressure due to a perceived lack of transparency and accountability (Kopczak and Johnson, 2007).

Timeliness, flexibility and reliability of delivery are furthermore some key drivers that explain why HOs like UNICEF, IFRC, UNHRD and WFP develop logistics concepts for other HOs, share facilities and try to act as logistics alliances or logistics service providers (Heaslip, 2013). Although strategic literature recommends that firms focus on their core competences, unfortunately the core competency of many HOs does not comprise logistics activities or development of supply chain concepts.

However, in the commercial sector outsourcing of logistics activities became a trend in the 1990s (Laarhoven et al., 2000). This outsourcing of logistics is known under different terms such as “contract logistics”, “third party logistics” (3PL) or “logistics alliances” (Sink and Langley, 1997; Lieb et al., 1993). 3PL activities encompass transportation, customs services and warehousing as well as the related information flow for different industries (Langely et al., 2003, Hamdan and Rogers, 2008). “Third-party logistics [(3PL)] involves the use of external companies to perform logistics functions that have traditionally been performed within an organization. The functions performed by the third party [logistics provider] can encompass the entire logistics process or selected activities within that process” (Lieb et al., 1993, p. 38).

Bagchi and Virum (1998) argued that a "logistics alliance as a long-term partnership arrangement between a shipper and a logistics vendor for providing a wide array of logistics services including transportation, warehousing, inventory control, distribution and other value-added activities" (p. 93). A 3PL relation promotes cooperation while solutions are tailored to a specific industry or client and the benefits or risks can mostly be shared in a fair manner between two partners, (i.e. buyer and seller (Selviaridis and Spring, 2007). Such developments increase customer satisfaction, provide access to a worldwide network for procurement and delivery of goods (Bask, 2001) and reduce costs of labour and assets (Bardi and Tracey, 1991). Fourth-party logistics (4PL) differs from 3PL because it does focus on a comprehensive supply chain perspective. It is a combination of different types of expertise, capabilities of management consulting, IT technology and 3PL activities (Skjoett-Larsen, 2000).

A 4PL provider is "[…] a supply chain integrator who assembles and manages the resources, capabilities and technologies of its organization with those of complementary service providers to deliver a comprehensive supply chain solution" (Bade and Mueller, 1999, p. 80). A 4PL concept often consists of several partners together in a joint venture organization and the 4PL provider is responsible for a considerable part of a supply chain. Recently, several logistics service provider initiatives have started in the humanitarian sector, where different organizations have collaborated to provide supply chain services in the humanitarian sector (Heaslip, 2013). However, little is known about the potential success of such a model in a humanitarian environment. In the commercial industry, there are several examples of successes of 4PL providers, e.g. Li and Fung steering a fashion retail supply chain (Christopher, 2005) or METRO MGL Logistik GmbH managing the end-to-end supply chain of METRO Group (Prümper and Butz, 2004). In this chapter, we aim to elicit to what extent and in what way the 4PL concept could enhance performance of humanitarian supply chains. We focus on the following research question:

RQ. In which way could a 4PL act as an innovative logistics concept for humanitarian supply chains?

We investigate the relevance and value of a 4PL concept for the humanitarian sector, we aim to understand why and how 4PL is an interesting concept and how could it support service providers to create new 4PL concepts for the humanitarian sector. "To attain the expected benefits from the 4PL applications, companies have to identify a suitable 4PL model for the supply chain they will operate. […] Decision criteria have to be selected, identified alternatives

have to be evaluated" (Büyüzközkan et al., 2009, p. 113). Therefore, we apply an analytical hierarchy process (AHP) as our key research method (Saaty, 2001). This method allows structuring of decision problems in the format of a network. AHP considers the dependence between the criteria that are involved in the defined network structure among decision makers (Saaty, 2001) and allows for a systematic analysis (Jharkharia and Shankar, 2007).

The chapter is divided in six sections; the next section of this research introduces the 4PL concept and 4PL core components and it presents three examples from the humanitarian field of existing service operations mechanisms in the style of logistics service provider concept. We then detail our research methodology in section 4.3. Data collection, results and analysis are outlined in section 4.4. Section 4.5 discusses the values of 4PL in humanitarian supply chains and presents an example of a structure of collaboration by integrating a 4 PL provider. Finally we conclude our research in section 4.6.

4.2 THEORETICAL BACKGROUND

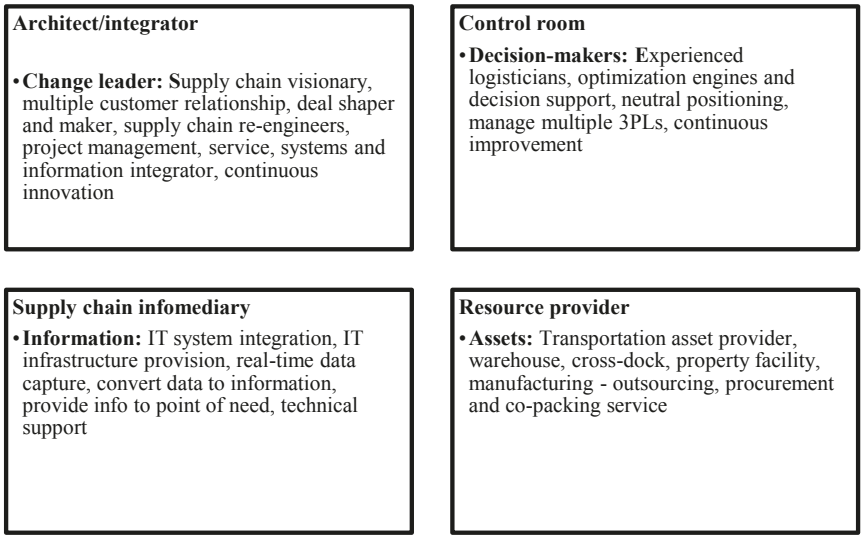
4.2.1 Fourth-Party Logistics (4PL)

According to Van Hoek and Chong (2001, p. 63), a 4PL provider is "[…] a supply chain service provider that participates rather in supply chain co-ordination than operational services". This is highly information-based and coordinates multiple asset-based players on behalf of its client(s). A 4PL provider allows humanitarian supply chain actors to have a single point of accountability across the supply and demand chain. A 4PL actor provides competences in information technology and skills in forming and building successful supply chain relationships among the actors (Coyle et al., 2003). Furthermore, a 4PL provider is able to drive cost-cutting initiatives and to increase flexibility to handle supply and demand irregularities (Frost and Sullivan, 2005). A 4PL provider is characterized by outsourcing execution to a 3PL provider for an effective management of logistics processes (Hingley et al., 2011). In addition, a 4PL provider "[…] is treated as a strategic partner, rather than a tactical one and is a supply chain integrator that synthesizes and manages the resources, capabilities, and technology of its own organization with those of complementary service providers to deliver a comprehensive supply chain solution" (Mukhopadhyay and Setaputra, 2006, p. 718). By using 4PL services customers - in humanitarian supply chains this could be HOs, government, suppliers and private sector organizations - are ensured of cost and process transparency, process re-engineering, strategy development and better management of resources across their supply chain and can focus their efforts on core competences (Jensen, 2010; Hingley et al., 2011). The

role and the work of a 4PL provider as well as the relevance of the 4PL concept for the entire supply chain is that "a 4PL provider is an independent, singularly accountable, non-asset based integrator of a client's supply chains. The 4PL provider´s role is to implement and manage a value creating business solution through control of time and place utilities and influence on form and possession utilities within the client organization. Performance and success of the 4PL provider's interventions are measured as a function of value creation within the client organization" (Win, 2008, p. 677).

Christopher (2005) presents four core components of a 4PL provider in such a venture as shown in Figure 4.1. The four core components give a description of a 4PL provider in the commercial sector and it is possible to relate these core components to the humanitarian sector. The first category is 'architect/integrator', which means that the 4PL provider has the competences to design and redesign a supply chain and has the needed skills to lead projects and to manage stakeholders. The second core component is called the 'control room'. This means that a 4PL provider supports as a decision maker to manage the operations including management of 3PL providers and the development of specific logistics concepts for clients. The third core component is 'infomediary' and deals with IT system integration, IT infrastructure provision, real-time data capture, data to information conversion, availability of information at point of need and technical support (Christopher, 2005). This component enables seamless integration of information across supply chains. The fourth core component is 'resource provider' focusing at asset management of a 4PL provider.

Figure 4.1: *Four core components of a 4PL provider (based on Christopher (2005))*



4.2.2 Logistics service providers in humanitarian supply chains

Supply chains have diverged and new types of services and operators have emerged in the logistics sector (Bask et al., 2010). Generally, as an emerging trend it can be recognized that HOs act as logistics service providers, i.e. WFP transport and distributes relief items of HOs and UNHRD or IFRC have installed hubs for HOs (Heaslip, 2013) or e-procurement in the UN (Walker and Harland, 2008). The interest of servitization of operations in humanitarian supply chain is increasing (Oloruntoba and Gray, 2009) and it can be seen as an instrument to gain competitive advantage (Vandermerwe and Rada, 1988). The term servitization was set by Vandermerwe and Rada (1988). Servitization is a standardized and highly customized package of customer-focused goods, service support (Robinson et al., 2002), self-service and knowledge (Vandermerwe and Rada, 1988; Baines et al., 2009). Heaslip (2013) formulated four "areas that humanitarian logistics academics could apply to services in humanitarian logistics: (1) servitization in humanitarian logistics, (2) service developments in humanitarian logistics, (3) Humanitarian Organisations as logistics service providers (4) service standardization" (Heaslip 2013, p. 43). Heaslip (2013) translated four servitization techniques that were determined by Baines et al. (2009) into the humanitarian supply chain context such as embedded services, comprehensive services, integrated solutions and distribution control.

The efficient organization of humanitarian supply chains relies on the support and supply chain management of logisticians on-site and off-site (Blecken et al., 2009). The wide range of humanitarian logistics processes in humanitarian relief operations implicates high costs: approximately between 40% and 60%, but can sum up to 80% of the total costs - relate to logistics activities, procurement costs included (Baumgarten et al., 2010; Long and Wood, 1995; Tomasini and Van Wassenhove, 2009b; Van Wassenhove, 2006a). As a result, optimized and efficiently coordinated humanitarian logistics that can be seen as the key performance driver for offering potential for saving logistics related costs, improving resource allocation, increasing service quality and reducing of complexity and lead times (Schulz, 2009; Tomasini and Van Wassenhove, 2009b). Gebauer et al. (2006) recommend establishing a market-oriented service development and defining a clear service development process; expanding service offerings, starting with product-related services (i.e. items catalogue of WFP and IFRC) and proceeding to services supporting the client and establishing relationship marketing. Below we describe four logistics concepts that aim to optimize and coordinate humanitarian logistics efficiently, ensure collaboration and increase customer service satisfaction.

Logistics Emergency Teams (LETs) have been launched in 2008, consist of four companies from the logistics, and transport industry: Agility, A.P. Moeller Maersk, UPS and TNT Express. These are four competitors in the commercial sector and they act as one business unit in the humanitarian logistics sector (Cozzolino, 2012). They have different corporate social responsibility programs and are experienced in humanitarian relief operations. LETs assist the humanitarian logistics sector with emergency response logistics after an occurrence of the disaster. In this phase LETs – with the coordination of WFP as the global lead of the logistics cluster – offer logistics professionals, logistics knowledge and assets such as warehouses, trucks, forklifts and transportation services to the relief community in the first three to six weeks after the occurrence of a disaster (LogCluster, 2008).

Table 4.1: *Logistics activities of the members of LETs*

Company	Activities
Agility	Logistics knowledge and global network. Reconstruction and recovery efforts, transportation of food and medical aid as well as offering logistics consultancy (Agilitylogistics, 2014).
A.P. Moeller Maersk	Risk assessment in the preparedness phase, in the response phase providing medicine, food and shelter. In the Reconstruction and recovery phase providing economic rehabilitation in the affected society (Maersk, 2014).
UPS	Transporting relief goods to affected countries, vetting in-kind donation, human resources, skills and knowledge, financial support, infrastructure and assets (UPS, 2014).
TNT Express	Support WFP in fighting world hunger and optimizing the relief operations in sharing knowledge and skills, emergency response, advocacy and engagement, warehouse and transportation capacity (TNT, 2014)

Logistics Cluster: In 2005, the UN established nine (later eleven) collaborative platforms of humanitarian activity (referred to as 'clusters') to address the problem of coordination among agencies. The Logistics Cluster is located in Rome and takes a role as a humanitarian coordinator at field level to improve and promote partnerships between humanitarian actors in the area of providing warehousing and transport capacities with the objective to enhance overall emergency response efficiency and effectiveness. The Logistics Cluster is responsible for coordination, information management, supply of training for corporate partners, for developing tools to improve capacity and for providing logistics services to ensure effective and efficient emergency response logistics (LogCluster, 2013).

DHL DRT: The DHL DRTs (Disaster Response Teams) step in to alleviate a possible lack of collaboration and coordination in humanitarian last mile distribution. Typically, regional airports are quickly congested during disaster response by supplies such as food, medical supplies and tents arriving from all over the world. Often there is no set disaster plan on how to manage such situations. The Disaster Response Teams (DRTs) cooperate closely with the UN Office for the Coordination of Humanitarian Affairs (UNOCHA). The DRTs consist of some 400 employee volunteers worldwide who are specially trained to handle the challenges of a deployment in the aftermath of a disaster. DRT team members help manage the logistics of disaster relief goods arriving at the airports. Together with local authorities and airport staff, they take care of incoming relief goods and set up and manage warehousing, which includes

sorting and stocking goods. DHL has three DRTs in place. The teams are ready for deployment within 72 hours after being called. DHL aid & relief is a concept that has emerged as a supply chain solution for humanitarian relief operations. The logistics experts provide logistics services to the international aid, humanitarian and development sector for the three phases of disaster management such as preparation, post-disaster, and regeneration and development of a region devastated by a natural disaster. After a detailed supply chain analysis, DHL selects different logistics provider's activities for each phase (DPDHL, 2014).

4.3 RESEARCH APPROACH

In this section, we will apply multi-criteria decision analysis (MCDM) to define the relevant decisive criteria of 4PL services in a humanitarian supply chain and to identify how 4PL may be applied to humanitarian supply chains. We think this is particularly appropriate to our study because the "[…] 4PL operating model selection can be considered as multi-criteria decision making problem" (Büyüközkan et al., 2009, p. 113). In the operations research discipline, there are a variety of MCDM methods. In this chapter, we use the Analytical Hierarchy Process (AHP) (Saaty, 1980) which solves multiple criteria problems in a hierarchical structure. This research method is a decision-supporting method that integrates qualitative and quantitative data for prioritizing alternatives when multiple criteria have to be considered or for evaluating complex multiple criteria alternatives (Saaty, 2001). Thomas L. Saaty shaped the AHP in 1970's (Saaty, 1990; Saaty and Vargas, 2001). With the AHP it is possible to construct a real life decision making problem in hierarchy as goal, criteria, sub-criteria and alternative (cf. Meixner and Haas, 2002). It means that the goal and criteria analytically are structured in a hierarchical order. Furthermore, with the AHP pair wise comparisons are possible to judge the relative importance/relevance of elements at each level of the hierarchy and evaluates alternatives at the lowest level of the hierarchy in order to make the best decision among multiple alternatives (cf. Sipahi and Timor, 2010). AHP is a preferred multi-criteria decision analysis method in several business related disciplines (cf. Apostolou and Hassell, 1993; Liberatore and Nydick, 2008). The general AHP procedure is subdivided in five main steps:

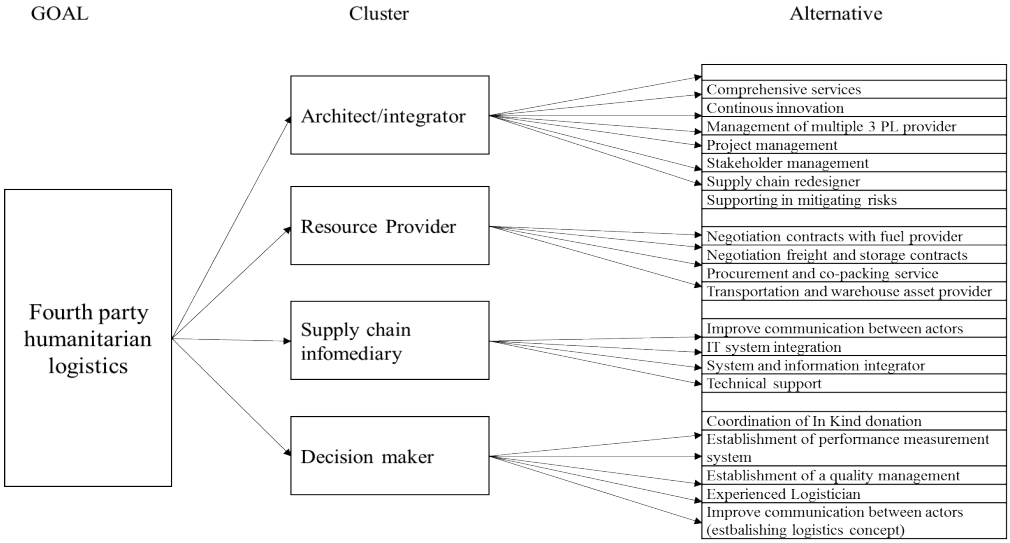
1) Problem definition and formulation, definition of the criteria and design of the hierarchy structure
2) Pair wise comparison of the clusters and pair wise comparison of the alternatives
3) Computation of total weight and proofing the consistency (if the consistency is not given then the elements have to be prejudged)

4) Sensitivity analysis

5) Evaluation of the alternatives

The hierarchy structure (step 1) has been developed based on the literature review. The decisive and crucial criteria for integrating and developing a 4PL concept into the humanitarian sector are depicted in Figure 4.2.

Figure 4.2: *Analytical hierarchy process structure*



The 4PL provider is an enabler; the capabilities encompass a suitable logistics network, IT services and support, process design, information and material flow coordination between the customers, execution of business service such as procurement, distribution, warehousing, and different value added services as well as service and carbon emission monitoring. Therefore we have used the four core components of Christopher (2005) 'architect/integrator', 'decision maker/control room', 'supply chain infomediary' and 'resource provider' for our AHP model. Because these provide an overview of the competences and skills of a 4 PL service provider. The criteria in the proposed AHP have been classified into three categories: goals, clusters and alternative:

a) The overarching goal is identifying decisive criteria for a 4PL service provider in the humanitarian supply chains. The integration of 4PL in humanitarian supply chains is supportive

because it is helpful for example in reducing delivery costs; furthermore, it ensures transparency and accountability. The goal is connected to clusters.

b) The clusters encompass 'architect/integrator' of supply chains, 'resource provider', 'supply chain infomediary' and 'control room'. We have decided to use the four core components provided by Christopher (2005) because these describe the key characteristics and skills of a 4PL provider. Furthermore, we have added criteria based on the review of the examples of logistics service providers in humanitarian supply chains and the servitization technique provided by Heaslip (2013) to the above mentioned components like for example 'coordination of Inkind donation' or 'supporting in mitigating risks'. These criteria form the alternative.

c) Alternative are the ultimate objectives such as comprehensive services, stakeholder management, project management, providing resources such as fuel, warehouse and transportation capacities, or IT integration in supply chains, performance measurement system or quality management (more details in Table 4.2). We have subgrouped these criteria to the four core components described by Christopher (2005). We have to add that we have removed one criteria "management of multiple 3PL provider" from control room and subgrouped it into architect/integrator because this criteria is to our point of view and discussion with practitioner during workshops related to project management; it fits more the humanitarian relief operation projects.

Table 4.2: *Modified selected decisive criteria based on Christopher (2005)*

Criteria	**Relevance in humanitarian supply chain**
Architect/integrator	
Comprehensive services	It describes the different services that is offered by a 4PL service provider in a transparent manner
Continous innovation	It illustrates different concepts (i.e. for processes) that are provided by a logistics service provider. These are innovative and ensure the continuous improvement in a humanitarian supply chain.
Management of multiple 3PL provider	Generally, 3PL provider offers transportation, warehouse capacities, IT services such as tracking and tracing etc. Therefore, a 4PLservice provider should be capable to manage multiple 3PL provider along a supply chain (i.e. transportation, warehouse capacities, freight invoices, claims etc.). Furthermore selecting the appropriate 3PL provider
Project management	Managing project that are outsourced from HOs such as new software implementation or restructuring of accounts department or deliver reports to donor or support the HOs in preparing auditing process
Stakeholder management	Managing stakeholder such as donor, supplier, audit agency, government or other humanitarian agencies
Supply chain redesigner	Possessing the ability to redesign a supply chain and align it with the situation
Supporting in mitigating risks	Supporting HOs in mitigating risks in cases of speed transportation of locally procured items or in replenishment of relief items
Resource Provider	
Negotiation contracts with fuel provider	Negotiation with fuel provider to get the best prices of fuel and to always have fuel capacities
Negotiation freight and storage contracts	Providing best transportation and warehouse prices

Procurement and co-packing service	Supporting HOs in exemplary making kits with elementary relief items for a response to a disaster or in order management
Transportation and warehouse asset provider	It should have the capabilities to respond HOs with transportation capacities and warehouse facilities in different countries worldwide
Supply chain infomediary	
Improve communication between actors	Establishing an ICT system that improve communication and collaboration along a supply chain
IT system integration	Allow HOs to be transparent and to standardize processes - Furthermore it ensures collaboration and increases trust between the humanitarian actors
System and information integrator	Provision of IT systems and take responsibility during the integration of IT systems in the humanitarian supply chain. It is necessary to improve communication and coordination
Technical support	Support HOs in using technology products or electronic as well as mechanical products
Control room	
Coordination of In Kind donation	Providing assistance to HOs in coordination of IN kind donation worldwide
Establishment of performance measurement system	It serves as measuring the humanitarian operations processes to promote effectiveness - HOs are transparent in reporting to donors and ensure customer relationship to beneficiaries
Establishment of a quality management	Right goods, right amount of goods and relief items to the right location to the right beneficiary in the right quality for the right price and with the right service
Experienced Logistician	It allows the material and information flow in an efficient manner - It facilitates to provide resources also form the commercial market and to verify synergies between commercial and humanitarian sector
Improve communication between actors (establishing logistics concept)	Generating innovative logistics concepts to support improving communication and collaboration among all actors in a supply chain

Each criteria of one level is compared to all other criteria of the same level. The results are summarized in a matrix (Zimmermann and Gutsche, 1991). The required data for the AHP were collected by a questionnaire (Appendix I). We used seven experts, coming from academia with knowledge of humanitarian supply chains (three participants) and from the humanitarian supply chain practice (four participants). They were based in Germany and Netherlands. The experts from the practice represent an HO, a consultant to the humanitarian sector and two experts from a 3PL service provider active in the humanitarian sector. For the applied method at least three experts are needed to have representative results (Jharkharia and Shankar, 2007; Coulter and Sarkis, 2006). For research on 4PL multicriteria decision making using AHP, we for example found studies of (Coulter and Sarkis, (2006): 3 respondents; Jharkharia and Shankar (2007): 6 respondents. Therefore, the selected sample size is sufficient.

Table 4.3: *Fundamental Scale for Making Judgment (Saaty, 2001)*

Intensity importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favour one activity over another
5	Strong importance	Experience and judgment strongly over another; its dominance demonstrated in practice
7	Very strong	An activity is favoured very strongly over another; its dominance demonstrated in practice
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values	

For the comparison, a ratio scale of 1-9, which was proposed by Saaty (2001), has been used to compare any two criteria. The 1 to 9 point scale has proven to be an acceptable scale of measurement. The reason is that a 1 to 9 scale accurately represent an individual's intensity of favourite (Harker and Vargas, 1987). The scale values are considered to be relative values. 1 indicates equal importance of the two criteria whereas 9 indicates a high importance of only one of the aspects.

4.4 DATA COLLECTION AND RESULTS

4.4.1 Data collection

The required data for the AHP were collected through a questionnaire (Appendix I). All respondents preferred to remain anonymous hence names will not be presented for confidentially reasons. An exemplary question is given below in Figure 4.3.

Figure 4.3: *Exemplary question in the AHP survey*

When you consider the 4PL component supply chain infomediary room which 4PL factor is ……important than the other 4PL factor in humanitarian supply chain?

1. Improve communication between actors	9	7	5	3	1	3	5	7	9	IT system integration

Meaning: Improve communication between actors is very strong important compared to IT system integration

For each question we contrasted two inducing factors in the network. In total we generated four clusters and 20 nodes (Figure 4.2). Each factor was compared with each other with respect to influences on 4PL using a fundamental scale between equally important (1) to extremely important (9). This questionnaire was tested with two persons from the academia. It should be also mentioned by a determination of high inconsistencies over the pair-wise-comparisons the judgment were revised. Hereby the experts were contacted again to judge their preferences once more.

4.4.2 Results and analysis

Seven academic and practitioner experts from the humanitarian sector have contributed to assess the decisive criteria for a 4PL service provider in the humanitarian supply chain. We used SuperDecision software to obtain a weighted supermatrix. This weighted supermatrix identifies the rating of the elements after pair wise comparison. The cluster comparison shows that the most decisive criteria of a 4PL provider in humanitarian supply chains is ‘decision maker/control room’ (33.42%), followed by the criteria ‘supply chain infomediary’ (27.84%), ‘archtitect/integrator’ (26.32%) and ‘resource provider’ (12.50%).

Table 4.4: *Results of cluster comparison*

Fourth-Party Humanitarian Logistics Competences	**Average**	**Ranking**
Architect/integrator	26.32%	3
Resource Provider	12.50%	4
Supply chain infomediary	27.84%	2
Decision maker/Control room	33.42%	1

Table 4.5 presents the overall priorities among all participants based on calculation of the average of their final judgments. From the group results we obtained that criteria such as 'improve communication between actors' (39.23%), 'negotiation freight and storage contracts' (32.93%), 'experienced logistician' (27.52%), 'procurement and co-packing service' (23.76%), 'system and information integrator' (23.59%) have the highest ranking among all other criteria.

To have a deeper insight in the results we have considered the results for each cluster (Table 4.6). First, the most decisive activities in the cluster 'architect integrator' that should a 4PL service provider offer for the humanitarian sector based on the judgment of the experts are: management of multiple 3PL provider (20.66%) followed by stakeholder management (16.51%), supply chain redesigner (16.32%), and continuous innovation (15.53%).

Project management does not possess a high ranking because the HOs see themselves as project manager and they would not outsource such responsibility to a 4PL service provider. Nevertheless, they consider management of multiple 3PL provider as a task in managing project of relief operation. A 4PL provider should be a supply chain redesigner because for this component a high logistics and supply chain knowledge is needed. In such complex supply network, almost logistics experts can provide this competence and skills. However, the 4PL should have the capability to manage stakeholder such as customs clearance, carriers, warehouse keeper etc. Here further high logistics skills and competences are required

Table 4.5: *Priorities of all decisive criteria among all participants*

Decisive criteria for a 4PL in humanitarian supply chains	Group results (n=7)	Ranking
Improve communication between actor (by establishing IT technologies)	39.23%	1
Negotiation freight and storage contracts	32.93%	2
Experienced logistician	27.52%	3
Procurement and co-packing service	23.76%	4
System and information integrator	23.59%	5
Transportation and warehouse asset provider	22.73%	6
Improve communication between actors (by establishing innovative logistics concept)	21.17%	7
Management of multiple 3PL provider	20.66%	8
Negotiation contracts with fuel provider	20.58%	9
Technical support	19.98%	10
Establishment of a quality management	19.30%	11
Establishment of performance measurement system	17.72%	12
IT system integration	17.20%	13
Stakeholder management	16.51%	14
Supply chain redesigner	16.32%	15
Continous innovation	15.53%	16
Supporting in mitigating risks	14.50%	17
Coordination of In Kind donation	14.30%	18
Project management	13.80%	19
Comprehensive services	2.67%	20

.**Table 4.6:** *Results of alternative comparison*

Architect/integrator	Respondent A (HO)	Respondent B (Academia)	Respondent C (3PL provider	Respondent D (Academia)	Respondent E (Consultant in	Respondent F (3PL provider	Respondent G (Academia)	Average	Ranking
Management of multiple 3PL provider	19.46%	16.12%	31.68%	44.35%	25.53%	4.49%	3.02%	20.66%	1
Stakeholder management	22.00%	1.65%	5.72%	12.39%	9.31%	18.66%	45.86%	16.51%	2
Supply chain redesigner	12.95%	26.73%	15.34%	11.96%	9.31%	22.49%	15.46%	16.32%	3
Continous innovation	30.53%	4.31%	26.59%	2.15%	18.33%	4.82%	21.99%	15.53%	4
Supporting in mitigating risks	8.43%	26.73%	15.34%	2.15%	10.88%	36.00%	1.97%	14.50%	5
Project management	5.13%	20.15%	3.37%	24.85%	25.53%	10.30%	7.27%	13.80%	6
Comprehensive services	1.51%	4.31%	1.95%	2.15%	1.12%	3.25%	4.43%	2.67%	7
Resource Provider	Respondent A (HO)	Respondent B	Respondent C (3PL	Respondent D	Respondent E	Respondent F (3PL	Respondent G	Average	Ranking
Negotiation freight and storage contracts	32.93%	32.14%	24.07%	30.98%	69.21%	16.19%	25.00%	32.93%	1
Procurement and co-packing service	23.85%	32.14%	33.10%	20.97%	8.94%	22.30%	25.00%	23.76%	2
Transportation and warehouse asset provider	28.75%	32.14%	24.07%	6.88%	19.15%	23.12%	25.00%	22.73%	3
Negotiation contracts with fuel provider	14.48%	3.57%	18.76%	41.17%	2.70%	38.38%	25.00%	20.58%	4

Supply chain Infomediary	Respondent A (HO)	Respondent B	Respondent C (3PL	Respondent D	Respondent E	Respondent F (3PL	Respondent G	Average	Ranking
Improve communication between actor	50.83%	42.84%	30.89%	25.00%	67.50%	6.44%	51.13%	39.23%	1
System and information integrator	15.12%	10.05%	30.89%	25.00%	22.50%	36.77%	24.77%	23.59%	2
Technical support	26.53%	42.84%	14.16%	25.00%	2.50%	10.98%	17.86%	19.98%	3
IT system integration	7.52%	4.27%	24.07%	25.00%	7.50%	45.82%	6.23%	17.20%	4
Decision maker/Control room	Respondent A (HO)	Respondent B	Respondent C (3PL	Respondent D	Respondent E	Respondent F (3PL	Respondent G	Average	Ranking
Experienced logistician	28.82%	6.37%	13.00%	16.66%	61.94%	17.10%	48.75%	27.52%	1
Improve communication between actors (establishing logistics concept)	10.54%	22.16%	12.02%	34.10%	15.51%	35.39%	18.46%	21.17%	2
Establishment of a quality management	14.79%	22.16%	37.99%	39.69%	5.07%	9.96%	5.42%	19.30%	3
Establishment of performance measurement system	3.51%	22.16%	33.34%	5.46%	15.51%	18.74%	25.33%	17.72%	4
Coordination of In Kind donation	42.33%	27.16%	3.65%	4.10%	1.97%	18.81%	2.05%	14.30%	5

Second, the humanitarian sector needs a 4PL service provider as a resource provider who is capable to negotiate freights and storage contracts (32.93%) and offers procurement and co-packing service (23.76%) instead of negotiating contracts with fuel provider (20.58%).

Third, in the cluster 'supply chain infomediary' we observed that the humanitarian sector focuses on improving communication between actors (39.23%) followed by system and information integrator (23.59%). It shows that communication and information systems in humanitarian sector are still a challenge. The participant of one HO has provided us with a statement that communication and information systems is a challenge not because they do not have any ICT systems it is due to a plethora of ICT systems in the humanitarian sector which are not interoperable.

Nevertheless the 4PL provider should act as a decision maker, provide logistics skills and be an experienced logistician (27.52%), improve communication between actors by establishing innovative logistics concept (21.17%) and establish a quality management system (19.30%) that ensure the quality of logistics processes. Quality management in humanitarian supply chain is crucial in particular when a HO serves beneficiaries with drugs. Here is for example mandatory that the complete medical supply chain is tracked and traced to avoid any cold chain failure. HOs that deal with drugs have to be always 100% Good Distribution Practice (GDP) compliant. Furthermore, other HOs ensure their quality by establishing quality management guideline to guarantee a delivery of mobile hospitals in Syria without any missing or damaged spare parts.

4.5 DISCUSSION

The results show that a 4PL service provider should be able to manage 3PL service providers and stakeholders along a humanitarian supply chain. A 4PL provider should be able to provide transportation and warehouse capacities as well as experienced logisticians. Furthermore, a 4PL should be a supply chain redesigner and assist HOs with innovative logistics concepts that support them in their continuous improvement. The main criterion is that a 4PL service provider should develop concepts as well as technologies that support communication and collaboration between humanitarian supply chain actors throughout a supply chain.

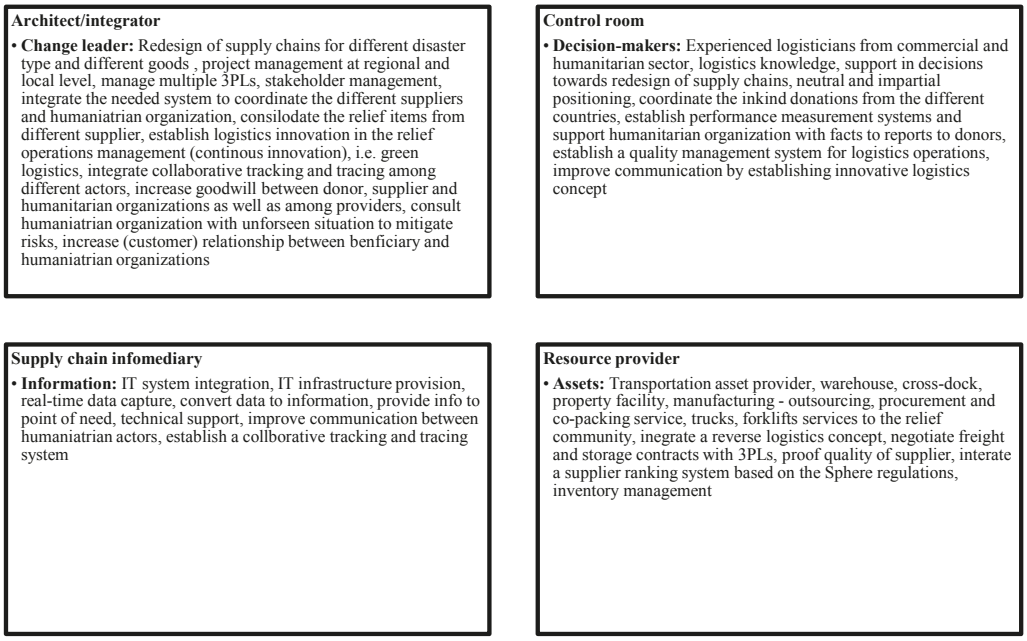
To provide an overview we use the four main core components 'architect/integrator', 'resource provider', 'supply chain infomediary' and 'decision maker/control room' that are presented by

Christopher (2005) to describe and summarize the components as well as tasks of a 4PL provider in humanitarian supply chains (Figure 4.4).

The first core component is 'architect/integrator'. Hereby the 4PL provider with having specific knowledge, skills and competences about humanitarian supply chains is able to make the supply chain working for the different actors along the humanitarian supply chain processes (Jensen, 2010; Jensen, 2012).

Emergency relief and the associated humanitarian aid have to be delivered more efficiently, as "…the most deadly killer in any humanitarian emergency is not dehydration, measles, malnutrition or the weather; it is bad management" (Telford, 1994). Therefore, a 4PL provider that is acting in humanitarian supply chains can execute the second core component that is called 'decision maker/control room'. Nevertheless, this phase has to be extended and reengineered that fits the humanitarian supply chain setting due to the nature of relief operations.

Figure 4.4: *Four core components for humanitarian supply chains modified from Christopher (2005)*



The third core component deals with 'IT system integration', IT infrastructure provision, real-time data capture, convert data to information, provide info to point of need and technical support (Christopher, 2005). This phase is needed. Taking into account that the increased attention to humanitarian supply chains was particularly sparked by the disastrous execution of logistics processes after the Indian Ocean tsunami in 2004; it resulted in high costs and the execution of logistics processes was flawed (Kovacs , 2011). The problems that need to be overcome in such natural disasters are various: information and communication network systems are destroyed, access to roads is limited, infrastructure is destroyed and equipment to remove destroyed buildings as well as resources such as trained local officials or volunteers are not available. All these problems complicate the coordination and organization of logistics in the aftermath of a disaster (Pettit and Beresford, 2005; BBC, 2005).

The fourth core component 'resource provider' fits in the humanitarian sector too without a need of modification. For example a humanitarian 4PL provider collaborates with different provider (cf. UNHRD; IFRC) of warehouses, cross docking depots or with firm owner specialized in packing as well as transportation services from the commercial sector to fulfill the demand of humanitarian sector.

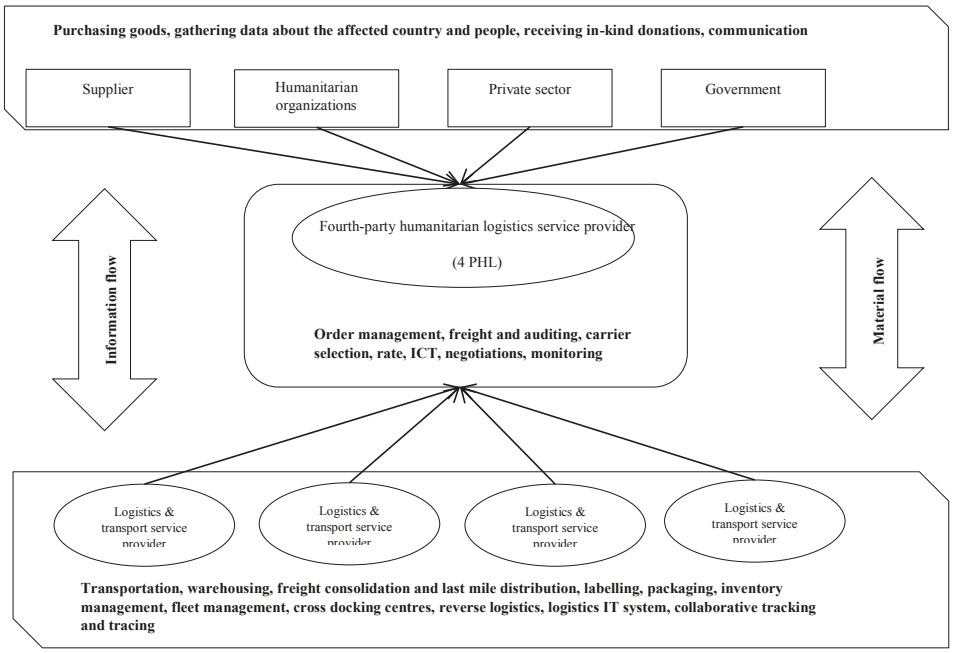
A 4PL provider should be capable to create value added services (Vandermerwe and Rada, 1988) for the humanitarian sector and to increase customer (i.e. beneficiary, donors, NGOs etc.) satisfaction (Oloruntoba and Gray, 2009). A 4PL provider acts as an independent, singularly accountable and non-asset based integrator (i.e Jensen, 2010; Hingley et al., 2011; Jensen, 2012), operates at operational, tactical and strategic levels as well as has the potential to coordinate logistics and manage resources across the network. Figure 4.5 shows an idea as an example of a 4PL provider in the humanitarian supply chain.

The proposed example shows that the 4PL service provider is responsible to ensure the information as well as material flow along the humanitarian supply chain.

The 4PL service provider in collaboration with the partnered HOs should capture data from, i.e. the host government about the affected country, i.e. no. of beneficiaries as well as the needed relief items. Furthermore, the 4PL service provider should be capable to gather data, consolidate physically the in-kind donated items, consolidate the relief items from different supplier, and report to partnered HOs. An integration of a tracking and tracing among different actors could support the task. In addition, the 4PL service provider should consult HOs with unforeseen situation to mitigate risks, i.e. ensuring that there is enough fuel capacity to avoid any interruption of relief operation process.

Moreover, the 4PL service provider monitors cost drivers such as transportation costs, inventory holding costs, distribution costs, administration costs (Akhtar et al., 2012) and packaging costs (Sohrabpour et al., 2012), flexibility and timeliness (Kopczak and Johnston, 2007). Another main task is to manage multiple 3PLs, to negotiate freight and warehouse contracts, to provide enough warehouse, freight as well as vehicle capacities, to manage the fleets as well as packaging services, to install reverse logistics concepts and to organize the last mile in an efficient manner with the carrier as well as the partnered HOs.

Figure 4.5: *Example of Structure of collaboration by integrating a 4PL service provider*



Implementation of 4PL in the humanitarian supply chain could enhance the long-term collaboration between the different humanitarian relief actors. There are a variety of values such as sharing transportation costs and modes, ensuring the last mile distribution, deploying new infrastructure, increasing responsiveness, promoting sharing information about the need of beneficiaries and in kind donations and synchronizing the logistics activities at tactical and operational level efficiently. Furthermore, it supports information sharing between supply chain members in developing countries in order to enable involved decision and policy makers, to collaborate and take actions towards decreasing supply chain sub-optimization (Sohrabpour et al., 2012). In this designed example several qualitative, e.g. skills, information sharing, staff and knowledge and quantitative benefits, e.g. cost reduction, establishing warehouses, improving sustainability and reduction of resources (Razzaque and Cheng, 1998; Bhatanagar et al., 1999) can be enhanced. The 4PL concept allows the coordination and secures the planning of logistics activities and support the sharing of the qualitative and quantitative benefits by defining the information, financial and decision flow between the different humanitarian relief actors in such supply chain.

4.6 CONCLUSIONS

4PL concepts for the humanitarian sector so far have rarely been explored in academia as well as in practice. Actors in the field have only taken first cautious steps in this direction. Nevertheless, as experienced in the commercial logistics sector, also humanitarian logistics operations may profit from this general logistics management concept in the future.

In this chapter, we highlighted examples of logistics services concepts that are used by HOs. These target efficient processes and an effective coordination of information, material as well as information flows among humanitarian supply chain actors in case of disasters.

In order to enhance management decision capabilities in this sensible field, crucial criteria for a successful development of 4PL in the humanitarian sector were identified by an elaborated AHP analysis using seven experts from academia (three participants) and practice (four participants) from the humanitarian sector based in Germany and Netherlands have contributed. The focus was to define the components that a 4PL service provider should possess. Based on the results we detailed the characteristics of a 4PL service provider in a humanitarian supply chain, using the four core components framework of Christopher (2005) as a basis. As such our research study presents the added value of a 4PL service provider in humanitarian supply chain for example simplifying collaboration between different actors, sharing transportation costs and modes, ensuring the last mile distribution, increasing responsiveness, and synchronization of the logistics activities on a tactical and operational level efficiently.

One interesting aspect we came across in our research is the relation between academic and practice experts from the humanitarian sector. The expert discussion has shown that humanitarian supply chain professionals require from academic partners that they speak the same ‘language’ and should provide solutions and services that are simple to implement in practice during a relief operation and that provide an added value that addresses their needs.

Further research may focus on three main aspects. First, it is necessary to detail the specific application of quality measures and standards in order to identify further application areas like for example transparency, cost sharing, infrastructure, responsiveness, information and demand management as well as logistics synchronization (demand of beneficiaries, supply of relief goods globally, logistics transport and warehousing capacities). All these aspects have to be specified and defined for supportive 4PL concepts.

Second, 4PL research has to be connected to the question of general development of platforms and standards in the sector by large actors like UN OCHA, IFRC, WFP, MSF and others in order to enable a seamless cooperation of actors (government and non-government) with logistics service providers as well as other partners (governments, military, fire and police departments etc.).

Third, it can safely be assumed that further details for 4PL applications have to be checked for different disaster types as well as regional and cultural differences in order to apply feasible solutions in the humanitarian sector. It has to be presumed that concepts being successful in Asia may not be successful in Africa or South America, and vice versa.

Altogether, our chapter shows that the basic concept of a 4PL in the humanitarian supply chain could improve and enhance efficiency and effectiveness due to an improved collaboration between the humanitarian supply chain actors. It can be an interesting path of inquiry for the development of excellence in managing humanitarian supply chains, which may benefit human fate and well-being in distress situations.

5 HORIZONTAL COOPERATION IN NETWORKS OF LSPS: HOW TO SELECT THE RIGHT PARTNERS?

5.1 INTRODUCTION

In recent years, horizontal cooperation among Logistics Service Providers (LSPs) has received increased attention from both academics (Raue and Wallenburg, 2013) and practitioners (Cruijssen et al., 2007a). It is estimated that approximately 60 percent of all LSPs are involved in at least one horizontal partnership with another LSP (Schmoltzi and Wallenburg, 2011) and this percentage is expected to grow in the future (Xu et al., 2012). When cooperating horizontally, LSPs share their logistics networks with each other on a structural basis. Such horizontal cooperation among LSPs aims to provide a flexible logistics service to clients by offering short lead-times, unpacking services, low-carbon transportation of goods, price tagging of items, extended geographical coverage at a low price, and better utilization of resources to reduce costs (Bernal et al., 2002; Cruijssen et al., 2007b; Raue and Wallenburg, 2013). Moreover, being part of an LSP network facilitates access to supplementary resources (Schmoltzi and Wallenburg, 2011). Networks of LSP partners may thus optimize the transportation and distribution of shipments, capacity usage when shipping loads, and asset utilization (warehouses, terminals, and transport modes) (Cruijssen et al., 2007a; Audy et al., 2012; Vanovermeire et al., 2013).

Choosing the right LSP partner for horizontal cooperation between LSPs is crucial for a logistics network to achieve high levels of performance (Lee and Cavusgil, 2006). Despite this, the literature provides no clear insights into partner selection criteria for horizontal cooperation between LSPs. There is an extensive body of literature on vertical business cooperation that focuses on buyer-supplier relationships. Several studies have illustrated the procedures and criteria involved in the selection of vertical business partners (Wu and Barnes, 2011; Doherty, 2009). Notably, each vertical supply chain partner has a distinctive role (for example, the assembly of vehicles for OEMs (Original Equipment Manufacturer) vs. sales of vehicles for retailers). In contrast, horizontal supply chain partners operate on the same hierarchical level in a supply chain and may even be competitors in providing logistics services in the same geographical area (Verstrepen et al., 2009). This type of cooperation is also referred to as co-opetition (Cruijssen et al., 2007a). Given the distinct setups of vertical and horizontal cooperation, criteria that have proven to be critical in selecting partners for vertical cooperation

may not be appropriate when it comes to LSP partner selection for horizontal cooperation, although they can at least provide a good starting point.

In this chapter, we aim to identify partner selection criteria for horizontal cooperation in networks of logistics service providers**.** To this end, we examined the existing literature on vertical cooperation first, checked criteria in interviews to identify to what extent they may apply to horizontal cooperation. We then empirically verified the horizontal partner selection criteria using the Analytical Hierarchy Process (AHP) at a medium-sized family-owned Dutch LSP and at a large family-owned German LSP. Both organizations are actively building and managing networks of LSP partners for their European transport and distribution activities. Both LSPs are family owned but differ in size and structure.

This chapter is structured in five sections. Section 5.2 contains a literature review on vertical partner selection criteria that might be applicable when it comes to horizontal cooperation among LSPs. Section 5.3 presents the research design and research method: the Analytical Hierarchy Process (AHP). Following this, Section 5.4 summarizes the findings, provides a comparison of selection criteria between horizontal versus vertical cooperation and includes a sensitivity analysis of the AHP application. Section 5.5 provides concluding remarks.

5.2 PARTNER SELECTION CRITERIA

5.2.1 Review approach

Partner selection is a key factor that impacts on the performance of partnerships (Ireland et al., 2002). Consequently, partners should be selected with care (Audy et al., 2012). To this end, appropriate and suitable selection criteria need to be identified and integrated into the partner selection process. In their literature review of horizontal cooperation in transport and logistics, Cruijssen et al. (2007a) build on vertical alliance models. We aim to establish selection criteria for horizontal partnerships based on those for vertical partnerships because they are expected to be related since both vertical and horizontal cooperation require inter-firm coordination, and the agreements between partners concerning performance and targets are expected to be similar for both cooperation types (Cruijssen et al., 2007a). As such, we believe that selection criteria used in vertical partnerships provide a good starting point and theoretical support for identifying potential selection criteria for horizontal partnerships between LSPs.

To determine criteria that appear relevant for the selection of horizontal partners among LSPs, we conducted a systematic literature review of selection criteria used in vertical partnerships. For this purpose, we defined a partnership as a purposive alliance between independent

organizations that acknowledge a high level of interdependence, strive for mutual benefits, have compatible goals, share risks as well as rewards, and make joint decisions to achieve intended outcomes and maintain a competitive advantage (Mattessich et al., 2001; Sridharan and Simatupang, 2009). We followed the steps of the systematic review approach recommended by Denyer and Tranfield (2009). First, we formulated a research question to guide and focus our search for relevant research studies. Second, we located studies related to our research question and then selected and evaluated the articles based on their relevance to our topic. Finally, we analyzed the promising articles to identify partner selection criteria and classified them into categories. In defining categories we followed the work of Liou et al. (2012) on partnerships in the airline industry, who used four categories: financial, organizational, performance and strategic. We reworded these into: organizational/complementary capabilities (e.g. Barrat, 2004; Wu et al., 2010), strategic (e.g. Büyüközkan et al., 2008), financial (e.g. Jharkharia and Shankar, 2007), and performance of logistics service (e.g. Büyüközkan et al., 2009; Jharkharia and Shankar, 2007). Below we discuss each of the four categories. We provide an overview of the identified criteria in Table 5.1.

5.2.2 Organizational/complementary capabilities

The organizational/complementary capabilities category reflects how a potential business partner operates, and our review of the vertical partnership literature identified the following selection criteria: leadership, business continuity, cultural fit, family-owned business, skills and know-how, communication, and trust/openness.

Leadership (ID 1) (Jharkharia and Shankar 2007; Büyüközkan et al., 2008) is seen as a key element of relationship stability in that it improves productivity and increases competitive market advantage (Dyer and Singh, 1998). When relationships are stable, partners are better able to focus on their core competencies (Anslinger, 2004). A stable relationship requires partners to possess compatible leadership styles. In a vertical relationship, it also requires business continuity (Büyüközkan et al., 2008) between manufacturers and distributers, with continuity (ID 2) important in safeguarding long-term mutual interest. Partner compatibility (or cultural fit; ID3) (Büyüközkan et al., 2008; Ariño, 2002; Chen and Wu, 2010) can be achieved by establishing a partnership with a family-owned business (ID 4) (Büyüközkan et al., 2008). Doing so not only increases the likelihood of a match between organizational cultures but also helps to ensure a longer-term engagement. Skills and know-how (or knowledge; ID 5) (Büyüközkan et al., 2008) includes outcomes such as increased market share and better export opportunities. Miscommunication, lack of communication, and misunderstandings produce

confusion and conflicts in a supply chain partnership (Paulraj et al., 2008). In a vertical partnership, effective communication (ID 6) facilitates improved supply chain performance (Yang, 2009; Chen and Wu, 2010). It also supports the creation of joint-knowledge aimed at developing a better understanding of the market (Cao et al., 2010). Lack of communication is one of the most common reasons for a partnership to fail (Sabath and Fontanella, 2002). Trust (ID 7) (Bernal et al., 2002; Büyüközkan et al., 2008, Chen and Wu, 2010; Lai et al., 2010) mitigates partnership failure and is critical to the success of any partnership (Sabath and Fontanella, 2002). Trust between partners increases productivity, allows increased transparency regarding the cost structure of each partner (Vanovermeire et al., 2014), improves partnership performance (Yang, 2009), reduces the need for specification and monitoring of contracts, provides material incentives for cooperation, and decreases uncertainty (Fynes and Voss, 2002, p. 592).

5.2.3 Strategic

The strategic category contains criteria that indicate whether organizations share a common objective and are striving for a shared goal. This category also identifies the capabilities of a potential business partner and therefore its capacity to pursue its goals and shared goals. The criteria commonly included in this category when looking at vertical integration are: long-term engagement, supply chain integration, sharing sales, security, information exchange, IT capability, and quality certificates.

Long-term engagement (ID 8; Büyüközkan et al., 2008) is important for partnerships because it can improve each company´s competitive position and contribute to developing an efficient and responsive supply chain (Mentzer et al., 2000; Lee et al., 2009). Sustained engagement can be enabled through the development of new technologies, new products, and new markets (Hitt et al., 2001). Long-term engagement with supply chain partners is defined as cooperating with other entities and supporting the integration of supply chain management business processes (Wu et al., 2004; Rezaie et al., 2016). Supply chain integration (ID 9; Büyüközkan et al., 2008) enables the discovery of optimization possibilities (Vanovermeire et al., 2014) and allows continuous improvement (Slone et al., 2010).

The sharing of sales (ID 10), information, and risks are critical components of a successful partnership (Liou, 2012; Brekalo et al., 2013; Zaefarian et al., 2013). Generally speaking, information sharing is an essential element within vertical cooperation and involves entities sharing confidential information on plans, ideas, processes, and customers (Sridharan and

Simatupang, 2009). Shared information should be secure, accurate, complete, and on time to provide transparency and visibility along the supply chain. This prevents future conflicts and reduces instabilities and incongruent objectives within a network, and helps to manage unforeseen problems such as the bankruptcy of one partner or cargo theft (security, ID 11; Simatupang and Sridharan, 2005; Jharkharia and Shankar, 2007; Sridharan and Simatupang, 2009) and reduces uncertainty over demand information (de Leeuw and Fransoo, 2009). Information exchange (ID 12; Jharkharia and Shankar, 2007) increases transaction speed and ensures transaction visibility and transparency. Further, IT capability (ID 13; Jharkharia and Shankar, 2007; Chen and Wu, 2011), and in particular the availability of compatible IT equipment, can reduce lead times (Thakkar et al., 2005). Quality management ensures adherence to quality standards, improves risk response strategies, and helps firms increase sales and reduce costs; as such, cooperating partners should possess appropriate quality certificates (ID 14; Huang and Keskar 2007; Simpson et al., 2002; Jharkharia and Shankar, 2007).

5.2.4 Financial

The financial category addresses criteria related to the fiscal aspects of a partnership, including financial stability, flexibility in billing and payment, price/cost ratio, and cost benefits though revenue sharing and increased inventory turnover.

In the partnership selection process, the decision-maker is generally interested in whether an organization is financially stable and, therefore, unlikely to file for bankruptcy. Financial stability (ID 15) has the potential to lead to a long-term relationship marked by mutual trust among parties (Büyüközkan et al., 2008; Chen and Wu, 2011). Billing and payment flexibility (ID 16), which improves goodwill among alliance partners (Akhilesh et al., 2008; Jharkharia and Shankar, 2007), requires a long-term relationship. Moreover, being involved in a partnership lowers operational costs (ID 17; Yang et al., 2015), reduces order variability, and shortens delivery lead times (Sridharan and Simatupang, 2009). Cost minimization (ID 18) is enabled by, among other factors, identifying the most cost-effective locations and distribution channels through which to deliver products and services to customers (Dyer and Singh, 1998; Bernal et al., 2002). The next criterion in the financial category is the implementation of revenue-sharing (ID 19) policies (Sridharan and Simatupang, 2009), or contracts, aimed at managing inventory turnover (Koulamas, 2006; Yao et al., 2008). Inventory turnover (ID 20) in this context is described as the ratio between incoming and outgoing goods exchanged between partners over a particular period (Sarkar and Mohapatra, 2006; Wu and Barnes; 2010).

5.2.5 Performance of logistics services

The fourth category reflects the delivery performance of the logistics services provided. The performance of partners in delivering logistics services is evaluated based on the network, complementary activities, growth, delivery, quality, service offering, and past achievements.

A supply chain (SC) is a network of organizations involved in processes and activities that produce value in the form of products and services for an ultimate consumer (Zeng et al., 2010; Albino et al., 2007). When participating in a network (ID 21), organizations have the opportunity to share knowledge and profit from complementary competencies (ID 22) (Verstrepen et al., 2009). Relative to non-networked organizations, linked organizations can achieve equal or greater results in terms of market success, growth, and competitiveness. Growth (ID 23) enables service costs to be reduced (Jharkharia and Shankar, 2007; Büyüközkan et al., 2008) and facilitates the development of customer loyalty and services that lead to positive results (both financial and non-financial) (Ratajczak-Mrozek, 2013).

In vertical partnerships, the most decisive criteria in selecting a supplier are: delivery (ID 24), quality (ID 25), price (ID 17), and service (ID 26) (Kannan and Tan, 2003; Ho et al., 2009; Golmohammadi and Mellat-Parast, 2012). Delivery (ID 24) reflects the overall quality of the delivery process (Chen and Wu, 2011; Golmohammadi and Mellat-Parast, 2012). Quality (ID 25; Chen and Wu, 2011; Golmohammadi and Mellat-Parast, 2012) refers to the quality of the service that is being delivered. The price (ID 17) is the amount paid for the service. Service (ID 26) measures the flexibility of an organization in responding to its clients' requests (Chen and Wu, 2011; Golmohammadi and Mellat-Parast, 2012). Another important aspect in vertical cooperation is past achievement. Past achievements (ID 27) is a measure of whether a partner is capable of handling and managing critical issues and uncertainties (Jharkharia and Shankar, 2007; Büyüközkan et al., 2008; Chen and Wu, 2011).

The above-detailed selection criteria are summarized in Table 5.1.

Table 5.1: *Partner selection criteria (NOTE: these are our own descriptions/definitions based on definitions in the publications listed in the right-hand column)*

Criteria			Identified by (authors/years)
Organizational/complementary capabilities			
ID 1	**Leadership**	Having the right managerial structure in place, one that motivates employees to do the best they can for the business – characterizes a good organization.	Jharkharia and Shankar (2007); Büyüközkan et al. (2008)
ID 2	**Continuity**	With positive past achievements and a dedicated and qualified workforce in place, a business is more likely to continue its operations.	Büyüközkan et al. (2008)
ID 3	**Cultural fit**	Having comparable cultures increases understanding of the underlying meanings of organizational processes and procedures.	Büyüközkan et al. (2008); Ariño (2002); Chen and Wu (2010)
ID 4	**Family busines**	Establishing a partnership with another family-owned business increases the likelihood of a long-term engagement and also the likelihood that there is a match between the cultures.	Büyüközkan et al. (2008)
ID 5	**Skills and know-how**	As one organization is performing on behalf of another, having the technical expertise necessary to perform the service is required.	Büyüközkan et al. (2008)
ID 6	**Communicati on**	Cooperating with a firm that has an identical hierarchical communication structure facilitates mutual understanding regarding communication and decision-making.	Chen and Wu (2010); Yang (2009)
ID 7	**Trust and openness**	Mutual trust can come from financial stability and achievements. As partners in an alliance can potentially be competitors, it is important that they trust each other.	Bernal et al. (2002); Büyüközkan et al. (2008) Chen and Wu (2010); Lai et al. (2010)
Strategic			
ID 8	**Long-term engagement**	Level of trust determines the long-term prospects of an alliance. Financial stability, past achievements, and having a good relationship increase the level of trust among alliance partners as well as the level of commitment towards the alliance.	Büyüközkan et al. (2008)
ID 9	**Supply chain integration**	Although more applicable to vertical cooperation, integrating activities performed consecutively among horizontally cooperating LSPs could increase the quality of services performed.	Büyüközkan et al. (2008)
ID 10	**Sharing sales**	Reflects commitment to the cooperation. Sharing the risks and rewards is part of developing a joint network.	Liou (2012); Zaefarian et al. (2012)
ID 11	**Security/stabil ity**	To prevent negative experiences and conflicts within a network, services should be performed with care.	Jharkharia and Shankar (2007)
ID 12	**Information exchange**	Information sharing benefits the quality of the service performed and the continuance of the relationship.	Jharkharia and Shankar (2007)
ID 13	**IT capabilities**	Good IT capabilities help reduce inventory levels and process uncertainties.	Jharkharia and Shankar (2007); Chen and Wu (2011)
ID 14	**Quality Certificates**	Cooperating LSPs take care of each other's goods while performing services, and they need to do this in a high quality way, for example, according to ISO standards. ISO certificates, LEAN, 6 sigma or other quality assurance approaches	Huang and Keskar (2007); Simpson et al. (2002)

	Financial		
ID 15	**Financial stability**	If an organization is financially stable, there is less risk of bankruptcy. Cooperation leads to a potentially long-term relationship where mutual trust exists among parties.	Büyüközkan et al. (2008); Chen and Wu (2011)
ID 16	**Flexibility in billing and payment**	Flexibility helps create goodwill among alliance partners.	Jharkharia and Shankar (2007)
ID 17	**Price/Costs**	This is the price asked for a service performed.	Ho et al. (2009); Chen and Wu (2011)
ID 18	**Cost advantage**	In general, organizations are experiencing declining profit margins due to current market conditions. Therefore, being able to exploit density economies, or economies of scale is beneficial for LSPs.	Bernal et al. (2002)
ID 19	**Revenue sharing**	There should be a mechanism to ensure fair allocation of revenue among cooperating LSPs.	Cruijssen et al. (2007a)
ID 20	**Inventory turnover**	The ratio between incoming and outgoing goods over a particular period among partners. Ideally, the flow of goods will be balanced both ways.	Sarkar and Mohapatra, (2006); Wu and Barnes (2010)
	Performance of Logistics Services		
ID 21	**Network**	A supply chain (SC) is a network of organizations involved in the various processes and activities involved in producing value in the form of products and services for an ultimate consumer. Potential business partners should be willing to be part of an interconnected network of LSPs.	Zeng et al. (2010); Albino et al. (2007)
ID 22	**Complementary activities**	Performing complementary activities results in a wider service offering, without having to bear the consequences of owning materials.	Verstrepen et al. (2009)
ID 23	**Growth**	The business partners need to agree on a common growth strategy.	Jharkharia and Shankar (2007); Büyüközkan et al. (2008)
ID 24	**Delivery**	The overall quality of the delivery process, for example its speed and punctuality.	Chen and Wu (2011);Golmohammadi and Mellat-Parast (2012)
ID 25	**Quality**	The quality of the product being delivered or of the service being performed.	Chen and Wu (2011); Golmohammadi and Mellat-Parast (2012)
ID 26	**Service offering**	An organization's flexibility towards its clients' wishes and needs, such as in its service range and ability to respond.	Chen and Wu (2011); Golmohammadi and Mellat-Parast (2012)
ID 27	**Past achievement**	A successful track record indicates the capabilities of potential business partners and contributes to the level of trust.	Jharkharia and Shankar (2007); Chen and Wu (2011); Büyüközkan et al. (2008)

5.3 RESEARCH DESIGN AND METHOD

5.3.1 Research approach

Ho et al. (2009) claim that partner selection has shifted from a traditional single criterion approach in which only the lowest cost bids were taken into account to multiple criteria decision-making (MCDM). An MCDM approach is seen as suitable for multi-attribute problems with potentially conflicting criteria (Büyüközkan et al., 2008). Over the years, a range of MCDM approaches have been used, for example to support supplier selection (Gencer and Gürpinar, 2007; Ho et al., 2009; Bruno et al., 2012) or to assist in service selection (Jharkharia and Shankar, 2007; Büyüközkan et al., 2008). One approach to modelling and solving MCDM problems is the AHP (Analytical Hierarchy Process) (Ho et al., 2009; Bruno et al., 2012). The AHP is a quantitative method for ranking decision alternatives given multiple criteria (Saaty, 2001) and is often applied in supplier selection (Sipahi and Timor, 2010). In our research, we therefore utilize the AHP approach to identify whether, and if so to what extent, the selection criteria for partners in a vertical arrangement also hold when selecting partners for horizontal cooperation among LSPs.

Once we had established the AHP structure, experts from our two focal LSPs were asked to evaluate the relative importance of the partner selection criteria at each level of the AHP structure (Figure 5.1) to determine priority weights and to provide a rating (e.g. Saaty and Vargas, 2001; Sipahi and Timor, 2010) (see Figure 5.1). This was achieved by presenting pairs of alternative criteria to be compared on a scale ranging from 1 to 9, with 1 indicating equal importance of the two criteria and 9 the highest possible importance of one criteria over the other. The results of this exercise were then used as inputs to create comparison matrices of the expert judgments. These matrices were normalized in order to generate individual weights for the selection criteria.

One of the major advantages of the AHP approach is its ability to deal with inconsistencies in judgments. This is particularly valuable since humans have an inability to make precise judgments (Harker and Vargas 1987). The AHP technique incorporates such inconsistencies in the model and provides the experts from our focal LSPs with a measure of these inconsistencies so that they can reflect and maybe revise their judgments.

Finally, we presented the AHP results to 12 managers of both focal LPSs and discussed the AHP results during structured interviews. The aim of the structured interviews was to identify

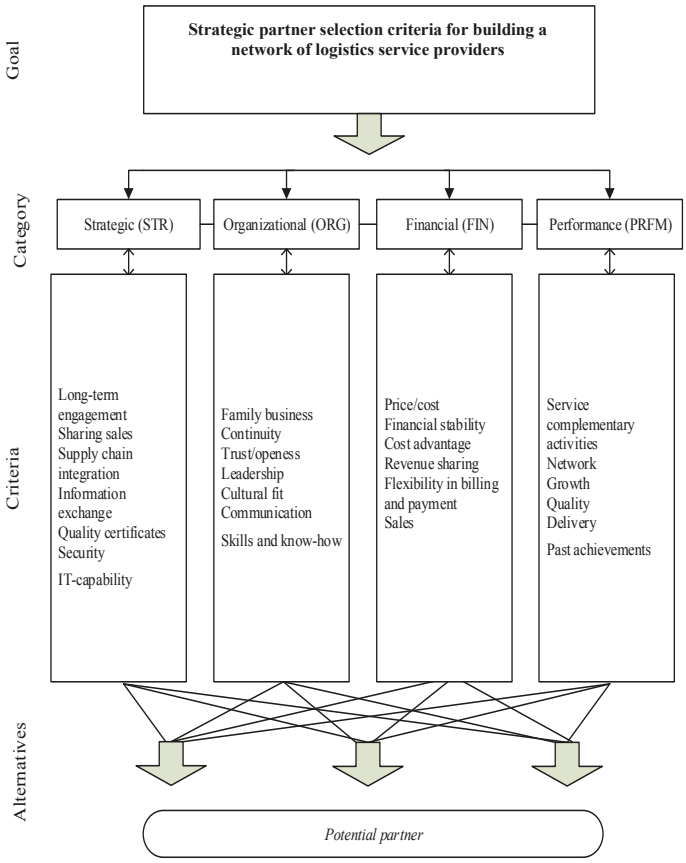
the reasons behind the ranking of partner selection criteria for forming a cooperative network of LSPs and to identify any deficiencies in the framework (most notably, missing criteria).

We applied the AHP at a medium-sized Dutch LSP and at a large German LSP that had each built horizontal cooperation networks for their European transport and distribution services. Both companies are family owned and transport shipments within Europe. The Dutch company is a mid-sized company offering primary logistics services to its clients (e.g. distribution, warehousing, and transportation) as well as secondary logistics services (e.g. custom formalities, value added services, and ICT/track and trace). The German company is a global company offering logistics transport and distribution services with offices and warehouses in many countries. The German company is working on building its own worldwide logistics network to provide multimodal logistics and transportation solutions to their customers (suppliers, manufacturers, distributors, retailers). Both LSPs are willing to bundle their resources and capabilities with other LSPs to pursue joint objectives.

5.3.2 AHP model structure

The AHP process started with creating a model structure as depicted in Figure 5.1. The goal was subdivided into the four identified categories (Organizational/complementary capabilities; Strategic; Financial; and Performance of Logistics Services), each consisting of the criteria discussed earlier. Once this structure has been established, the importance of each category can be determined with respect to the goal, as can the relative importance of each criterion within a category. From these, the importance of each criterion with respect to the overall goal can be determined. This ranking (i.e. preferences for one category or criteria over another) was determined through pair wise comparisons of two categories, or two criteria, at a time (Meade and Sarkis, 1998).

Figure 5.1: *Construction of AHP Structure*



The first pair wise comparisons were carried out among the categories, whose weights were calculated with respect to the goal. The second set of pair wise comparisons focused on calculating the weights of the partner selection criteria within each category. Combining the two weights enables the importance of each criterion with respect to the overall goal to be determined.

5.3.3 Data collection procedure

To generate input for the AHP, we used a questionnaire that consisted of two sections. The first section asked respondents to list five criteria that they regarded as the most important in selecting an LSP business partner. The purpose of this section was to capture the respondents' initial thoughts on the criteria involved in that process of selecting an LSP partner. The second

section contained a list of the 27 selection criteria we had identified in the literature for selecting partners in vertical cooperation settings subdivided into the four categories (see Table 1). The respondents were asked to perform pair wise comparisons of the criteria in order to evaluate their relative importance.

Ideally, such an expert group should include members from all the functional areas within an organization that are involved in the partner selection process (Jharkharia and Shankar, 2007). Therefore, the respondents from the Dutch company were drawn from six departments. We sent our questionnaire to 40 employees in these six departments and received back a total of 27 completed questionnaires (response rate: 67.50%). Similarly, with the German company, we sent 39 requests to five departments and received back 24 usable responses (response rate 61.50%).

These sample sizes are considered adequate given that, for example, Coulter and Sarkis (2005) used input from eight experts to develop and test a comprehensive AHP model for media selection and budget allocation, and Saaty (1990) considered input from one expert as sufficient.

In section 5.4.1, we present and discuss the results of the AHP study for both companies. Moreover, we compare the rankings of the selection criteria by the two LSPs we investigated. In section 5.4.2 we compare selection criteria between horizontal versus vertical Cooperation. In section 5.4.3, we present a sensitivity analysis on the stability of the ranking.

5.4 FINDINGS

5.4.1 Cross-case analysis

We now present a cross-case analysis to examine similarities and differences among the rankings obtained. The cross-case analysis is based on interview results with 12 managers from both focal companies and addresses the four main categories of criteria in order of attached importance. We used the interviews to validate our selection criteria. For this purpose, we first asked the respondents to list five partner selection criteria that they regard as the most important partner selection criteria. The purpose of this question is to capture the interviewees' first thoughts on these criteria involved, as suggested by Schmidt (2007). We then showed the AHP results and explicitly asked to add further criteria that were not listed in order to verify the results obtained from AHP. The result of this validation was that the list of criteria developed based on the literature was deemed sufficient to cover partner selection problems in horizontal logistics networks. No further criteria were added.

For both focal companies, the most important category of criteria when selecting a horizontal LSP partner is 'strategic' (relative importance: Dutch company: 64.6%; German company: 43.2%; see Table 2). Within this category, both companies evaluated 'information exchange' (ID 12) as an important criterion (Dutch company: 37.5%; German company: 27.0%) because they considered sharing common objectives and goals as a key element in improving their competitive position in the market, such as by extending geographic reach and enabling optimization possibilities such as by bundling transport and logistics services or customer consolidation. Further, both companies considered the 'long-term engagement' criterion (ID 8) as important (Dutch company: 14.0%; German company: 27.6%). Both aim to have a high level of inter-organizational information flow within their partnerships, such as on skills and know-how over managing logistics activities or on calculation schemes for warehouses or transportation vehicles because this enables continuous improvement in their logistics network and allows insight into the cost structures of their partners (based on interviewees with the managers of the focal companies). However, when it came to the 'sharing sales' criterion (ID 10), the two companies priorized this very differently (Dutch LSP: 17.7%; German LSP: 2.7%). The German company explained in the interviews that this criterion was less important because it already had its own system for sharing sales and associated profits in a joint network. A further difference in priorities within the 'strategic' category was that the German company ranked 'security' (ID 11) much more highly than the Dutch LSP (25.4% vs. 10.7%). The German company focused heavily on this criterion because they wanted to prevent future conflicts and to reduce instabilities and incongruent objectives among the LSP network partners and to manage unforeseen problems such as the bankruptcy of a partner, cargo theft, or failures to establish a long-term relationship with a partner within their large worldwide network with over 400 own locations and over 35 partners in different countries.

Turning to the next most important category overall, 'organizational/complementary capabilities', there was a strong contrast between the two LSPs. While the German company evaluated this category as very important, the Dutch company attached very little importance to it (39.3% vs. 5.6%). In the interviews, the managers of the Dutch company explained that currently they were more focused on the financial stability of partners in wanting to extend their products and logistics service range. Compared to those from the Dutch company, the German interviewees indicated a stronger need to attract compatible LSPs to their current network to reduce incongruent objectives and avoid conflicts among the existing large LSP network. Incompatibility of partners is, in fact, one of the most cited reasons for partnership failure

(Büyüközkan, 2008). Within this category, the German company evaluated the 'skills and know-how' criterion (ID 5) as much more important than the Dutch company (47.9% vs. 12.5%) because one of their company's objectives is learning enrichment and extending the knowledge and skills of its employees. Their learning focus is on planning decisions regarding distribution, operational costs, lead times, stock levels, customer service etc. within a complex network system. Conversely, the Dutch company put greater emphasis on the 'cultural fit' (ID 3) criterion (9.1% vs. 4.7%). The managers of the focal Dutch company argued that the 13 partners needed to match one another in order to synchronize their decisions at the strategic, tactical, and operational levels such as when it came to developing business, acquiring new customers or extending the logistics network.

Turning now to 'financial' category, this was ranked second in terms of importance by the Dutch LSP (20.7%) but fourth and least important by the German company (4.0%). In our interviews with the managers of the Dutch company, they explained that this was important because they were seeking partners with financial stability in order to develop customer-tailored products (i.e. same day delivery or even within one hour) through shared investment that would result in increased sales and greater continuity in the logistics service. In this category, the most decisive criteria, for both the Dutch and German companies, were price/costs (ID 17) with the highest ratings (41.3% and 37.2% respectively) followed by financial stability (ID 15) (30.4% and 31.9%). Both focal companies argued that, notwithstanding the other more-qualitative criteria, quantitative criteria such as price/cost and financial stability were the major drivers for seeking horizontal cooperation among LSPs because logistics operations are costly. Here, the Dutch LSP scored the 'cost advantage' criteria (ID 18) higher than the German LSP (16.8% vs. 7.8%). In general, organizations were experiencing declining profit margins due to the current market conditions and, therefore, being able to exploit economies of scale was attractive. The difference in attached importance is attributed to the fact that the German network largely consists of partners that belong to the same company, whereas the partners of the Dutch company are all independent. Further, the Dutch LSP's network is smaller than that of the German LSP. The German LSP's network includes over 400 of its own locations plus 40 independent partners while the Dutch LSP has 13 of its own locations plus those of its partners.

The final category, 'performance of logistics services', received the lowest overall score although both focal companies placed it in third place (Dutch company: 9.9%, above 'organizational/complementary capabilities'; German company: 13.4%, above 'financial'). Here, the following criteria were considered important by both focal companies: service range

(ID 26) which was ranked highest by both the Dutch and German companies (36.5% and 43.1% respectively), quality (ID 25) (36.0% and 12.5%), and delivery (ID 24) (10.4% and 22.0%). Both companies considered 'performance of logistics services' when selecting partners for their LSP network because they were aiming to provide a range of high-quality logistics services (e.g. unpacking the transported goods and placing them on the shelves of the stores with a short lead time or developing innovative and sustainable models to deliver goods into inner cities areas) worldwide. They saw these aspects as increasing customer satisfaction and attracting new customers, which would, in turn, boost turnover and use resources more efficiently. During the interviews, the managers were consistent in their views on the 'performance of logistics services' category, and confirmed the importance of the 'service range', 'quality', and 'delivery' criteria in selecting partners for horizontal cooperation among LSPs.

Finally, we note that the three most decisive criteria overall are 'information exchange' (ID 12) (German company: 11.68%; Dutch company: 23.95%), 'long-term engagement' (ID8) (11.94% and 8.93%) and 'security' (ID 11) (10.98% and 6.84%). (Table 5.2; right-hand columns in bold). These three criteria have a strategic orientation and are beneficial for both focal companies, and offer potential for improvements based on a better understanding of the effects that transportation decisions have on the entire supply chain.

Table 5.2: *Importance attached to selection criteria (German and Dutch companies)*

ID	*Criteria*	Organizational/ complementary capabilities (39.33%) German Company CI (1.4%) CR (0.01)	Organizational/ complementary capabilities (5.55%) Dutch Company CI (1.6%) CR (0.02)	Strategic (43.24%) German Company CI (0.1%) CR (0.01)	Strategic (63.86%) Dutch Company CI (1.74%) CR (0.13)	Financial (4.03%) German Company CI (7.9%) CR (0.04)	Financial (20.66%) Dutch Company CI (5.5%) CR (0.04)	Performance of logistics services (13.41%) German Company CI (6.6%) CR (0.041)	Performance of logistics services (9.93%) Dutch Company CI (1.5 %) CR (0.01)	Global Priority German Company	Global Priority Dutch Company	Overall ranking German Company	Overall ranking Dutch Company
ID 1	**Leadership**	**14.26%**	**40.18%**							5.61%	2.23%	6	13
ID 2	**Continuity**	11.27%	3.83%							4.43%	0.21%	8	26
ID 3	**Cultural fit**	**4.70%**	**9.13%**							1.85%	0.51%	13	21
ID 4	**Family Business**	5.40%	3.09%							2.12%	0.17%	12	27
ID 5	**Skills and Know-how**	**47.92%**	**12.51%**							**18.84%**	0.69%	**1**	18
ID 6	**Communication**	**3.63%**	**7.35%**							1.43%	0.41%	16	23
ID 7	**Trust/openness**	**12.82%**	**23.92%**							5.04%	1.33%	7	14
ID 8	**Long-term engagement**			**27.63%**	**13.98%**					**11.94%**	**8.93%**	**2**	**3**
ID 9	**Supply Chain Integration**			6.56%	7.82%					2.84%	4.99%	11	7
ID 10	**Sharing Sales**			2.66%	**17.68%**					1.15%	**11.29%**	18	**2**
ID 11	**Security**			**25.39%**	**10.71%**					**10.98%**	**6.84%**	**4**	**5**
ID 12	**Information exchange**			**27.01%**	**37.50%**					**11.68%**	**23.95%**	**3**	**1**
ID 13	**IT capability**			**8.18%**	7.82%					3.54%	4.99%	9	7
ID 14	**Quality certificates**			2.57%	4.50%					1.11%	2.88%	19	12
ID 15	**Financial Stability**					**31.30%**	**30.35%**			1.26%	6.27%	17	6
ID 16	**Flexible billing and payment**					7.77%	3.14%			0.31%	0.65%	25	19
ID 17	**Price/Costs**					**37.19%**	**41.25%**			1.50%	**8.52%**	15	**4**
ID 18	**Cost Advantage**					7.77%	**16.84%**			0.31%	3.48%	25	11
ID 19	**Revenue sharing**					**9.51%**	4.66%			0.38%	0.96%	24	16
ID 20	**Inventory turnover**					6.45%	3.77%			0.26%	0.78%	27	17
ID 21	**Network**							3.13%	3.58%	0.42%	0.36%	23	25
ID 22	**Complementary operations**							**6.36%**	**4.17%**	0.85%	0.41%	21	22
ID 23	**Growth**							**7.19%**	3.77%	0.96%	0.37%	20	24
ID 24	**Delivery**							**21.98%**	**10.43%**	2.95%	1.04%	10	15
ID 25	**Quality**							**12.45%**	**35.96%**	1.67%	3.57%	14	10
ID 26	**Service**							**43.13%**	**36.46%**	**5.78%**	3.62%	**5**	9
ID 27	**Past achievements**							5.76%	**5.62%**	0.77%	0.56%	22	20

5.4.2 Selection criteria differences: horizontal versus vertical cooperation

Although both horizontal and vertical partnerships are focused on collaborative efforts, our research shows slight differences in criteria used in partner selection between these two types of partnerships. The selection criteria applied when seeking partners for horizontal cooperation among LSPs focus on strategic aspects of partnerships: information exchange, long-term engagement, and security. As firms are spreading their global reach (such as through global manufacturing and sourcing), they also require global services from a potential LSP (Raue and Wallenburg, 2013). Horizontal cooperation among LSPs facilitates resource and competency sharing among LSPs. As such, the LSPs are therefore better able to perform a wider range of flexible services, access more customers through a wider geographic reach, optimize the efficient utilization of facilities, thereby controlling costs and increasing productivity, and create innovative solutions for their clients through interfirm specialization (Bernal et al., 2002; Cruijssen et al., 2007b; Raue and Wallenburg, 2013). However, as our interviewees explained, such developments require more intense information exchange between partners, for example to ensure transport bundling takes place and reduces costs. In addition, long-term horizontal partnerships are important in terms of combining assets and resources.

The interviews also showed that international partnerships among LSPs that cross national and cultural boundaries have a fragile structure and a higher level of relational risks and conflicts than other partnerships. This may explain why the security criterion was seen as important in horizontal cooperation among LSPs in that this aspect is important in preventing future conflicts, reducing instabilities and incongruent objectives within the LSP network, and managing unforeseen problems such as the bankruptcy of one partner or cargo theft.

In contrast, partners that are vertically cooperating view operational aspects, including ‘delivery’, ‘quality’, and ‘price/cost’ (Soosay et al., 2008; Yang et al., 2009; Golmohammadi and Mellat-Parast, 2012) as important criteria when forming a partnership. These partner selection criteria aim to maximize the overall value of the supply chain, to enhance operational flexibility in order to handle high demand uncertainties, and to improve service within a buyer-supplier partnership. In vertical cooperation, partnerships are established among multiple businesses that operate on different levels of the supply chain (Cruijssen et al., 2007a). Typically, these partnerships are established to minimize logistics costs and waste (Simchi-Levi et al., 2009). Partners join a vertical cooperation network if this enables them to improve their performance in terms of cost, delivery, and quality of their products and services

(Golmohammadi and Mellat-Parast, 2012). Here, cost reductions potentially occur through increased integration with suppliers (Çelebi and Bayraktar, 2003). Partners in a vertical network are furthermore perceived as performing well if they deliver goods to customers on time since this ensures continuity of supply to customers, improves customer service, and reduces cycle time.

Our research also shows that horizontal and vertical cooperation selection criteria share common goals. It is generally understood that both vertical and horizontal cooperation lead to cost savings, service improvements, risk reduction, and the maximization of overall value to the organization (Laarhoven et al., 2000; Wang and Che, 2007; Schmoltzi and Wallenburg, 2011). The overarching aim of horizontal cooperation among LSPs as well as of vertical cooperation is thus to create a net positive value (Cruijssen et al., 2007b) and to develop a competitive advantage (Bernal et al., 2002). Both cooperation types aim to gain more customers and to increase sales growth, to be able to expand worldwide the business of each partner involved, in part in order to respond to the challenge of protecting market positions.

5.4.3 Sensitivity analysis

To determine whether the partner selection criteria for building a network of LSPs identified in Section 5.4.1 are robust, we, as suggested by Saaty and Vargas (2013), conducted a sensitivity analysis. We used a similar approach to that of Wu et al. (2007) and Chang et al. (2007) and used their approach to determine our sensitivity analysis scenarios. We started with the weights attached to the individual categories, as depicted in Table 2 column 7, and modified these weights in successive scenarios using percentages similar to those mentioned in the papers of Wu et al. (2007) and Chang et al. (2007). In the first scenario, we decreased the weight of the highest ranked category (‘strategic’) by 20% and, in the second scenario, we increased its weight by 15%. In this way, we were able to assess the impact of a change in the ranking if we decrease the weight by 20% or increase the weight by 15% of the top two strategic-related criteria: ‘information exchange’ and ‘sharing sales’. From both scenarios, we observed that the rankings do not change, indicating that the results in Section 4 are stable. Further, we tested similar percentage changes in the priorities attached to the four overarching categories (strategic, financial, performance of logistics services, and organizational/complementary capabilities) and this also failed to change the order of the highest ranked criteria.

5.5 CONCLUSIONS

In this research, we aimed to identify partner selection criteria for horizontal cooperation in networks of logistics service providers. To this end, we first studied the literature on vertical cooperation to identify potential partner selection criteria employed and then investigated their relevance in building horizontal cooperation networks among Logistics Service Providers (LSPs). To assess their relevance we verified these criteria in interviews and we applied the Analytical Hierarchy Process (AHP) approach at a medium-sized family owned Dutch LSP and at a large family-owned German LSP that have each actively built a network of horizontal LSP partners for their European transport and distribution activities.

In this study, we identified, based on the literature, 27 partner selection criteria that are potentially relevant for horizontal LSPs that we classified into four categories based on Liou et al. (2012): organizational/complementary capabilities, strategic, financial, and performance of logistics services. Using these four categories, we constructed an AHP model with which we could identify the key partner selection criteria for forming a horizontal partnership among LSPs. Next, we developed an AHP decision-making model building on an AHP-based study that involved 26 participants from the Dutch LSP and 24 from the German LSP. We verified the selection criteria in interviews. We can conclude from our analysis that the key LSP partner selection criteria in seeking horizontal cooperation are information exchange and long-term engagement.

The results show that horizontal cooperation among LSPs is more strategically oriented than is the case with vertical cooperation networks, with the latter being more operationally oriented. Strategically oriented criteria refer to the culture of a partner, long-term engagement, security, and structure of the partner. These criteria are seen as relevant because they facilitate synergy bundling and extending networks. Operationally oriented criteria, such as service, quality, and delivery, refer more to production and business processes and distribution channels. These criteria are critical in vertical integration because they sharpen organizational focus on the core competency and increase flexibility. Notably, information exchange is an important criterion in both types of cooperation.

Our study is based on two family-owned LSPs that had already built networks of LSPs. Future research could explore organizations that are aiming to build such a network in order to achieve more – offer larger service packages, reach more customers, use facilities more efficiently, increase effectiveness, or develop and provide innovative solutions (Cruijssen et al., 2007b;

Carbone and Stone, 2005; Cruijssen et al., 2010) – than they could achieve on its own (Pomponi et al., 2015). Moreover, future research could specifically focus on how companies trade off environmental factors in selection. While the interviews did not reveal a need to incorporate environmental criteria in our current study the increased pressure on reducing environmentally harmful aspects of business (production of greenhouse gasses, noise, vibration, wastewater, and solid waste), may change how companies trade off criteria. We further suggest studying LSPs in other countries to identify whether there are cultural differences in the importance attached to the individual partner selection criteria. Such research would generate information applicable to a wide range of LSPs and, in particular, to other logistics networks.

6 STRATEGIC PARTNER EVALUATION CRITERIA FOR LSP NETWORKS

6.1 INTRODUCTION

In recent years, many companies have been active in developing cooperative networks of firms. Cooperating within a business network supports companies in reaching their goals, in responding to market opportunities, and in developing products with competitive prices and high product quality (Zacharia et al., 2009). In the airline industry, cooperation between airlines in the form of a strategic alliance is increasingly being perceived as an essential element of business networks (Liou, 2012). Networks among airlines like Star alliance, Sky Team and One World are made to attract more passengers, to expand networks, to provide cost reductions, to take advantage of product and service complementarities such as joint luggage handling, code sharing and gates and check-in counters (Liou et al., 2011). In the maritime industry, networks of ocean liner shipping companies are also well known (often referred to as the liner conference system (Shashi Kumar, 1999)). These conferences can focus on specific aspects, e.g. route specific ventures, vessels sharing and slot sharing agreements (Midor and Pitto, 2000; Panayides and Wiedmer, 2011). Examples of these global networks in the maritime industry are the shipping line alliances CKYH Alliance, the Grand Alliance and the New World Alliance in Panayides and Wiedmer (2011).

Similar to other transportation sectors, LSPs active in road transport and logistics more and more engage in forming networks with partner LSPs. For example, IDS Logistik is a German horizontal cooperation among LSPs was founded by SME LSPs in 1982 (IDS Logistik, 2019). IDS Logistik consists of eight LSP partners like Kühne & Nagel and DSV (IDS Logistik, 2019). IDS Logistik is located in 48 countries and has one central hub in Hessia and two regional hubs in south and north Germany (IDS Logistik, 2019); or System Alliance Europe is a horizontal cooperation of 44 medium-sized LSPs. System Alliance Europe was founded in 2005 (System Alliance, 2019). System Alliance Europe consists of 61 partners, with 147 branches across 28 European countries. This LSP network transported 4.14 million shipments in 2017(System Alliance, 2019). This type of cooperation is often referred to as horizontal cooperation and is aimed at reducing activity costs through load consolidation, joint-route planning, and group purchasing (Pérez-Bernabeu et al., 2014, p. 586). LSPs also seek to exploit win-win situations (Pomponi et al., 2015) and combine resources and competencies in their logistics networks by cooperating horizontally (Raue and Wallenburg, 2013). Such cooperation with other LSPs

enables LSPs to offer more comprehensive service packages, to reach more customers, to obtain more cargo, to use facilities more efficiently, and to develop and provide more effective logistics solutions (Cruijssen, et al. 2007b; Carbone and Stone, 2005; Cruijssen et al., 2010) compared to what could be achieved individually (Pomponi et al., 2015). Such cooperation also occurs even though companies may compete with each other. In fact, Cruijssen et al. (2007b, p. 135) show that the proposition that LSPs cooperate on core activities was supported the strongest in their survey (75.9% of the respondents agreed or strongly agreed with this proposition). Moreover, formal hypothesis testing allowed the authors to conclude (Cruijssen et al., 2007b p. 138) "Since smaller companies have smaller economies of scale and can thus operate less efficiently individually, they could benefit from forming a coalition in order to compete more effectively with larger companies." Therefore, it becomes more and more crucial to evaluate horizontal partner LSPs as a company's position in the market is affected by the performance and quality of its partners (Kannan and Tan, 2002).

So far, studies in the transportation industry on logistics partner evaluation have predominantly been oriented towards evaluating vertical logistics cooperation among strategic partners (i.e. the cooperation between an LSP and a shipper who owns the freight; cf. Dickson, 1966; Weber et al., 1991; Geringer, 1991; Wang and Kess, 2006; Jharkharia and Shankar, 2007; Büyüközkan et al., 2008; Ho et al., 2010; Chen; 2011). Martin et al. (2018) argued that horizontal cooperation between LSPs in the transportation industry and logistics industry is a fairly recent phenomenon, the research body on this topic is rather limited. They state that several other horizontal cooperation aspects LSP networks, especially at the strategic and management level (to which LSP partner evaluation in an LSP network belongs) are still scarcely researched. With regard to strategic partner evaluation, the literature contains only few studies from the transportation industry that focus on how to evaluate a horizontal partner. These scarce studies typically use evaluation criteria that are derived from vertical cooperation. Examples are Liou (2012) and Liou et al. (2011), who evaluated strategic alliances in the airline industry using criteria from vertical cooperation. Solesvik and Westhead (2010) examined criteria for strategic alliances from maritime industries based on studies on vertical cooperation.

The main reason for a distinction between horizontal and vertical logistics cooperation is the existence of differences in goals. The goal of a vertical cooperation is to establish mutual benefits between (vertical) actors in the supply chain. Typically, these partnerships are established to minimize logistics costs and waste, to improve their performance in terms of delivery and quality of their products and services (Li et al, 2006). Partners in horizontal

cooperation aim to offer complementary services to avoid unnecessary logistics costs (Cruijssen et al. 2007b; Verdonck 2017). Horizontal cooperation among LSP partners increases the productivity of core activities such as transportation and warehousing, reduce the costs of supporting logistics costs and allow companies to efficiently transport volumes that are too small to transport efficiently for the individual LSPs (Cruijssen et al. 2007a). As acknowledged by Martin et al. (2018) cooperation among LSPs has become an important research area, since severe competition in global markets, rising costs and heightened customer expectations have caused profit margins of companies to decrease. As far as we know, to date there has been no study yet focusing on developing criteria for evaluating horizontal LSP partners, despite the fact that horizontal cooperation among LSPs is growing in importance (Cruijssen et al., 2007b; Raue and Wallenburg, 2013, Martin et al., 2018).

In this chapter, we first aim to develop an approach for evaluating LSP partners involved in horizontal cooperation. Similar to studies in the aviation and maritime industry we start from evaluation criteria for vertical cooperation to develop a framework of evaluation criteria for horizontal cooperation among LSPs. To this end, we examine the literature on vertical logistics cooperation in logistics networks. These criteria are then used to develop a framework for horizontal LSP partner evaluation.

Second, we aim to show how these criteria can be used to develop a model for evaluating LSP partners in LSP networks. We apply Analytical Network Processing (ANP) at a case company to determine the relative weights of the criteria derived from the literature. We chose ANP because it is a well-known model to deal with partner evaluation and selection problems (Talluri et al., 2006). We conducted the ANP model development at a medium-sized Dutch LSP (referred to as: LSP1) that had already constructed a network of LSPs for international transport and distribution activities. The results of an ANP study are typically context-specific. Therefore, most of the papers that develop ANP models present results that are applicable to the particular case considered (Meade and Presly, 2002). However, we contend that the our ANP model for partner evaluation may provide a good starting point for the evaluation of strategic partners in similar transport and distribution networks. A third purpose of this chapter is therefore to investigate to what extent our ANP model can be used as a starting point for cases that are similar in scope. To this end, we used the ANP results of LSP1 to evaluate five horizontal partnerships of another LSP (LSP2; a large internationally operating family-owned German LSP) and to discuss the extent to which the criteria as well as their relative importance as proposed by the ANP model based on LSP1 apply to other situations.

This paper is subdivided into six sections: the next section presents the research design and data collection procedure for the application of Analytical Network Process (ANP). Section 6.3 reviews the background literature on criteria considered when evaluating partners within a vertical cooperation to build a framework for evaluating LSPs in networks. In section 6.4 an ANP-based decision-making model is presented based on a case with LSP1. Section 6.5 applies this model to five strategic horizontal partnerships of LSP2 and discusses the general applicability of this model based on interviews. In section 6.6 we discuss differences and similarities in partner evaluation criteria between horizontal and vertical cooperation as well as the wider use of our ANP model. We conclude in section 6.7.

6.2 RESEARCH DESIGN

Our research started with the development of a framework of evaluation criteria using literature from vertical cooperation between shippers and LSPs. Using an approach similar to Liou et al (2011) we performed a structured literature review and obtained input from three LSP managers to make an overview of partner evaluation criteria.

In a second step, this framework has been applied in a case study to show how these criteria can be used for evaluating LSP partners in horizontal cooperation. Since partner evaluation deals with many conflicting objectives, different criteria need to be taken into account for evaluating partner (Büyüközkan and Görener, 2015). Evaluation of strategic partners is a multi-criteria issue due to the nature of tangible and intangible criteria (Bhutta and Huq, 2002). Multiple criteria decision-making (MCDM) is widely used for evaluating and ranking problems containing multiple, usually when criteria are conflicting (Işıklar and Büyüközkan, 2007). There are a wide variety of methods and models that may apply to and that have been used in the context of evaluating a business partner: simple scoring models (Dean and Nishry, 1965), Data Envelopment Analysis (Saen, 2007; Sarkis and Talluri, 2006; Talluri and Baker, 2002), Analytical Hierarchy Process, further – AHP (Bhutta and Huq, 2002; Büyüközkan et al., 2008; Chan et al., 2007), combinations of AHP with single process methods (Forkmann et al., 2012; Ramanathan, 2013; Sevkli et al., 2007), Analytical Network Process, further – ANP (Bayazit, 2006; Çelebi et al., 2010; Sarkis and Talluri, 2006). ANP is commonly used in strategic partner selection and evaluation procedures for vertical logistics cooperation (Ho et al., 2009; Bruno et al., 2012) and has been applied to related settings before. Sarkis and Talluri (2006) applied ANP to supplier selection, and supported their findings with a numerical example. Bayazit (2006) used ANP as a tool for multi-objective vendor selection decisions. Çelebi et al. (2010) used an ANP model for determining if logistics services need to be kept

in-house or be outsourced. Forkmann et al. (2012) applied ANP for establishing the relationship between networking strategy changes and the amount of factors influencing these changes. We therefore believe that ANP is an appropriate methodology given the research purpose since it enables the evaluation of relational dependencies for evaluation criteria, within categories and between categories of criteria. The use of ANP allows for incorporating dependencies between criteria as well as expert feedback, thus providing an accurate prediction for the priorities derived from the expert judgments (Saaty and Vargas, 2012).

In our study we applied Analytical Network Processing (ANP) at a medium-sized Dutch LSP to define the relative importance of the partner evaluation criteria. The medium-sized Dutch LSP (referred to as LSP1) had already constructed a network of LSPs for international transport and distribution activities. LSP1 offers transportation, warehousing, customs clearance, value added services and access to the track and trace system. LSP1 calls itself 'one-stop shopping' where a client gets all support required from warehousing to transportation.

Third, we apply ANP to a second case study with the aim to investigate the generalization of results. Typical sample sizes used to make such predictions using ANP are fairly small and only apply to the case considered (cf. Ramanathan, 2013). For research on partner evaluation using ANP, we found that sample sizes typically do not exceed 20 respondents (Jharkharia and Shankar (2007): 6 respondents; Tseng et al. (2009): 11 respondents; Gencer and Gürpinar (2007): 16 respondents). Respondents provide expert judgments for specific case circumstances, which may explain why such relatively small sample sizes apply (compared to large-scale surveys that focus on testing hypotheses). As a result, ANP models provide context-specific outcomes (since experts judge their own particular situation). This would imply the need to replicate ANP in every situation that one encounters even if problems are similar in nature. In this chapter, we therefore investigate whether the results from an ANP model from one organization may be used in another, yet somewhat similar organization. To this end, we applied the results of the study at LSP1 to an LSP in a comparable situation (LSP2). LSP2 is larger in size (over €5 bln. annual turnover with 20,000 employees world-wide, but also family-owned like LSP1). In a similar way as Ramanathan (2013), who discusses the results of AHP (Analytical Hierarchy Process – an earlier variant of ANP) with management in interviews, we employed interviews to investigate whether the ANP model developed for LSP1 also applies to five partnerships of LSP2. We furthermore conducted interviews to discuss findings and in particular whether the horizontal LSP partner evaluation criteria developed with LSP1 apply

more generically or require amendment before application elsewhere. Section 5.2 provides further detail on the approach taken in these interviews.

6.3 BACKGROUND LITERATURE ON CRITERIA FOR PARTNER EVALUATION

Based on a literature survey Martin et al. (2018) argue that research in the domain of decision frameworks for horizontal collaboration is limited and therefore state (p. 34) "… publications regarding the decision process in horizontal collaboration are rather scarce." Similar to other studies on horizontal partner evaluation in the transportation industry (Liou, 2012; Liou et al., 2011)), we therefore base our framework of evaluation criteria for horizontal LSP partnerships on criteria for vertical logistics partnerships. To determine the factors that determine successful vertical logistics partnerships, we conducted a structured literature review based on the approach described in Denyer and Tranfield (2009). Using this approach, we identified 18 criteria, which we grouped into four categories similar to the work of Liou et al. (2012) on horizontal partnerships in the airline industry: 1) financial criteria, 2) organizational criteria, 3) operational performance criteria, and 4) strategic criteria. In the following subsection, we discuss each of these categories and provide an overview of the criteria in Table 6.1.

6.3.1 Financial criteria

The financial resources of partners can be as important as their operating capabilities (Miller, 1998). Financial stability (ID1) is critical because if an organization is financially stable there is less risk of a bankruptcy and related consequences (Büyüközkan et al., 2008; Chen and Wu, 2011). Sharing revenue (ID 2) in a fair manner is another key feature for successful close cooperation with partners (Lambert, 2008, Rezaie et al., 2016). Revenue sharing is used to distribute revenues/profits achieved from a business partnership (Andersson and Norrman, 2002; Rese, 2006). Finally, having the right sales strategy (ID 3) to minimize transaction and production costs is a prerequisite for the financial success of a partnership (Liou, 2012; Luo et al., 2009). Minimizing transaction and productions costs (ID 4) are crucial within a partnership because this allows for maximizing transaction value (Dyer, 1997; Jharkharia and Shankar, 2007).

6.3.2 Organizational criteria

Successful cooperation between partners goes beyond financial abilities and includes organizational abilities and trustworthiness. Trustworthiness (ID5) between partners creates a better work environment, reduces uncertainties, increases productivity, and enhances

flexibility. A situation in which a firm trusts its partners leads to relationship commitment and more sustainable partnerships (Chen and Wu, 2010; Lai et al., 2010; Zaefarian et al., 2013).

To maintain a sustainable partnership know-how (ID6) and knowledge transfer are crucial (Lambert, 2008; Büyüközkan et al., 2008). The presence of high quality knowledge and skilled employees increases sales performance, strengthens relationships between partners, and improves operational and relational outcomes. Together these lead to competitive advantage, efficient asset usage, high customer satisfaction, and profitability (Lai, 2009). Ultimately, skilled employees lead to effective communication (ID7) within a partnership, which is important because effective communication facilitates the improvement of supply chain alliance performance (Yang, 2009) and supports information exchange that simplifies the coordination of business activities (Lee and Cavusgil, 2006; Wu and Barnes, 2010; Zaefarian et al., 2013).

In selecting a partner, it is important to have a good fit with partners in terms of culture and philosophy (Audy et al., 2012). In particular, family-owned (ID8) companies may benefit from partnering with other family-owned companies. Cooperation between family-owned businesses increases the chance that there will be a cultural fit (ID9) between partners and that the partnership will be sustained over the long term because partners often have similar philosophies, visions, and organizational objectives (Svensson, 2004).

6.3.3 Operational performance criteria

Operational performance is one of the most critical evaluation factors cited in the literature on vertical partnerships (Huang and Keskar, 2007). A key aspect of operational performance is quality (ID10), which encompasses accuracy of order fulfillment, cost of loss and damage, and commitment to continuous improvement (Ho et al., 2010; Jharkharia and Shankar, 2007; Zeydan et al., 2011). On-time delivery (ID11) is furthermore an important aspect of operational performance within a supply chain because buffer inventories can be reduced if uncertainty is reduced (Kannan and Tan, 2002; Liou, 2012). Additionally, service levels (no.12) such as on-time delivery demonstrate an organization's ability to respond flexibly to a client requests (Golmohammadi and Mellat-Parast, 2012). High service levels may boost growth as business between partners expands and new markets are developed (Jharkharia and Shankar, 2007; Büyüközkan et al., 2008).

6.3.4 Strategic criteria

Growth (ID13) relates to the opportunity for partners in a cooperation to create new businesses and to minimize liabilities such as lack of IT capacities and capabilities. Having appropriate IT capability (ID14) allows for information sharing and exchange, transparency, and knowledge development within a partnership (Büyüközkan et al., 2008; Wu and Barnes, 2010). Moreover, IT capability enables a partnership to create a sustainable competitive advantage and to establish effective communication (Cao et al., 2010). Information exchange (ID15) enriches the knowledge resources of a firm (Chen and Wu, 2010; Forkmann et al., 2012), increases confidence, and builds mutual trust within a partnership (Teo et al., 2009). Long-term engagement (ID16) in a partnership leads to the development of interdependent activities and resources, which are beneficial for productivity within the network (Jharkharia and Shankar, 2007; Kannan and Tan, 2002). Being part of a network (ID17) is particularly advantageous if an alliance partner is already familiar with a market, has access to other parties and has acquired necessary information and resources (Jharkharia and Shankar, 2007; Büyüközkan et al., 2008). A widespread network also enables high inventory turnover (ID18), which is particularly relevant for LSP customers since inventory is one of the largest assets on their balance sheets.

Table 6.1: Literature review on criteria

Criteria		Description	Authors/Year
		Financial (FIN)	
ID1	**Financial stability (FST)**	If an organization is financially stable there is less risk of a bankruptcy.	(Büyüközkan et al., 2008; Chen and Wu, 2011)
ID2	**Revenue sharing (REV)**	It is important to negotiate how revenue generated during the partnership will be split between parties.	(Andersson and Norrman, 2002; Rese, 2006; Lambert, 2008; Rezaie et al., 2016)
ID3	**Sales (SAL)**	This encompasses a company's level of sales activity and number of customers. A good sales team is a prerequisite for success.	(Liou, 2012; Luo et al., 2009)
ID4	**Cost (CST)**	This includes transaction and production costs. Transaction costs consist of four elements: search, contracting, monitoring, and enforcement. Production costs describe total logistics costs and are usually composed of cost per km, cost per shipment, and inventory carrying costs.	(Dyer, 1997, Huang and Keskar, 2007; Jharkharia and Shankar, 2007; Liou, 2012; Luo et al., 2009)
		Organizational (ORG)	
ID5	**Trust (TR)**	Mutual trust can come from financial stability and achievements. As potential alliance partners can be	(Bernal et al., 2002; Büyüközkan et al., 2008; Teo et al., 2009; Chen and Wu, 2010; Lai et al., 2010; Zaefarian et al., 2013)
ID6	**Know-How (KH)**	Because one organization is performing on behalf of another having the technical expertise to perform the service is required.	(Lambert, 2008; Büyüközkan et al., 2008)
ID7	**Communication CMN)**	Cooperating with firms that have similar hierarchical communication structures facilitates mutual understanding with regard to communication and decision-making.	(Yang, 2009; Cao et al., 2010 Chen and Wu, 2010)
ID8	**Family business (FB)**	Establishing a partnership with another family-owned business increases the chance for a long-term engagement and also the likelihood that there is a match between the cultures.	(Svensson, 200; Audy et al., 2012)
ID9	**Cultural fit (CF)**	Having comparable cultures increases understanding of the underlying meanings of processes and procedures in an organization.	(Büyüközkan et al., 2008; Chen and Wu, 2010)
	Operational Performance (PFRM)		
ID10	**Quality (QLT)**	This is measured by two aspects: orders received with no damage and orders received accompanied by proper documents.	(Ho et al., 2010; Jharkharia and Shankar, 2007; Zeydan et al., 2011)
ID11	**On-time Delivery (DLV)**	Delivery is measured by two parameters: on-time delivery and completed orders received	(Kannan and Tan, 2002; Liou, 2012; Sharma et al., 2008; Simpson et al., 2002)
ID12	**Service (SER)**	The organizations' flexibility towards the clients' wishes and needs, e.g. their service range and ability to respond.	(Golmohammadi and Mellat-Parast, 2012)

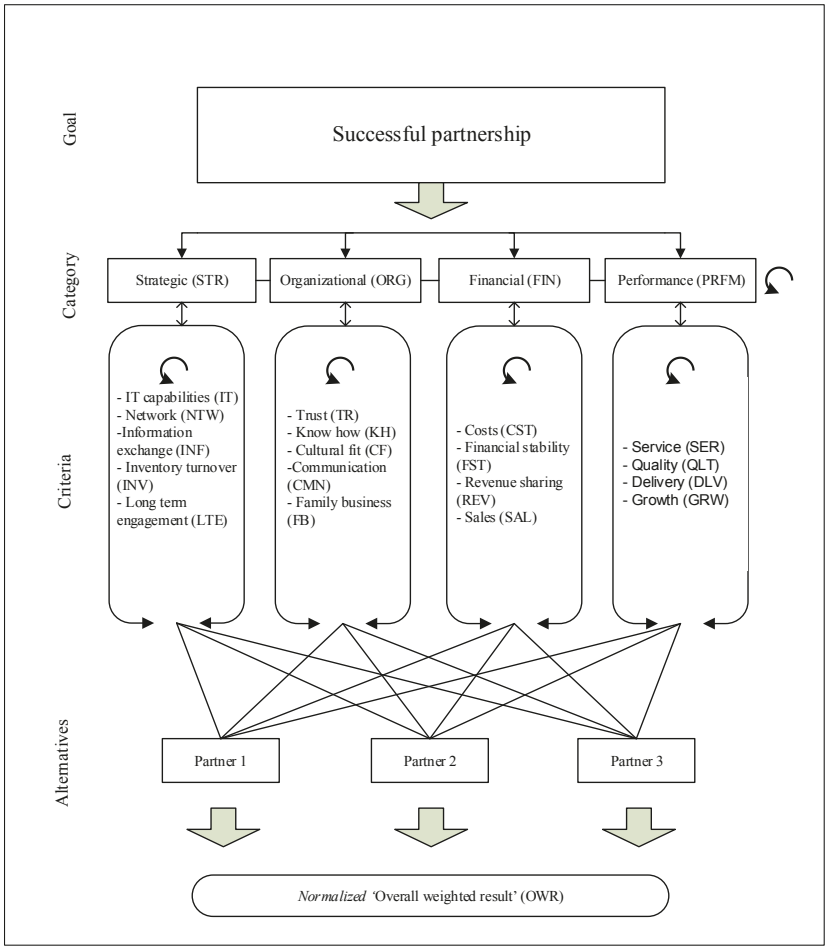
Strategic (STR)			
ID13	**Growth (GRW)**	The business partners need to agree on a growth strategy.	(Jharkharia and Shankar, 2007; Büyüközkan et al., 2008)
ID14	**IT-capabilities (IT)**	Good IT capabilities lead to a reduction in both inventory levels and uncertainties in the process.	(Jharkharia and Shankar, 2007; Büyüközkan et al., 2008; Wu and Barnes, 2010; Chen and Wu, 2011, Cao et al., 2010)
ID15	**Information exchange (INF)**	Information exchange incorporates mutual trust issues. It is necessary to exchange information not only for smooth daily operations but also for continuous improvement.	(Chen and Wu, 2010; Forkmann et al., 2012; Lee and Cavusgil, 2006; Wu and Barnes, 2010; Zaefarian et al., 2013)
ID16	**Long-term engagement (LTE)**	The level of trust determines the long-term prospects of the alliance. Financial stability, past achievements, and having a good relationship increases the level of trust among alliance partners as well as the level of commitment towards the alliance.	(Kannan and Tan, 2002; Jharkharia and Shankar, 2007 Büyüközkan et al.., 2008)
ID17	**Network (NTW)**	A supply chain is a network of organizations involved in a variety of processes and activities that produce value in the form of products and services for the ultimate consumer. The potential business partner should be willing to be part of an interconnected network of LSPs.	(Jharkharia and Shankar, 2007; Büyüközkan et al., 2008; Christopher, 2016)
ID18	**Inventory turnover (INV)**	The ratio between incoming and outgoing goods of a particular period between partners. Ideally the flow of goods is balanced both ways.	(Ha et al., 2011; Wu and Barnes, 2010)

6.4 USING ANP FOR DEVELOPING AN LSP PARTNER EVALUATION MODEL AT LSP1

6.4.1 ANP structure

We use a case study at LSP1 to show how ANP can be used for the development of a horizontal LSP partner evaluation model. Figure 6.1 shows the ANP problem formulation structure based on the evaluation criteria identified in the literature. The ANP structure contains the goal (a successful partnership), the four criteria categories (or clusters), and the criteria themselves. In ANP each of the criteria receives a weight and partners are scored on each criterion, resulting in an overall weighted result (*OWR*) for each partner evaluated. These *OWR* scores can then be compared among the partners. Below we will discuss the steps to establish the ANP model.

Figure 6.1: *Partner evaluation structure*



6.4.2 Establishing priorities

In order to identify priorities for the individual criteria, we composed an ANP questionnaire that includes comparison matrices. A scale of 1 to 9 was used to compare sets of two criteria, with 1 indicating that criteria are equally important and 9 indicating the extreme importance of one criterion over another. We piloted the ANP questionnaire with two persons (one from academia and one from practice) and adjusted it using their feedback. Sarkis (1998) suggested involving a variety of employees who have a stake in the final decision. Therefore, we selected potential respondents together with the board in order to guarantee sufficient spread among staff that work directly or indirectly with customers and LSP partners. We sent the ANP questionnaire to 35 employees of LSP1 and received 26 responses (74% response rate). These numbers are well within the recommended sample sizes for such studies (Zahedi, 1986;

Jharkharia and Shankar, 2007; Gencer and Gürpinar, 2007; Tseng et al., 2009; Ramanathan, 2013). The resulting overall priorities of the ANP model are represented in an unweighted supermatrix (Table 6.5) and a weighted supermatrix (Table 6.6).

Next, the interdependence of categories is established. A matrix presenting the interdependence of criteria categories, the eigenvectors, and the consistency index is shown in Table 6.2. The eigenvectors (e-vector) show the importance of each of the criteria and are composed using SuperDecisions software. The consistency of the data gathered is measured for each matrix using a consistency index (*C.I.*). The data are consistent if the *C.I.* is smaller than the threshold of 0.10.

Table 6.2: *Pair wise comparison of criteria categories*

Categories	**STR**	**ORG**	**FIN**	**PRFM**	**Normalized e-vector**
Strategic (STR)	1	3	1/3	½	0.163
Organizational (ORG)	1/3	1	1/5	1/6	0.064
Financial (FIN)	3	5	1	2	0.465
Performance (PFM)	2	6	1/2	1	0.308
				Consistency Index: 0.027	

The relative importance of each individual criterion within a specific category is then established. As an example, the matrix representing the Strategic (STR) category is shown in Table 6.3. This table shows the influence of criterion *a* on the strategic category as compared to criterion *b*. Four matrices are developed in this step, one for every category (see Appendix J).

Table 6.3: *Pair wise comparison of Strategic criteria (STR)*

Strategic criteria	**INF**	**INV**	**LTE**	**IT**	**NTW**	**Normalized e-vector**
Information exchange (INF)	1	2	3	4	6	0.422
Inventory turnover (INV)	½	1	2	3	4	0.257
Long-term engagement (LTE)	1/3	1/2	1	2	4	0.166
IT capability (IT)	¼	1/3	1/2	1	3	0.104
Network (NTW)	1/6	1/4	1/4	1/3	1	0.051
					Consistency Index: 0.026	

From Table 6.3 we for example observe that the importance of information exchange (INF) compared to long-term engagement (LTE) is valued at 3 (out of 9), which means that the preference of respondents is closer to INF than to LTE. INF is thus considered more important than LTE. Moreover, information exchange (INF) has the largest normalized eigenvector

(0.422) in the strategic category, implying it is the most important within this category. The network (NTW) has the least importance (0.051) in the strategic category.

Table 6.4: *Pair wise comparison for interdependencies among STR category with INF as a dependent*

INF as dependent	**INV**	**LTE**	**IT**	**NTW**	**Normalized e-vector**
Inventory turnover (INV)	1	1/4	1/4	1/2	0.047
Long-term engagement (LTE)	4	1	4	5	0.402
IT capability (IT)	4	1/4	1	4	0.232
Network (NTW)	2	5	1/4	1	0.320
			Consistency Index: 0.270		

Table 6.4 presents the relative importance of criteria considering information exchange (INF) between partners. It shows for example that IT capability (IT) is four times more important than long-term engagement (LTE) when considering information exchange between partners (INF).

We created 18 interdependency matrices, one for each criterion (see Appendix K). The values from these 18 interdependency matrices are used to form an unweighted supermatrix (Table 6.5). The unweighted supermatrix shows the relative importance of all the evaluation criteria. In order to obtain stable weights, the unweighted supermatrix is converted to a weighted matrix (Table 6.6). For convergence to take place, the sum of each column in the general matrix has to be equal to 1.

Table 6.5: *Unweighted supermatrix (before convergence)*

	INF	INV	LTE	IT	NTW	TR	KH	CF	CMN	FB	CST	FST	REV	SAL	SER	QLT	DLV	GRW
INF	0.198	0.254	0.197	0.185	0.165													
INV	0.198	0.254	0.198	0.185	0.165													
LTE	0.198	0.254	0.198	0.185	0.165													
IT	0.199	0.254	0.198	0.185	0.165													
NTW	0.198	0.254	0.198	0.185	0.165													
TR						0.194	0.066	0.263	0.251	0.225								
KH						0.194	0.066	0.263	0.251	0.225								
CF						0.194	0.066	0.263	0.251	0.225								
CMN						0.194	0.066	0.263	0.251	0.225								
FB						0.194	0.066	0.263	0.251	0.225								
CST											0.199	0.078	0.357	0.366				
FST											0.199	0.078	0.357	0.366				
REV											0.199	0.078	0.357	0.366				
SAL											0.199	0.078	0.357	0.366				
SER															0.374	0.176	0.382	0.068
QLT															0.374	0.176	0.382	0.068
DLV															0.373	0.176	0.383	0.068
GRW															0.373	0.176	0.383	0.068

Table 6.6: *Weighted supermatrix (before convergence)*

	INF	INV	LTE	IT	NTW	TR	KH	CF	CMN	FB	CST	FST	REV	SAL	SER	QLT	DLV	GRW
INF	0	0.047	0.402	0.232	0.320													
INV	0.384	0	0.069	0.266	0.281													
LTE	0.109	0.533	0	0.272	0.087													
IT	0.140	0.303	0.487	0	0.071													
NTW	0.325	0.501	0.067	0.107	0													
TR						0	0.109	0.327	0.451	0.114								
KH						0.151	0	0.343	0.228	0.278								
CF						0.111	0.063	0	0.318	0.508								
CMN						0.459	0.061	0.276	0	0.205								
FB						0.176	0.059	0.476	0.289	0								
CST											0	0.085	0.644	0.270				
FST											0.079	0	0.212	0.709				
REV											0.205	0.072	0	0.722				
SAL											0.323	0.089	0.587	0				
SER															0	0.244	0.687	0.070
QLT															0.288	0	0.635	0.078
DLV															0.717	0.205	0	0.078
GRW															0.683	0.117	0.200	0

6.5 APPLYING AND EVALUATING THE ANP MODEL – LSP PARTNER EVALUATION AT LSP2

6.5.1 Applying the ANP model

Typically, ANP models are used to develop case specific weights of evaluation criteria. Although criteria used may be similar different companies may place different weights on certain aspects, as for example in the case of a buyer-supplier situation as investigated by Ramanathan (2013). We believe there is merit in identifying a base ANP model that can be used as a point of reference for similar studies in evaluating horizontal LSP partners. To identify whether this is possible we evaluated five horizontal partners of a second case company (LSP2) from five European locations, using the model developed for LSP1. The five partners are family businesses that run warehouses and offer a range of transport and logistics services like LSP2. These partners provide a large network with branches in countries in East-Europe, North-Europe and West-Europe. First, we asked the management of LSP2 to rank their five partners on the management's perception of their performance from 1 (best) to 5 (poor); see Appendix L. Second, we asked the management of LSP2 to apply our ANP framework and to judge the performance of each partner using a scale from 1 (extremely poor) to 9 (extremely good). Third, we discussed the rankings and ANP results with the management of LSP2 in an interview and evaluated whether certain aspects of performance where missing or needed to be incorporated in the evaluation model. This will be further discussed after the ANP results below.

In order to evaluate each of the five partners, an overall weighted result (*OWR*) is calculated, which represents the relative importance of each partner. A higher value indicates a better fit of the partner based on the weights of the evaluation criteria developed for LSP1. We calculated the *OWR* for the five partners as follows:

$$OWR_k = \sum_{i=1}^{4}\sum_{j=1}^{18} C_i \times D_{ji} \times I_{ji} \times E_k \qquad (1)$$

In equation 1, i represents the number categories while j is the number of criteria. C_i is the relative impact of criteria category on the decision. D_{ji} is the relative impact of criterion j on its category i for a dependency strength. I_{ji} shows the stabilized relative impact of criterion j on its category i. E_k represents the weights given to five partners. The *OWR* figures are taken from the weighted supermatrix (Table 6.6). The *OWR* presented in Table 6.7 represents the relative importance of the five partners. The third column in this table (labeled C_i) represents the

importance of criteria categories; values are taken from Table 6.5. Figures in the fourth column (D_{ji}) represent the importance of individual criteria on their respective category based on Table 6.6. The fifth column represents stabilized values of interdependence between criteria (I_{ji}) and values are imported from Table 6.7. The sixth, seventh and eighth columns represent the weights given to five partners based on the judgment by the management of LSP2.

Table 6.7: *Presentation of Overall Weighted Results (OWR) and their normalized values*

Category	Criterion	C_i	D_{ji}	I_{ji}	E_k					Result				
Strategic (STR)					Partner 1	Partner 2	Partner 3	Partner 4	Partner 5	Partner 1	Partner 2	Partner 3	Partner 4	Partner 5
	INF	0.163	0.422	0.198	8	6	5	4	4	0.109116	0.081837	0.068198	0.054558	0.054558
	INV	0.163	0.257	0.254	5	5	5	5	5	0.053354	0.053354	0.053354	0.053354	0.053354
	LTE	0.163	0.166	0.198	9	9	9	5	5	0.048189	0.048189	0.048189	0.026771	0.026771
	IT	0.163	0.104	0.185	8	7	5	6	6	0.025117	0.021977	0.015698	0.018838	0.018838
	NTW	0.163	0.051	0.165	9	7	7	3	6	0.012396	0.009641	0.009641	0.004132	0.008264
Organizational (ORG)														
	TR	0.064	0.475	0.194	9	7	9	9	3	0.053220	0.041393	0.053220	0.053220	0.017740
	KH	0.064	0.229	0.066	7	6	7	7	7	0.006797	0.005826	0.006797	0.006797	0.006797
	CF	0.064	0.142	0.263	9	9	8	9	6	0.021647	0.021647	0.019241	0.021647	0.014431
	CMN	0.064	0.102	0.251	8	7	6	7	4	0.013127	0.011487	0.009846	0.011487	0.006564
	FB	0.064	0.052	0.225	9	9	9	9	9	0.006838	0.006838	0.006838	0.006838	0.006838
Financial (FIN)														
	CST	0.465	0.483	0.199	7	9	9	6	6	0.312613	0.401931	0.401931	0.267954	0.267954
	FST	0.465	0.349	0.078	9	8	5	9	4	0.114080	0.101404	0.063378	0.114080	0.050702
	REV	0.465	0.103	0.357	4	6	7	7	4	0.068698	0.103047	0.120221	0.120221	0.068698
	SAL	0.465	0.065	0.366	8	5	4	6	6	0.088498	0.055311	0.044249	0.066373	0.066373
Performance (PRFM)														
	SER	0.308	0.476	0.374	7	6	3	9	6	0.384197	0.329312	0.164656	0.493968	0.329312
	QLT	0.308	0.289	0.176	7	6	3	9	6	0.109489	0.093847	0.046924	0.140771	0.093847
	DLV	0.308	0.176	0.383	7	6	5	9	6	0.144914	0.124212	0.103510	0.186317	0.124212
	GRW	0.308	0.059	0.068	7	4	4	5	8	0.008723	0.004985	0.004985	0.006231	0.009969
Overall weighted result (OWR)										15.810	15.162	12.409	16.536	12.252
Normalized OWR										0.3644	0.3495	0.2860	0.3812	0.2824

We normalized the *OWR* such that $\sum_{k=1}^{5} OWR_k = 1$. The row 'normalized *OWR*' in Table 6.7 contains the overall weighted results for each of the five partners. As can be seen from Table 6.7 Partner 4 has the highest normalized *OWR* score (0.3812) and was therefore evaluated highest.

As outlined above, we asked the management to rank the five partners from the best performing partner (1) to the least performing (5). We compared this to the outcomes of the ANP exercise. It turned out that the results of the ranking by the management of LSP2 were the same as the results based on our ANP framework, except for the ranking of Partner 3 and Partner 5 (these were reversed in ranking).

6.5.2 Evaluating the ANP model

We then discussed the evaluation criteria and the applicability of the ANP model in 12 semi-structured interviews with managers from LSP2. The interviewees were selected based on their job title, main responsibilities in relation to partner evaluation at LSP2. The interviews aimed to 1) discuss if there are missing criteria in the horizontal partner evaluation model established, and 2) verify if the relative importance of the criteria in our ANP model may apply to a variety of LSP partners in horizontal cooperation. The interviewees possessed on average more than 24 years of experience in the logistics and transport industry, are active across Europe and had worked for a variety of LSP companies before joining LSP2. Table 6.8 illustrates the list of the interviewees of the study, their job title and responsibilities.

Table 6.8: *Job title, roles and responsibilities of interviewees at LSP2*

Job title:	**Main responsibilities and relation to partner evaluation:**	
Corporate Director (1x)	Development of transportation and logistics solutions for the whole LSP network. Cooperate with different partners in order to implement the solutions in the different locations worldwide. Provide input on strategic level about the capabilities, capacities and cooperation willingness of partners	
General Managers (7x)	Managing European transport, warehouse and logistics services within a specific city. Cooperate with partners at the tactical and operational level European wide. Provide inputs on the operational performance of partners to the headquarter	
Head of Global LSP Network (1x)	Responsible for the network development and relationship management with partners worldwide. Evaluate and analyze the cooperation among the LSP network at strategic and operational levels. Identify bottlenecks and provides potential concepts in order to improve the partnership	
Managing Director (1x)	Managing transport, warehouse and logistics services in a country. Cooperate with partners at the strategic level worldwide. Provide inputs on the strategic and operational performance of partners to the headquarter	
Production Manager International Forwarding(1x)	Securing and developing international overland freight forwarding services. Discuss and provides concepts to partners in order to increase the volume of freight within an LSP network. Provide inputs on the operational performance of partners to the headquarter	
Project Manager within an LSP Network (1x)	Helping to identify and evaluate possible partners, and then project manage the integration of the partner into the network	

An interview protocol was established (Appendix M) as a guide for the interviews. All interviews were conducted via telephone. The interviews had a duration between 35-60 minutes and were recorded, transcribed and sent back to the interviewees for feedback and approval. As suggested by Eisenhardt and Graebner (2007) additional documentation, such as web pages (for example, about horizontal partner organizations) were reviewed where necessary as secondary sources of empirical data.

The interviews did not reveal criteria that required deletion from the list. Two interviewees observed that green logistics criteria are missing in the applied ANP model. The interviewees indicated that because for example reliable electric trucks with a long range are not yet available green logistics is not yet an evaluation criterion for partners. All in all, green logistics should be considered a partner evaluation criterion in horizontal LSP networks, though not yet now but in the future.

The interviews revealed that the ranking of the categories is applicable to a variety of LSP networks, however the weights of the individual criteria will require adjustment on a case-by-case basis. In line with the LSP1 based ANP model outcomes, the interviewees at LSP2 agreed that the financial category should be leading in LSP partner evaluation. Several interviewees clarified that cooperating with a partner that is financially stable (FST) leads to a long-term relationship marked by mutual trust among the partners within an LSP network. Furthermore, a focus on costs (CST) by the partners was argued to be critical because cost is still a major consideration for customers. Of second importance is the category Operational Performance. The managers interviewed explained that the ability of a partner to increase customer satisfaction (SER) and quality (QLT) is key for keeping customers and extending cooperation with these customers. Increasing customer satisfaction is dependent on the service and quality offered by each LSP partner, which have to be continuously optimized. One manager explained that if a customer is not satisfied with the service level offered by an LSP, the customers might decide to work with another network of LSPs instead. The interviewees argued that this affects the growth and financial situation of the LSP, which turn leads to an increase in logistics costs and decreasing service levels. As a result, this category is important for both the financial and the strategic category. The interviewees furthermore explained that the third-ranked category in terms of importance is the strategic category. From this category they mentioned in particular sharing IT-capabilities (IT) and information exchange (INF) to improve the synchronization of the information and material flow with the transport channel worldwide. The interviewees said that cooperation with LSP partners implies sharing infrastructure and resources and developing

common standards. For example, IT is standardized in an LSP network to share information easily and process documents in an automated manner. This results in increasing transport efficiency and reduced coordination effort within an LSP network, as well as enhanced mutual trust. The last category is the organizational category. The interviewees indicated that in this category particularly trustworthiness (TR) and cultural fit (CF) are key because these stabilize the cooperation between partners and can mitigate conflict between contract partners. One interviewee indicated that because of trust between partners imbalance in workload between two partners was not invoiced every time it occurred because the partners knew that relatively more work for one partner now would be offset by relatively more work for the other partner in the near future.

During the interviews the usefulness of ANP for LSP partner evaluation was also discussed. Three of the interviewees indicated they preferred the ANP model over scoring and matrix methods or more complex mathematical approaches. The proposed ANP model takes the middle road of these approaches, not requiring the complexity of the mathematical models, yet providing a robust solution. One of the interviewees criticized the fact that the criteria in the scoring approach are related to each other and appreciated that the ANP model explicitly takes interdependencies between the criteria into account through a pair-wise comparison. Through the pair-wise comparison within an ANP network structure, the decision-makers can understand trade-offs between the criteria. According to the managers interviewed, the major advantage of the ANP model is that it compelled them to think in a comprehensive and detailed manner about the partnerships and provides an objective approach to evaluate partners. The interviewees also expressed their expectation that the weights of the individual criteria in the ANP model required some adaptation dependent on, e.g. industry focus of the LSP (for example, transporting chemicals has different requirements than transporting large capital goods) or the geographic focus (national vs international focus of an LSP, which relates to the ability to deal with different cultural aspects). However, they also indicated that overall the relative importance of the categories will be similar across LSPs.

6.6 DISCUSSION

6.6.1 Vertical vs horizontal partnership evaluation

In our research, we studied criteria to evaluate horizontal partnerships in logistics networks using criteria from vertical partnership studies, similar to other studies (Jharkharia and Shankar, 2007; Büyüközkan et al., 2008; Wu and Barnes, 2011). We noted that criteria from vertical cooperation research are indeed useful to evaluate horizontal cooperation based on the

conducted interviews. Our interviews did not reveal any additional horizontal partnership evaluation criteria that we needed to add to the criteria derived from vertical partnership studies. The driving force behind horizontal and vertical cooperation are the high fixed costs involved in doing business, the strive to increase the quality of the performance and to deal with the complexity of serving a global market (Bernal et al., 2002; Verstrepen et al., 2009). Both cooperation types support doing business for each partner involved in a logistics network in order to respond to market requirements.

Whereas the partner evaluation criteria appear overall the same for these two types of cooperation our research does show slight differences in the relative importance of the individual criteria. The interviews showed that the most important financial criteria considered in evaluating horizontal cooperation among LSPs are financial stability and price/cost. In vertical cooperation, revenue sharing benefits and price/profit margin are typically the most relevant financial criteria (Yang, 2009).

In the category operational performance, quality and customer satisfaction were considered most relevant for horizontal cooperation in the interviews. These criteria are also highly ranked criteria for evaluating partners in vertical cooperation. Customer satisfaction relates to many factors like accuracy of order fulfillment or promptness in attending customers' complaints; quality is characterized by providing good service and a managing operational performance well (Jharkharia and Shankar, 2007). These criteria are useful for both vertical and horizontal cooperation because they enhance competitive positions or market power, improve operational processes and allow focus on a narrow range of activities and engage in complex interactions with other firms (cf. Cruijssen et al., 2007a)

For horizontal cooperation the key strategic criteria were identified as information capabilities, and IT capabilities, which is also in line with vertical cooperation (Brekalo et al., 2013). IT capabilities and information exchange can simplify processes, facilitate the coordination of activities among partners in order to reduce risks and support the planning of logistics activities among partners (Brekalo et al., 2013). This is something that is relevant for both horizontal and vertical cooperation.

There is a slight difference in criteria between horizontal and vertical cooperation for the category organisation. In this category, the success of vertical cooperation depends on criteria like commitment, trust, effective communication and conflict resolution (Rezaei et al., 2015). These are key drivers to reduce costs, improve customer satisfaction and processes (Yang, 2009). Our research emphasizes the importance of cultural fit in horizontal cooperation, which

is especially relevant to promote partnership performance and improve business continuity (Svensson, 2004).

6.6.2 Towards a starting point for partner evaluation in LSP networks

The results of our ANP framework show that the financial (FIN) category is the most important category for strategic partner evaluation in horizontal cooperation among LSPs. The interviews showed that within the financial category, cost (CST) and financial stability (FST) were important criteria. Financial stability (FST) influences the cooperation between LSPs because it allows for joint investment, which results in more efficient use of resources and in innovation (Rezaie, 2016). This finding is also in line with prior studies on vertical logistics cooperation, which suggest that cooperation is an effective strategy to reduce operational costs which in turn results in positive business outcomes (Cousins, 2005).

The interviews furthermore revealed that the operational performance (PRFM) category is considered second in rank of importance. Because cooperating partners support each other to perform a wider range of flexible services, reach more customers through a wider geographic reach, optimize utilization of facilities in order to control costs and increase productivity, and create innovative solutions for their clients via interfirm specialization (Bernal et al., 2002; Cruijssen et al., 2007b; Raue and Wallenburg, 2013). Within the operational performance category, interviewees discussed that service (SER) and quality (QLT) are the key evaluation criteria for horizontal cooperation among LSPs, because customer satisfaction is dependent on the service and quality offered by each partner LSP. This is in line with findings from the literature on vertical logistics cooperation (Kannan and Tan, 2003; Ho et al., 2009; Golmohammadi and Mellat-Parast, 2012).

Third is the category Strategy (STR), in which information exchange (INF) was indicated as the most relevant aspect to evaluate LSP partners on. Prior research (Thakkar et al., 2005; Vanovermeire et al., 2014) indicates that in collaborative engagements information exchange (INF) increases mutual trust and that it is necessary to exchange information not only for daily operations but also to ensure continuous improvement. Information exchange is key to synchronizing flows of goods with information flows in an LSP network as this improves transport efficiency and reduces coordination effort. The importance of information exchange in a collaborative partnership is also reported in vertical logistics cooperation (Sridharan and Simatupang, 2009).

In the organizational (ORG) category, trust (TR) is most important according to the interviews. Trust (TR) enables the communication (CMN) between partners and affects the cultural fit (CF) of partner within an LSP network. Effective communication is important for enabling data transparency between partners, which in turn strengthens the relationship and trust between partners (Yang et al., 2015). Research on vertical partnership also indicates that the right partner is one with a similar organization, culture fit, and philosophy (Audy, et al. 2012). Because they reflect the manner in which a service is organized or provided to customer, Trust (TR) and cultural fit (CF) are fundamental to strengthen the relationship and a cooperation of a network as explained by the interviewed managers.

6.7 CONCLUSIONS AND RECOMMENDATIONS

In this chapter, we aimed (1) to establish criteria for evaluating strategic partners in a network of LSPs, (2) to show how Analytical Network Process (ANP) can be used to identify the weights of these criteria on a case specific basis, and (3) to investigate whether the ANP model can be used as a starting point to evaluate strategic partners for other LSP networks. We consulted the literature on vertical cooperation between LSPs and shippers as well as three LSP managers to develop a list of criteria useful for evaluating LSP partners active in horizontal cooperation. We applied these criteria to LSP1 and showed that in that case the most important category was financial criteria (FIN), then performance criteria (PRFM), strategic criteria (STR) and last organizational criteria (ORG). We then applied our ANP model to a second case study (LSP2) to show that the model can be applied to another LSP with similar characteristics. We compared the results of a ranking of five partners by the LSP management team and concluded that this led to relatively similar overall results as when applying the ANP framework developed for LSP1. We then discussed the ANP model in 12 interviews with top-level managers of LSP2 and concluded that the order of importance of the overall categories are as identified in the ANP model, though the priorities of individual criteria may change dependent on the specific characteristics of an LSP and their partners.

This study's results indicated that the differences between vertical and horizontal cooperation in the relative importance (ranking) of LSP partner evaluation criteria are small. These similarities may be useful for other collaborative issues: contracts between partners may for example contain similar components in situations of horizontal and vertical collaboration, or performance measurement frameworks may be developed along the same lines. However, managing horizontal cooperation among LSPs may be more difficult than managing vertical cooperation. The sharing of profits and risks of joint operations is a source of conflict inherent

in horizontal cooperation among LSPs whereas vertical cooperation is governed by a supplier-customer relation. One may argue that in such a supplier-customer relation the customer is a leader and the supplier a follower, whereas this is less apparent in horizontal collaboration partnerships. This may have implications for price setting strategies in horizontal vs vertical partnerships.

It is a well-known fact that trust between partners can make cooperative efforts more effective (Zaefarian et al., 2013). Consequently, adequate governance mechanisms have to be established similarly to vertical cooperation to gain benefits from horizontal collaboration (Wallenburg and Raue, 2011; Schmoltzi and Wallenburg, 2011). The potential of horizontal collaboration for increasing load factors in transport and thereby reducing the environmental impact of transport and logistics has encouraged the European Commission to fund a variety of research projects on these topics. The NEXTRUST project in particular, aims to increase efficiency and sustainability in logistics by developing interconnected trusted collaborative networks along the entire supply chain and by providing clear guidelines to practitioners on how to set up competition law compliant and more sustainable collaboration networks (see http://nextrust-project.eu/). However this is a careful balancing act since collaborative partnerships may be considered to be non-competitive and in violation of antitrust laws if the allied firms earn excessive profits at the expense of their competitors (Hoyt and Huq, 2000). Horizontal partnerships thus need to be scrutinized frequently on that aspect. Such frequent evaluations may not only prevent antitrust issues from occurring (e.g. the impression of price-fixing) but will also foster an environment of trust between the partners. Research shows that trust is built amongst others by frequent joint activity, but also by providing transparency (Akkermans et al., 2004).

For practitioners, the results of this study might serve as a starting point for a tool to evaluate LSP partners active in horizontal cooperation. ANP may be a useful tool compared to other multi-criteria decision-making tools because of the relatively simplicity of using the tool while the results are robust. A structured analysis provided by an ANP model can help reduce the risk of poor decisions regarding partnership improvement or continuation.

Like any study also our study comes with limitations. First, the approach we have followed does not allow for identifying which individual criteria are the generally speaking most important criteria for evaluating partners in horizontal LSP networks. To answer such a research question would require a different research approach, e.g. involving a large-scale survey and

the development of hypotheses, similar to what e.g. Yang (2009) has done for investigating evaluation criteria in vertical cooperation.

Second, we have verified the general applicability of the order of importance in the categories of evaluation criteria with 12 interviewees. A detailed comparison of evaluation criteria across industries to provide a rationale behind differences between types of industries requires additional in-depth empirical (case) studies in a variety of LSP industries. More specifically, it would be interesting to study LSPs that are entirely different from each other, and for example to contrast relatively stable commercial supply chains from for example the chemicals industry with supply chains characterized by very high levels of demand volatility and high uncertainty in infrastructure availability and in demand, as experienced in humanitarian relief.

Third, although our case studies indicated that the differences in the relative importance (ranking) of the criteria for vertical and horizontal cooperation are small, it is impossible to draw strong conclusions on whether a distinction between both types of collaboration remains meaningful for partner evaluation. More research is needed to provide strong evidence for the question whether success factors for vertical logistics cooperation are similar to those for horizontal partnerships among LSPs. If differences remain small it will be interesting to investigate this, e.g. using case studies within LSPs that are active both in an LSP network and in vertical cooperation.

Our interviews indicate that the logistics companies will put more emphasis on delivering services that are not only efficient and effective but also sustainable—both in response to governmental regulations and in order to raise customer awareness regarding environmental protection (Mirhedayatian, 2014). Future research should therefore focus on the integration and quantification of environmental aspects in partner evaluation criteria in order to achieve a sustainable logistics network.

7 SUMMARY OF FINDINGS, IMPLICATIONS AND CONCLUSIONS

"Management is doing things right; leadership is doing the right things."

In this thesis we have explored qualitative and quantitative methods to assist HOs and LSPs in developing performance management and have presented five studies on the topic performance management in Chapters 2 to 6. These chapters cover separate studies, each focusing on managing performance in supply chains. Specific research questions are formulated and discussed. We have addressed performance measurement and management in humanitarian and business supply chains. In this concluding chapter, we summarize the main findings of the five studies, and discuss the contribution, the theoretical and practical implications. The research questions and the key findings of each of these chapters are summarized in Table 7.1. Finally, we present limitations and propose ideas for future research.

7.1 SUMMARY OF MAIN FINDINGS

In this section, we discuss how performance management may improve supply chain performance in humanitarian and business settings. In a first Subsection 7.1.1., we present our key findings on measuring and managing humanitarian supply chains. We show the state of the art of performance measurement and management in humanitarian supply chains, and demonstrate that business performance management practices do apply to humanitarian supply chains. Moreover, we discuss the relevant performance criteria in order to use a 4PL concept in the humanitarian supply chain environment that manage performance because of an improved collaboration between the humanitarian supply chain actors. Implementing the 4PL concept and LSPs in humanitarian supply chains allows humanitarian supply chain actors to have a single point of accountability across the supply and demand chain.

It is widely recognized that LSPs support supply chain actors meet fulfillment requirement while ensuring shipment are accurate on time and also supporting supply chain actors speed their products to market and flex up or down based on demand (Langely et al., 2017). This greater demands on the supply chain lead supply chain actors to have a greater expectations of what they want their LSPs to accomplish. This expectation drives LSPs to become better prepared and to enhance their logistics networks to meet the requirement of the supply chain actors. To form a logistics network, LSPs need to select and to evaluate LSP strategic partners. Therefore in subsection 7.1.2. we discuss LSP strategic partner selection and evaluation within

a horizontal cooperation among LSPs and provide a structured approach that helps LSPs to select and to assess LSPs partner for their logistics network.

7.1.1 Measuring and managing humanitarian supply chains

HOs are under extreme pressure to demonstrate their achievements (Moxham and Boaden 2007, Moxham 2009), which helps ensuring continuity in funding. Due to the central role of logistics in any kind of operation (Van Wassenhove 2005), the effectiveness and efficiency of the humanitarian supply chain are performance indicators that are particularly important (Beamon, Balcik 2008). However, to achieve sustainable success, a HO must manage and measure performance (de Leeuw, 2010). As there are no clear guidelines for measuring and managing performance in humanitarian supply chains we examined in Chapters 2, 3 and 4 how to do so.

Using a systematic literature review, we have examined in Chapter 2 theoretical perspectives in performance measurement and management in humanitarian supply chains and have contributed to understand the current state of research in the field and its future development. This chapter is believed to be the first to study performance measurement and management in humanitarian supply chains. Out of 52 papers focusing on performance measurement and management in humanitarian supply chains, 44% examined critical success and measurement criteria of humanitarian supply chains. Only a few papers deal with not empirically tested approaches and 94 indicators to measure performance exist. We have linked the 94 humanitarian supply chain performance metrics to the five supply chain phases (plan, source, make, deliver, return) similar to the work of Gunasekaran and Kobu (2007). We have compared these metrics to the ones used in business that were presented in the work of Gunasekaran and Kobu (2007). We firstly observed that there are no humanitarian supply chain metrics addressing the supply chain processes ‘make’ and ‘return’. We secondly have determined that there are similarities between humanitarian and business metrics such as, capacity utilization, delivery reliability, forecasting accuracy, inventory costs, labor efficiency, lead-time for procurement, overhead cost, stock out cost, transportation cost, and delivery time. We thirdly have identified that there is no emphasis on measuring supply chain performance at the network level due to a lack of collaboration between HOs. 36% of the papers obtained from the systematic literature review explored improvement-oriented approaches to design an effective and an efficient humanitarian supply chain and examined manifold logistics concepts to achieve the best logistics performance within a humanitarian supply chain. Some of the improvement-oriented approaches consider facility location decision for humanitarian relief chain as a response for quick-onset disaster (Balcik and Beamon, 2008) or the application of the agility

concept (Scholten et al., 2010) or the contribution of logistics skills and their effect on humanitarian supply chain performance (Kovacz and Tatham, 2010) or the establishment of temporary depots in the affected areas and the required vehicles and resources Lin et al. (2012). The remaining 20% of the papers analyzed in Chapter 2, have provided the challenges on supply chain performance management that HOs are facing during a relief operation: non-existence of data and limited number of empirically examined performance indicators at HOs, a chaotic and complex environment, contradicting goals of long-term versus short-term disaster response as well as limited information technology capacity and infrastructure, input vs output-oriented indicators, short-term vs long-term goals (Van der Laan et al. 2009; Blecken et al. 2009; Davidson 2006; Widera and Hellingrath 2011; Tatham and Hughes 2011; Jahre and Heigh 2008). Furthermore, the findings of Chapter 2 have highlighted that to date supply chain performance management has not been designed and implemented systematically in HOs compared to business and military (Oloruntoba and Gray, 2006; Thomas, 2007; de Leeuw, 2010). At this stage in Chapter 2, we have developed a research agenda that focuses on four research questions for designing, deploying and disseminating performance measurement and management in humanitarian supply chains.

In Chapter 3, we have used action research at MSF Belgium. During four years, we have applied ten supply chain performance management practices from business to design and to implement performance measurement in HOs. In Chapter 3, we have presented how performance management practices from business might be applied by HOs to design and implement humanitarian supply chain performance measurement and we have provided an in-depth understanding of the design and implementation of supply chain performance measurement at HOs. During the action research at MSF Belgium, we have found that the findings are in line with Singh et al. (2018) who have indicated that the fundamental structure of humanitarian supply chain is not different from the business supply chain. Because the supply chain performance management design and implementation practices applicable in business are also useful to HOs, albeit with adjustments. In addition, we have observed that tools and techniques from business such as workshops and technical sheets are applicable at HOs in order to design and implement performance measurement. During the workshop as a solution, we shared views from different levels of HO as advised by Bititci et al. (2004) to reduce resistance and to enhance the design and implementation of performance management. Then, we have established a common understanding to the topic performance management and enhanced their commitment and engagement to implement performance management in the relief projects and to provide us feedback. The technical sheet based on Neely et al. (2002) was a good instrument

to provide a structure and visibility of each performance indicator. The technical sheet provided the purpose, format, target, responsibility, data source and frequency of report and use of each Performance indicators. This instrument simplified even the implementation process of performance management in the relief projects worldwide. In Chapter 3, we have observed that gathering data in a chaotic environment with unreliable, unusable and incomplete data information is risky for the design and implementation of performance measurement at an HO. Wouters and Wilderom (2008) and Lohman et al. (2004) have highlighted that IT systems lead to an effective performance management. Therefore at MSF Belgium the design and implementation of performance measurement was connected to an IT project. During our research in the implementation of performance management phase, we observed that setting supply chain objectives allowed to redesign processes and to take actions. Moreover, we have observed that paying explicit attention to cultural changes influence employee's behavior and performance. The employees were motivated in using and reviewing the performance indicators. Moreover, they contributed to discussions to give feedback about the measured performance in order to revise the performance indicators and to achieve organizational goals. Future research should focus on examining further practices in order to manage supply chain performance at HOs.

In Chapter 4 we have contributed to a greater understanding of 4 PL in humanitarian supply chains. We discussed performance criteria based on the four core components of a 4PL provider described by Christopher (2005) that hold for 4PL concept in humanitarian to manage the performance of humanitarian supply chains: a 'decision maker', 'supply chain infomediary', 'supply chain architect' and a 'resource provider' because the core competency of many HOs does not comprise supply chain activities. As a 'decision maker' a 4PL provider is an experienced logistician that supply logistics skills and that is able to establish innovative logistics concepts and a quality management system along a humanitarian supply chain. As an 'infomediary' the 4PL provider should be able to improve communication between actors and to integrate system and information technologies. A 4PL provider as a 'supply chain architect' should manage multiple 3PL provider and different stakeholder within a humanitarian supply chain. As a' resource provider' a 4PL should provide transport, assets, procurement and co-packing service and should be capable to negotiate freights and storage contracts with 3PL providers. Cooperation between a HO and a 4 PL provider might ensure cost and process transparency, process re-engineering, strategy development and better management of resources across the humanitarian supply chain. In Chapter 4, we have indicated possibilities for an increased supply chain scope where activities are handled by a fourth-party logistics

service provider that has the best capabilities, could secure collaboration, increase service levels as well as efficiency and therefore create additional value within a humanitarian supply chain. Future research has to consider different disaster types and needs to further emphasize the added value for beneficiaries of implementing a fourth-party logistics concept in a humanitarian supply chain environment.

Throughout 2017, earthquakes, tsunamis and hurricanes brought devastation to areas throughout the world. In such situation humanitarian supply chain efforts are often filled with uncertainty as well as time and resource constraints (Langely, 2017). LSPs are capable to draw upon their employee skills/expertise and technology to supply rapid response (Langely, 2017). LSPs offer different services such as freight consolidation, delivery shipments to customers, coordination material shipments, undertaking customs clearance, freight forwarding (ocean, air or overland transportation) or operation administration (Bowersox et al., 2007). They provide competencies in information technology and skills in forming and building successful supply chain relationships amongst the actors (Coyle et al., 2003). Hence, choosing and evaluating the right LSP strategic partner is highly important for the performance of the cooperation among a logistics network and is afflicted with complexity as well as uncertainty (Lee and Cavusgil, 2006). Therefore, in the following section we will advance insights for LSP partner selection and evaluation in order to build a logistics network.

7.1.2 Managing and improving supply chains

The right choice of a strategic LSP partner could bring a competitive advantage, whereas inability to establish a proper relationship would bring overwhelming problems (Lee and Cavusgil, 2006). To this end, we have examined in Chapters 5 and 6 LSP strategic partner selection and evaluation within a horizontal cooperation among LSPs.

In Chapter 5 we have provided criteria for selecting a strategic partner for horizontal cooperation in networks of logistics service providers (LSPs) and have showed that Analytical Hierarchy Process (AHP) can be used to identify partner selection criteria on a case specific basis. An AHP analysis was conducted at a medium-sized family-owned Dutch LSP and at a large family-owned German LSP that had each been actively building a network of LSPs for their European transport and distribution activities. The findings of these two studies showed that criteria for selecting vertical partnerships between shippers and LSPs are applicable to select horizontal partnerships of LSPs. Additionally, the findings indicate that horizontal cooperation among LSPs is more strategic oriented, as compared to the more operational oriented vertical cooperation. Strategic oriented criteria refer to the culture of a partner, long-

term engagement, security, and structure of the partner. These criteria are seen as relevant because they reduce risks and ensure effective information exchange; the sharing of sales information; and the planning of logistics activities among partners (Brekalo et al., 2013). Operational oriented criteria, such as service, quality, and delivery, refer more to production and business processes and distribution channels. These criteria are critical in vertical integration because companies aim to maximize the overall value of the supply chain, to enhance operational flexibility in order to handle high demand uncertainties, and to improve service within a buyer-supplier partnership. Notably, information exchange is an important criterion in both types of cooperation. The difference between the two types of cooperation can be explained by characteristics of vertical and horizontal cooperation. Based on these two studies we have concluded that partner selection criteria used in vertical cooperation between LSPs and shippers are useful selection criteria for horizontal cooperation between LSPs but that the ranking of these criteria differs. We believe to be the first that have presented a structured approach taking strategic LSP partner selection criteria into account to support multi-criteria decision making in selecting a strategic partner for horizontal cooperation among LSPs. Future research should focus on standardizing criteria and on including environmental factors for auditing partners.

In Chapter 6 we extended the work described in Chapter 5 by showing that Analytical Network Process (ANP) can be used to identify the weights of LSP partner evaluation criteria on a case specific basis. In addition, we have investigated usefulness of the ANP model as a starting point to customize the evaluation framework according to their specific needs or operating environments. ANP was applied because it is a well-known model to solve partner evaluation problems (Talluri et al., 2006). In addition, we have showed that criteria for evaluating vertical partnerships between shippers and LSPs are applicable to evaluating horizontal partnerships of LSPs. Our findings have indicated that the most relevant evaluation criteria are in order of importance: cost (CST), financial stability (FST), service (SER), quality (QLT), information exchange (INF), inventory turnover (INV), trust (TR) and know-how (KH). We have provided a structured analysis to reduce the risk of poor decisions regarding partnership improvement or continuation. To the best of our knowledge we are the first to bring forward horizontal LSP partner evaluation criteria, to develop an ANP model for LSP partner evaluation and to apply this to two cases, and to provide a starting point for evaluating partners in similar horizontal LSP networks. A variety of research in this field, including our research, evaluates partners only from the economic and social perspectives; literature on partner evaluation that considers the environmental perspective is scarce (Govindan et al., 2013; Wu and Barnes, 2015). Future

research might therefore focus on integration of environmental aspects in partner evaluation criteria in order to achieve a sustainable logistics network.

Table 7.1: *Overview of research questions and research methods*

Chapter	Topic	Research Questions	Research results
2	Humanitarian Supply chain performance management: a systematic literature review	What is needed for developing a performance measurement system for the humanitarian supply chain field?	• We highlight a classification of 94 performance measurement indicators that fit to assess humanitarian supply chains. • We provide key problems why performance management have not been widely developed and systematically implemented in humanitarian supply chains and are not part of the supply chain strategy. • Presentation of a performance measurement guidelines that include input and output criteria.
3	Performance management practices in humanitarian organizations	Whether supply chain performance management practices in business are applicable to Humanitarian Organizations (HOs) because many factors of business supply chains might be similar to humanitarian supply chains?	• We apply performance management practices in business at a HO to manage performance management development in HO focusing on the design and implementation phases. • Firstly, tools and techniques such as workshops or technical sheets are essential for the design and implementation of performance measurement projects at HOs. Secondly, connecting performance management to an IT-project is crucial to implement performance measurement at HOs. Thirdly, our case indicates that performance management practices from business apply to and are relevant for humanitarian supply chains. • We show that business performance management practices do apply to humanitarian supply chains. • This chapter provide an in-depth understanding of the design and implementation of supply chain performance measurement at HOs.
4	The value of fourth-party logistics services in the humanitarian supply chain	Which decisive criteria support a 4PL as an innovative logistics concept for humanitarian supply chains?	• The study highlights an increased value for humanitarian supply chain actors of establishing a fourth-party logistics concept. • We present four 4PL core competencies for humanitarian modified from Christopher (2005). • The results present a positive influence of fourth-party logistics in complex disasters environments and provide key drivers for increasing and simplifying collaboration between the humanitarian supply chain actors. • We provide an example of a structure of collaboration by integrating 4th party Logistics.

5	Strategic Partner Selection Criteria for Building a Network of Logistics Service Providers	What extent the criteria for partner selection in vertical cooperation could be used to support horizontal cooperation among LSPs.	• Our results show that the main criteria when selecting a partner for horizontal cooperation among LSPs are, in order of importance, information exchange, long-term engagement, and security. • We present differences between vertical and horizontal cooperation criteria. • We identify that the different rankings of selection criteria between the two types of cooperation can be explained by the different characteristics of vertical and horizontal cooperation.
6	Strategic Partner Evaluation for an LSP Network	Whether success factors for vertical logistics cooperation hold for horizontal partnerships among LSPs	• We identify and validate criteria associated with successful vertical cooperation that can be integrated into a multi-criteria decision framework to evaluate partners for horizontal cooperation among LSPs. • We provide an evaluation model and a proper weight setting for these factors are presented for evaluating horizontal using cooperation among logistics service providers (LSPs) using ANP. • The research shows that financial criteria are the most important for evaluating partnerships, followed by performance criteria, strategic criteria and organizational criteria. Moreover, empirical verification confirms that the derived ANP framework is useful to evaluate horizontal LSP partners.

7.2 LESSONS LEARNED FROM BUSINESS AND HUMANITARIAN SUPPLY CHAINS

This thesis addressed research in both humanitarian and business sector supply chains. This begs the question what findings can be learned from each other. This section addresses these learnings.

A first major finding of Chapter 4 is that developing simple and user-friendly methods are advisable to designing and implementing supply chain performance management. Even though performance management in business supply chains is common practice, designing and implementing performance management that considers the development of partnership, collaboration, flexibility, information productivity and business excellence remain challenging for business supply chains (Arzu Akyuz and Erman Erkan 2010; Bititci et al., 2012). Using simple methods results in a motivated team and induces productive organizational behavior to improve and promote the design and implementation process of supply chain (de Waal and Kourtit, 2013). Therefore, applying simple methods is something that does not only apply to humanitarian supply chains but to business supply chains as well when designing and implementing performance management.

Secondly, HOs can learn from their business counterparts about applying advanced collaboration practices such as fourth party logistics (4PL). Fouth party logistics is a well-known concept to better manage supply chain performance in business supply chains (Saglietto, 2013). 4PL providers possess a well-developed IT structure to ensure the integration of different external actors into a network. As indicated in Chapter 4, 4PL providers are now also formed in the humanitarian sector. If a 4PL provided is involved in managing a humanitarian supply chain they may potentially be in a better position to provide information about the supply chain using their IT infrastructure. That results in establishing effective communication and ensuring transaction visibility and transparency along the humanitarian supply chain.

Third, we identified that ANP is a useful approach for evaluating strategic partners within a network. Due the large number of actors in relief operations, including UN agencies, military, local government, affiliated government, GOs, NGOs, private companies, media as well as religious organizations with different ideologies and different mandates during in operations relief (Oloruntoba and Gray, 2009). ANP may also be useful to select and evaluate such partners. ANP might thus also support HOs in deciding about cooperation with other actors during a relief operation in a comprehensive and detailed way.

The fourth and last point relates to performance management practice ID4 discussed in Chapter 3 (defining operational performance indicators jointly with all the departments involved) identified in Chapter 3. Goals are often negotiated based on stakeholder /donor requirements which are not linked to department and team goals (Handfield et al., 2015; Oloruntoba and Kovacz, 2015). Unfortunately, this often results in unsuccessful performance management development (de Waal and Counet, 2009). Applying supply chain performance management practice ID4 in the humanitarian or in the business sector provides information on designing and implementing performance management, reinforces motivation and communication and enables early identification of problems. In addition, using supply chain performance management practice ID4 promotes integration and coordination among all departments and teams involved in supply chain performance management design and implementation.

7.3 IMPLICATIONS, SUGGESTIONS FOR FUTURE RESEARCH AND LIMITATIONS

7.3.1 Theoretical contributions

The main research question addressed in this thesis is how to develop performance management in humanitarian and business supply chains. To that end, we have explored how qualitative and quantitative methods assist HOs and LSPs in managing performance.

The first major contribution of our research is that humanitarian supply chains are structurally not different from business supply chains. We have demonstrated that supply chain performance management at HOs benefit from using performance management practices and tools. We discussed the large potential for applying other business performance management practices to humanitarian supply chains such as: the concept of collaborative planning, forecasting and replenishment (CPFR), the concept of integrated supply chain management or the concept of process integration. All these concepts are well examined in business supply chains and have contributed for business companies to achieve common goals and unique logistical solutions that are both effective, efficient and crucial in supply chain performance management.

A second important contribution of our thesis is the finding that both vertical and horizontal cooperation are similar when it comes to select and evaluate strategic partners. We suggest a structured analysis and decision framework including relevant criteria based on literature on vertical cooperation to select and evaluate strategic LSP partner for a horizontal cooperation among LSPs. Our findings in Chapters 5 and 6 showed just slight differences in ranking of the partner selection and evaluation criteria between the two types of cooperation. We believe in the need to bridge divisions between vertical and horizontal cooperation by exploring areas

such as blockchain for supply chain. Because of the increased demand for visibility within a supply chain, actors within a vertical cooperation are interested in blockchain technology which breaks each movement down into a block and documents transactions every time a shipment changes hands (Langely et al., 2017). Currently actors within a vertical cooperation are investigating the clear value from the technology and working on standards and agreement criteria. LSPs might begin examining or implementing blockchain technology in order to create visibility along supply chain and their logistics networks that results in competive advantages.

A third contribution is the development of user-friendly methods for desiging and implementing performance management. We have showed that simple methods such as the technical sheet worked 'better' than sophisticated methods such as Analytical Hierarchy Process (AHP) in practice. Unfortunately, we found that using AHP does not hold potential for the design of key performance indicators at HOs because due to the high number of indicators, the definition of indicators, the lack of clarity and because AHP needs a lot of effort and skills to be conducted. Contrary, using the technical sheet was understandable by the decision makers and therefore we were able to reach team consensus on the performance measurement result at MSF Belgium. We believe that there is a large opportunity to develop a user-friendly method in other areas such as facility location and inventory decisions for a humanitarian supply chains. A simple user-friendly facility location method would determine locations and the number of distribution centers in an operation relief network and the number of relief items to be stocked at each distribution center in order to fulfill the needs of beneficiaries.

7.3.2 Practical implications

This thesis offers managerial insights that have practical implications. Firstly, the implementation of performance management needs a cultural change on performance in order to reduce resistance by employees. Creating a performance culture requires a systematic approach to managing the performance of organizations, teams and individuals. We showed that it seems to be difficult for employees to create a shared consensus on how to effectively manage supply chain performance when not being aware of their own professional discussions and that of other employees in different countries with a different culture. Accordingly, we argue that linking culture change to desired performance is emerging as one of the leading management topic.

The second implication for practitioners shows that a structured and decision-making approach to extracting and structuring tacit knowledge is crucial in managing supply chain performance. Our research findings showed that selecting and evaluating an LSP strategic partner for a

horizontal cooperation is still executed intuitively and might be explained as tacit knowledge. This implication support LSPs within a horizontal cooperation to make decisions earlier resulting in moving away from functional partnership toward meaningful relationship.

The third practical implication of this thesis highlights the importance of knowing which data is needed by supply chain managers at HOs to improve humanitarian supply chain performance measure processes. Lord Kelvin (1883) indicated "when you can measure what you are speaking about, and express it in numbers, you know something about it". The findings showed that there is a plethora of useful of data but the supply chain manager stucks in collecting, transmitting, understanding and analyzing the amount of data in order to measure the humanitarian supply chain performance. We argue that supply chain managers might shift from physical efficiency to data efficiency and to leverage advanced technologies in order to identify which data is needed to be optimized for measuring the performance.

7.3.3 Limitation and suggestions for future research

The studies presented in this thesis also come with limitations: Firstly, the generalization and transferability of the findings to other contexts is frequently criticized lacking scientific rigour. (Thompson and Perry, 2004). Therefore, we suggest the application of multi case studies at UN agencies or GOs to ensure different perspectives on managing supply chain performance. In addition to extend our findings to other HOs that have a different funding structure to enhance the generalization of our findings because our findings can be extended or perhaps contradicted in other humanitarian supply chain context.

Secondly, the appropriate selection and evaluation of strategic partners within a supply chain support organizations to identify current and evolving challenges through the sharing of assets, knowledge, resources, and capabilities (Paulraj 2011). However, the finding in this thesis on LSP partner selection and evaluation among an LSP network, does not allow for identifying which individual criteria are the generally speaking most crucial criteria for selecting and evaluating partners in horizontal LSP networks. Therefore, future research should focus on large-scale empirical data and the development of individual criteria.

Thirdly, our research studies do not consider environmental aspects that combines green procurement, environmental management of manufacturing materials, environmental circulation, marketing, and reverse logistics as defined by Hervani (2005). Considering environmental criteria in managing supply chain might contribute to significant productivity improvements and cost savings (Shaw et al. 2010). Therefore, further effort should thus be put

into establishing environmental aspects in managing performance in supply chains in order to achieve a sustainable logistics network.

This thesis also identifies different areas for further research. Firstly, many performance measurement systems are available (e.g. Prism, BSC, SCOR model) amongst others to plan and to control the overall humanitarian supply chain or to monitor and evaluate the processes or even though to get a support in their decision making at HOs. However, little empirical research exists about the actual impact of external performance measurement systems on humanitarian supply chain performance. This strongly underlines the importance for future research in exploring the negative or positive effects of using only a standard model on humanitarian supply chain performance.

Secondly, HOs save lives using limited resources, competing for donor money, and operating in chaotic and complex environments. In order to operate effectively they need a variety of information and interoperability within the different data formats. The data formats are often unstructured due the availability of technological solutions such as RFID or the more advanced Internet of Things. The data are, e.g. identification of LSPs, collaboration between agencies during humanitarian operations, response time of logistics agencies/organizations, generated data from social media, number of beneficiaries. An immense amount of data is generated during a disaster within a short time span and is unstructured. Therefore, it may be useful to conduct further study on Big Data and predictive analytics and its impact on the humanitarian supply chain performance. This can provide new insights into visibility and its constituent resources in creating agility, adaptability and alignment in supply chains as suggested by Gunasekaran et al. (2017); Fosso Wamba et al. (2017).

Thirdly, cooperation with between UN, NGO and GO attracts strong interests from academics and practitioners. Horizontal cooperation with other HOs allows information sharing (Wakolbinger et al., 2013), cooperating fundraising activities (Toyasaki and Wakolbinger, 2014) and cost allocation of information technology (Ergun et al., 2014) that improves for example on-time deliveries and reduces warehousing and transportation costs. In general a HO that cooperate effectively with other HOs in the supply chain relationships creates for itself a basis for improving performance (e.g. Zacharia, Sanders and Nix, 2011). Therefore, the research might be extended in investigating cooperation mechanisms between UN, NGO and GO to increase the overall humanitarian supply chain performance in the field.

SUMMARY

It is commonly accepted that performance management is a crucial instrument for the effective and efficient management of supply chains. Organizations use it to keep their supply chain under control and to manage processes that often extend beyond their boundaries in order to fulfill their goals. Since the organizational performance within a supply chain depends on supply chain partners, there is a need of extending the management´s view and performance control along the supply chain. Performance management within a supply chain supports the participating actors (e.g. customer service, warehousing, supplier relationship management, inventory management, logistics and transportation) to improve their performance using resources and capabilities effectively. In this dissertation we examine supply chain performance practices in humanitarian organizations and how supply chain performance management could be improved by advancing insights for the commercial sector.

The topic performance management in supply chains - applications to humanitarian and commercial sector- is addressed in seven chapters. Starting from a systematic literature review on the state of the art of performance measurement and management in humanitarian supply chains we have first defined the research gaps in this field of science. Then, we examined the extent to which as well as how supply chain performance management design and implementation practices that have proven successful in commercial organizations are applicable to humanitarian organizations to guide the process of designing and implementing performance management in humanitarian organizations. Additionally, we have studied the value and the benefits of fourth-party logistics services in the humanitarian supply chain environment for which we have developed a conceptual framework. Building further on the literature on vertical cooperation in supply chains, we have identified and tested partner selection criteria that might be critical in forming a horizontal cooperative network of Logistic Service Suppliers. Next, we have established criteria for evaluating strategic partners in a network of logistics service providers and showed how Analytical Network Process (ANP) could be used to identify the weighing factors associated with these criteria. Finally, we have investigated whether the ANP model could be used as a starting point to evaluate strategic partners for other Logistics Service Provider networks.

SAMENVATTING

Prestatie beheer (Performance management) wordt aanzien als een belangrijk instrument om bevoorradingsketens effectief en efficiënt te beheren. Organisaties gebruiken het om vooropgestelde doelen in hun bevoorradingsketen te behalen en om processen te sturen die dikwijls de eigen organisatiegrenzen overstijgen. Prestaties van een bevoorradingsketen worden bepaald door de activiteit van alle partners in deze keten. Hieruit vloeit de behoefte voort om het beheer van deze prestaties over de volledige bevoorradingsketen te beschouwen. Binnen een bevoorradingsketen ondersteunt prestatie beheer alle actoren (b.v. klantendienst, voorraad en magazijnbeheer, logistiek en transport) teneinde hun prestaties te verbeteren door hun middelen en mogelijkheden zo effectief mogelijk te gebruiken. Er zijn verschillende vormen van aanpak voor een organisatie om hun bevoorradingsketen te beheren en zodoende hun vooropgestelde bevoorradingsketen strategie en doelstellingen te bereiken. In deze thesis onderzoeken we prestatiebeheer in humanitaire organisaties en gaan we na hoe prestatiebeheer verbeterd kan worden door gebruik te maken van de ervaring en inzichten uit de commerciële sector.

Het onderwerp prestatiebeheer in bevoorradingsketens – toepassingen in de humanitaire en commerciële sector – wordt besproken in zeven hoofdstukken. We zijn gestart met systematisch literatuur onderzoek over prestatiemetingen en -beheer in humanitaire bevoorradingsketens om de onderzoekskloof te definiëren in dit gebied van de wetenschap. Daarnaast hebben we het belang onderzocht van de zogenaamde fourth-party logistics services in het domein van humanitaire bevooradingsketens en hebben hiervoor een conceptueel raamwerk gedefinieerd. Verder bouwend op de literatuur over verticale samenwerking in bevoorradingketens hebben we partner keuze criteria geïdentificeerd en getest die interessant kunnen zijn in het vormen van horizontaal samenwerkende netwerken van Logistieke dienstverleners. Verder hebben we criteria opgesteld om strategische partners te evalueren in een netwerk van logistieke dienstverleners en hebben we aangetoond hoe Analytical Network Process (ANP) kan aangewend worden om de gewichtsfactoren voor deze criteria te bepalen. Tenslotte hebben we nagegaan of het ANP model gebruikt kan worden om strategische partners te evalueren voor andere logistiek dienstverlenende netwerken.

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APPENDICES

APPENDIX A. LITERATURE OVERVIEW

Year	Source	Author	Title	Methodology					Characteristics		
									Performance management scope		
				Conceptual model	Mathematical model	Case/Field study/ Interview	Review	Survey	PM indicators	PM framework	PM system to improve performance and efficiency
1998	Safety Science	Worm et al.	Mission efficiency analysis: Evaluating and improving tactical mission performance in high-risk, time-critical operations			x					x
1999	Disaster Prevention and Management	Ghafory-Ashtiany	Rescue operation and reconstruction of recent earthquakes in Iran			x					x
2001	Transportation Research: Part A: Policy and Practice	Chang and Nojima	Measuring Post-disaster Transportation System Performance: The 1995 Kobe Earthquake in Comparative Perspective			x			x		
2006	Master Thesis (MIT)	Davidson	Key Performance Indicators in Humanitarian Logistics			x			x		
2006	The International journal of Logistics Management	Beamon and Kotleba	Inventory management support systems for emergency humanitarian relief operations in South Sudan			x			x		
2006	Journal of the Operational Research Society	Van Wassenhove	Humanitarian Aid Logistics: Supply chain Management in high Gear			x					x
2007	Transportation Research Part E	Wei and Kumar	Ant colony optimization for disaster relief operations		x						x
2007	Journal of the Operational Research Society	Medina-Borja et al.	Large-scale data envelopment analysis (DEA) implementation: a strategic performance management approach		x				x		
2007	Disaster Prevention and Management	Moe et al.	Balanced scorecard for natural disaster management			x				x	
2008	International Journal of Public Sector Management	Beamon and Balcik	Performance measurement in humanitarian relief chains					x	x		
2008	International Journal of Logistics Research and Applications: A Leading Journal of Supply Chain Management	Balcik and Beamon	Facility location in humanitarian relief		x						x
2008	Journal of Contingencies and Crisis Management	Lutz and Lindell	Incident command system as a response model within emergency operation centers during hurricane Rita			x					x

2009	International Journal of Productivity and Performance Management	Kumar et al.	Educating the supply chain logistics for humanitarian efforts in Africa: a case study				x		x		
2009	International Journal of Productivity and Performance Management	Kovacs and Tatham	Humanitarian logistics performance in the light of gender				x				x
2009	International Journal of Services Technology and Management	Blecken et al.	A humanitarian supply chain process reference model	x					x		
2009	Management Research News	Schulz and Heigh	Logistics performance management in action within a humanitarian organization			x			x		
2009	International Journal of Risk Assessment & Management	Van der Laan et al.	Performance measurement in humanitarian supply chains			x			x		
2009	Management Research News	McLachlin et al.	Not-for-profit supply chains in interrupted environments The case of a faith-based humanitarian relief organisation			x					x
2009	International Journal of Physical Distribution & Logistics Management	Oloruntoba and Gray	Customer service in emergency relief chains				x				x
2009	Management Research News	Whiting and Ayal-Öström	Advocacy to promote logistics in humanitarian aid				x				x
2009	Supply Chain Management: An International Journal	Maon et al.	Developing supply chains in disaster relief operations through cross-sector socially oriented collaborations: a theoretical model			x					x
2009	International Journal of Physical Distribution & Logistics Management	Pettit and Beresford	Critical success factors in the context of humanitarian aid supply chains			x					x
2010	IFIP Advanced in Information and Communication Technology (Book chapter)	de Leeuw	Towards a reference mission map for performance measurement in humanitarian supply chains			x			x		
2010	International Journal of Physical Distribution & Logistics Management	Blecken	Supply chain process modelling for humanitarian organizations					x		x	
2010	Journal of Manufacturing Technology Management	Chandes and Pache	Investigating humanitarian logistics Issues: from operations management to strategic action				x				x
2010	International Journal of Physical Distribution & Logistics Management	Scholten et al.	(Le)agility in humanitarian aid (NGO) supply chains			x					x
2010	Production and Operations Management	Salmeron and Apte	Stochastic Optimization for Natural Disaster Asset Prepositioning		x						x
2010	International Journal Production Economics	Gatignon et al.	The Yogyakarta earthquake: Humanitarian relief through IFRC´s decentralized supply chain			x			x		

2010	Supply chain Forum An International Journal	Kovacs and Tatham	What is special about a humanitarian logistician? A survey of logistic skills and performance			x					x
2010	IFIP - International Federation for Information Processing	Rongier et al.	Towards a performance measurement system to control disaster response			x				x	
2010	International Journal Production Economics	Egan	Private goods and services contracts: Increased emergency response capacity or increased vulnerability?			x					x
2010	Journal of Contingencies and Crisis Management	Abrahmsson et al.	Towards a system-oriented framework for analysing and evaluating emergency response			x					x
2010	International Journal of Physical Distribution & Logistics Management	Ertem et al.	Multiple-buyer procurement auctions framework for humanitarian supply chain management	x					x		
2010	International Journal Production Economics	Oloruntoba	An Analysis of the Cyclone Larry Emergency Relief Chain: some key success factors			x					x
2011	Supply Chain Management: An International Journal	Wild and Zhou	Ethical procurment strategies for international aid non-government organisations					x			x
2011	Book chapter	Tatham and Hughes	Humanitarian logistics indicators				x			x	
2011	International Journal of public administration	Rietjens et al.	Measuring the immeasurable? The effects-based approach in comprehensive peace operations			x				x	
2011	Journal of Network and Computer Applications	Yang et al.	Hybrid Zigbee RFID sensor network for humanitarian logistics centre management			x					x
2011	Logistics Operations and Management (book chapter)	Nikbakhsh and Zanjirani Farahani	Humanitarian logistics planning in disaster relief operations				x				x
2011	Journal Global Optimization	Vitoriano et al.	A multi-criteria optimization model for humanitarian aid distribution		x						x
2011	Annals of Operations Research	Medina-Borja and Triantis	Modeling services performance: a four-stage DEA approach to evaluate fundraising efficiency, capacity building, service quality, and effectiveness in the nonprofit sector	x					x		
2012	Transportation Research Part A	Quiang and Nagurney	A bi-criteria indicator to assess supply chain network performance for critical needs under capacity and demand disruptions		x				x		
2012	Omega	Liang et al.	An option contract pricing model of relief material supply chain		x						x
2012	Transportation Research A	Holguin-Veras et al.	Comparative performance of alternative humanitarian logistic structures after the Port-au-Prince earthquake; ACEs,PIEs, and CANs					x			x

2012	International Journal of Production Economics	Heaslip et al.	Employing a system-based perspective to the identification of inter-relationships within humanitarian logistics	x							x
2012	International Transactions in Operational Research	Nagurney and Quiang	Fragile networks: identifying vulnerabilities and synergies in an uncertain age		x				x		
2012	Socio-Economic Planning Sciences	Lin et al.	Location of temporary depots to facilitate relief operations after an Earthquake		x						x
2012	Socio-Economic Planning Sciences	Lodree Jr. Et al.	Pre-positioning hurricane supplies in a commercial supply chain		x						x
2012	British Journal of Surgery	Leow et al.	Mass casualty incident training in a resource-limited environment					x			x
2012	Accident Analysis and Prevention	Parlak et al.	Population behavioural scenarios influencing radiological disaster preparedness and planning					x			x
2012	Transportation Research Part E	Huang et al.	Models for relief routing: Equity, efficiency and efficacy		x				x		
2012	Journal of Humanitarian Logistics and Supply Chain Management	Cozzolino et al.	Agile and lean principles in the humanitarian supply chain: The case of the United Nations World Food Programme			x					x

APPENDIX B. INTERVIEW PROTOCOL AT MSF BELGIUM

Beamon (1999)	What is being measured? How frequently is the measurement performed? When and how are the measures re-evaluated?
Neely et al. (1995, 2002 ,2005)	Which performance measures are used? What are they used for? What benefit do they provide Are the measures related to the business units objectives? Are some measures used for benchmarking? Is there any measure that should be discontinued?
Kennerly and Neely (2003)	Does the measure definitely assess what it is supposed to assess? Can the data be promptly communicated and easily understood? Is there any possibility of ambiguity in data interpretation? Is it possible to take actions based on the data? Can the data be analysed quickly enough so that actions can be taken?

APPENDIX C. TECHNICAL SHEET

"Supply Chain Performance Management at MSF "

Key performance indicator	
Title of Kpi	
Purpose	
Relates to	
Target	
Formula	
Frequency	
Who measures?	
Source of data	
Who acts on the data?	
What do they do	
Is it valuable or useless?	
Comments	

APPENDIX D. QUESTIONNAIRE AT MSF BELGIUM

1) What is your job title?

2) How long have you been working for your organization?

3) Gender

4) What type of supply is your organization managing?

- ☐ Communications: radio, phones, internet, etc.
- ☐ Transports: trucks, cars, planes, cargo, horses, etc.
- ☐ Sources of energy: fuel, batteries, etc.
- ☐ Accommodation or quartering
- ☐ Hygiene: water and sanitation
- ☐ Procurement: material, food, etc.
- ☐ Storage: warehousing and handling
- ☐ Shipment: staff, food, special fittings, handling material, etc.
- ☐ Education: seminars
- ☐ Health: medicine
- ☐ Other, please specify _____

5) What is your yearly budget which you manage and control for

a) Humanitarian relief
- ☐ None
- ☐ < 1,000 USD
- ☐ < 2,500 USD
- ☐ < 5,000 USD
- ☐ > 10,000 USD
- ☐ > 50,000 USD
- ☐ < 90,000 USD
- ☐ > 100,000 USD
- ☐ > 500,000 USD
- ☐ > 2,000,000 USD
- ☐ Don´t know

b) Humanitarian logistics
- ☐ None
- ☐ < 1,000 USD
- ☐ < 2,500 USD
- ☐ < 5,000 USD
- ☐ > 10,000 USD
- ☐ > 50,000 USD
- ☐ < 90,000 USD
- ☐ > 100,000 USD
- ☐ > 500,000 USD
- ☐ Don´t know

6) What is the estimated number of beneficiaries that your organization attends to?
- ☐ Less than 2000
- ☐ Between 2000 and 10 000
- ☐ Between 10 000 and 25 000
- ☐ Between 25 000 and 75 000
- ☐ Between 75 000 and 125 000
- ☐ More than 130 000
- ☐ Don´t know

7) Please indicate the degree of logistics outsourcing in your organization.

8) a) Please indicate the proportion of employees in your organization.

White collar-worker	%	Blue collar-worker	%
Field		Field	
Country		Country	
Region		Region	
Headquarter		Headquarter	

b) For which country (ies)

9) How do you define a humanitarian supply chain?

10) In case of disaster who are the supply chain actor in the process of supplying relief items?

11) What Objectives are central for your supply chain?

12) What decisions or actions are keys to these objectives?

13) How do you measure the success and goals of your supply chain?

14) Please asses the key performance indicator in your organization by allocation 100 points on each item.
0 point= no usage/irrelevant 100 points= high usage/extremely relevant

- Human resources indicator (e.g. total number of staff working hours)
- Financial indicator (e.g. supply chain costs)
- Process indicator (e.g. purchase order or number of stocks)
- Innovation indicator (e.g. implementation of ICT systems or supply chain concepts)
- Risk indicator (e.g. volatility index)
- Beneficiaries indicator (e.g. persons, location, countries served with aid)

15) How many information systems are used in the process of supplying aid to beneficiaries?

16) How many information systems are used in the process for capturing data?

17) Are the involved information systems interoperable?

a) If yes, what makes them interoperable?

b) If no, what can improve their interoperability?

18) Which of following key performance indicators have been captured in your organization?

Objectives	**Key performance indicators**	**X**
Responsiveness/ Speed	Minimum response time	
	Percentage of products that were delivered within promised lead time	
	Delivery date reliability	
	Donation-to-delivery Time	
Achievement of Objectives	Realised service level	
	Degree of service	
Beneficiaries and Donors Satisfaction	Confirmation rate of customer's desired delivery date	
	Complaint rate	
Reliability	Delivery date reliability	
	Delivery reliability	

	Complaint rate	
Flexibility	Number of individual units of Tier 1 supplies that an organization can provide in time period	
	Mix of different types of supplies that the relief chain can provide in a specified time period	
	Number of individual units of Tier 1 supplies that an organization can provide in time period	
Inventory Performance	Accuracy of stock records	
	Stock efficacy	
	Mean costs per incoming goods item	
	Mean quality inspection costs per incoming goods item	
	Evaluated turnover rate	
Bottleneck Management	Delivery quality reliability (Procurement)	
	Delivery quantity reliability (Procurement)	
	Delivery date reliability (Procurement)	
Cooperation	Framework agreement quota	
	Number of suppliers/logistic service providers	
	Number of externally sources articles	
	Information exchange quota	
	Order/setup costs	
	Inventory holding costs	
	Cost of Supplies	
	Number of relief workers employed per aid recipient	
	Number of "value added" hours (the number of direct hours spent on dispending aid per total number labour hours)	
	Dollars spent per aid recipient	
	Donor dollars received per time period	
	Evaluated turnover rate (distribution)	
	Mean costs for distribution activities per order-picking item	
	Mean costs of transport per goods consignment	
Standardization	Degree of standardization	
Innovation	Degree of investments in trainings	
	Degree of investments in information systems	
	Quota of supported processes by information systems	
Costs Efficiency	Total cost (of resources used)	
	Total Cost of distribution (including transportation and handling cost)	
	Inventory investment (the investment value of held inventory)	
	Inventory obsolescence (and spoilage)	
Other		
Other		

19) Which measures have to be captured in your supply chain? (Qualitative and Quantitative)

20) Who should use the PMS?

21) How should be the performance measurement be designed?

22) Please tell us your evaluation for following questions.

a) Please tell us your assessment to the following aspects of the PMS in your humanitarian organization. Our PMS …

	to a great extent		➔	not at all		Don´t know
	1	**2**	**3**	**4**	**5**	
…has a great value for our management						
…has a very high acceptance from our employees						
…has a very high acceptance from our stakeholder (e.g. donor)						
…is of central importance for our performance						

b) How familiar is your organization with the PMS in supply chains?

I use our PMS very often						
I have a detailed substantive understanding of our PMS						
I have a detailed understanding of the costs which are linked to the construction and maintenance of our PMS						

c) To what extent do you agree on the following statements about multidimensionality of your PMS? Our PMS …

	to a great extent		➔	not at all		Don´t know
	1	**2**	**3**	**4**	**5**	
…doesn't only consists of financial ratios but also measures performance and success along several dimensions (e.g. process, beneficiaries and innovation ratios)						
... ensures that all areas that are relevant for the humanitarian aid success are considered						
... offers a bride spectrum of ratios (e.g. financial and non-financial, internal and external, early and late indicators)						

d) To what extent do you agree on the following statements of the combination of strategy and operative humanitarian relief in your PMS? Our PMS …

	to a great extent		➔	not at all		Don´t know
	1	**2**	**3**	**4**	**5**	
... creates causal connections between value drivers on operative level and output quantity on strategic level						

… connects all (operational) activities with the achievement of targets of the entire organization						
… shows how the humanitarian operation relief activity of one organization unit can influence the entire organization						
… ensures the compatibility of personal performance targets and appeals with the overall strategy of the company						

e) To what extent do you agree on the following statements on focusing your PMS on relevant information? Our PMS …

	to a great extent		→	not at all		Don´t know
	1	**2**	**3**	**4**	**5**	
… concentrates on relevant information to success and performance measurement on basis of chosen ratios						
… creates strongly compacted and focused performance and success ratios on higher hierarchical levels of the organization						
… doesn't try to generate as many measure values as possible but to priorize the most important ratios						
… has the right detail level for the requirements of different user groups						

f) To what extent do you agree on the following statements of timely availability of information in your PMS? Our PMS …

	to a great extent		→	not at all		Don´t know
	1	**2**	**3**	**4**	**5**	
… ensures that ratios for the operative daily activities are measured more often than results ratios						
… ensures that information for the performance and success measurement are available continuous and on time						
… makes a quick reaction between the performance measurement and the der correcting measures followed by them possible						

g) To what extent do you agree on the following statements on connections across non-profit organizations of your PMS? Our PMS …

	to a great extent		➔	not at all		Don´t know
	1	**2**	**3**	**4**	**5**	
… gives us measurement categories which connect our intern activities with those of our partners in the supply chain (donors, beneficiaries, suppliers, cooperation partners)						
… shows the connection of our success with beneficiaries, donor (e.g. efficiency) and (sub-) suppliers (e.g. cost savings in processes)						
…creates transparency regarding performance and success dependency between the different participants in the humanitarian supply chain						
… integrates extern orientated ratios (e.g. quality of operations relief or performance of sub suppliers)						
… ensures a compatibility of ratios with those of our humanitarian supply chain partners						
... supports the coordination with our humanitarian supply chain partners						

h) To what extent do you agree on the following statements on the adaptability of your PMS? Our PMS…

	to a great extent		➔	not at all		Don´t know
	1	**2**	**3**	**4**	**5**	
… can be adapted easily in case of new knowledge or additional requirements						
… is able to react flexible on new requirements or situations						
… can be adapted easily to our standard solution in contrast to our specific humanitarian aid requirements						

i) To what extent do you agree on the following statements on the kind of use of your PMS? Our management uses our PMS …

	to a great extent		➔	not at all		Don´t know
	1	**2**	**3**	**4**	**5**	
… to track the progress in gaining our targets						

… to control central humanitarian operations indicators						
… to monitor results, efficiency						
… to compare results with expectations						
… to bring the organization on a common line						
… to enable our organization to concentrate on the critical success factors						
… to create an uniform understanding in the organization for the humanitarian aid targets						
… to encourage discussions in meetings between executives and employees and between colleagues and donors						
… to make strategic decisions if a quick reaction is necessary						
… to make decisions when there is an unclear problem that has never appeared before						
… to make decisions when there was a similar problem in the recent past						
… to anticipate the future adjustment of the organization instead of just reacting to given problems						
… to be able to make final decisions in every case with high strategic importance						

j) How do you evaluate performance of your organization in service quality compared to your competitors?

	to a great extent		➔	not at all		Don´t know
	1	2	3	4	5	
The permanent fulfilling of the contracted delivery dates and amounts						
The ability to concentrate on customer wishes and needs						
The part of deliveries with missing/ wrong/ damaged products						
The observance of beneficiaries' specifications						
Your overall evaluation how the performance fulfills the expectations of your internal and external customers						

23) What is your reflection on these questions?

APPENDIX E. ANALYTICAL HIERARCHY PROCESS QUESTIONNAIRE AT MSF BELGIUM

Working instructions:

Please compare which performance measurement indicators have to be esteemed important. Please use following rating scale:

1 = Equally important

3 = Moderately important

5 = Strongly important

7 = Very strongly important

9 = Extremely important

Please do not leave anything blank!

For example 1):

When you consider the supply chain area **procurement** *which performance measurement indicator is ……important than the other performance measurement indicator at* ***capital*** *level?*

Performance measurement indicator	Extremely important	Very strongly important	Strongly important	Moderately important	Equally important	Moderately important	Strongly important	Very strongly important	Extremely important	Performance measurement indicator
	9	7	5	3	1	3	5	7	9	
Actual capacity to planned capacity (human resources)							X			Donations per (project/country)

Meaning: *donations per project/ country is strongly important than actual capacity to planned capacity (human resources)*

For example 2):

Performance measurement indicator	Extremely important	Very strongly important	Strongly important	Moderately important	Equally important	Moderately important	Strongly important	Very strongly important	Extremely important	Performance measurement indicator
	9	7	5	3	1	3	5	7	9	
Donations per (project/country)		x								Validation delay

Meaning: *Meaning Validation delay is strongly important than donations per project/ country.*

APPENDIX F. QUESTIONNARE DURING SUPPLY SEMINAR AT MSF BELGIUM

For this interview/survey, the term Supply Chain Management (SCM) includes procurement and logistics, including warehousing and inventory management, and excludes fleet management. Please keep this in mind as you answer the questions.

- The term "big project" refers to projects whose budgets exceed $1M over the life of the project.
- Data should be from 2014 unless otherwise stated.
- Financial numbers should be listed in USD.
- Please provide an organigram for each country at a level which shows where SCM reports in.

OVERVIEW – SECTION 1. Country "numbers"

	Country 1	**Country 2**	**Country 3**
2014 est. number of direct beneficiaries served			
2014 est. number of indirect beneficiaries served			
Total country budget in USD (the most recently amended budget)			
Percentage of country budget allocated to Emergency Response			
Name of department into which SCM reports			
Percentage of country budget allocated to SCM			
Number of Implementing Partners (IPs)			
Number of SCM IPs			
Number of Projects			
Number of big Projects			
Types of items used/distributed:			
In kind commodities			
Locally sourced commodities			
Globally sourced commodities			
MSF OCB STAFF			
Total current number of staff (Existing and occupied positions)			
Total current number of vacant posts (Existing vacant plus New-vacant)			
Turnover of staff (number of posts vacated in 2013)			
Current number of SCM staff			

Current number of vacant SCM posts			
Number of SCM posts vacated in 2013			
MSF NATIONAL STAFF			
Total current number of National Staff			
Total current number of vacant National posts			
Number of National posts vacated in 2013			
Current number of National SCM staff			
Current number of vacant Nat'l SCM posts			
Number of National SCM posts vacated in 2013			

OVERVIEW – SECTION 2.

Country program and SCM detail. Please fill in for each country.

Country	
Major donors	
Changes in donor requirements (over the last 3 years) e.g increased use of local purchasing, changes in reporting requirements or in procurement guidelines.	
Recent program trends – 2010 to 2014 (growth, funders, objectives, nature of activities)	
Expected future program trends – 2014 to 2020 (growth, funders, objectives, nature of activities)	
Supply Chain Management	
SCM trends (stocks, in kind vs local markets, objectives, nature of activities)	
SCM Strategic initiatives underway	
Role of MSF in the supply chain (prime contractor?, activities)	
Role of local government in the supply chain	
Role of SCM Implementing Partners (IPs)	
Trends in use of local markets (current split of in kind vs locally purchased food, transport, non-food commodities)	
SCM Information and IT	
Type of SCM information system used by MSF & activities covered	
SCM IT Strategic initiatives that are underway	
Types of reports currently used by MSF to monitor SCM (check all that apply)	
Procurement plan	
Asset report (vehicles, telecom, computer equipment, etc.)	
Inventory report	

Audit report	
Other (list)	
Types of SCM information passed from IPs to MSF *electronically*	
Types of SCM information passed from IPs to MSF *using paper forms*	
Percentage of MSF/IP operating locations with acceptable mobile phone coverage	
Percentage of MSF/IP operating locations with acceptable internet coverage	

OVERVIEW – SECTION 3. Please provide background on 1 to 3 big projects from each country. We will focus on these projects when we conduct our interviews.**3a. Project Information**

COUNTRY_____

	Project 1	**Project 2**	**Project 3**
Number of direct beneficiaries served			
Number of indirect beneficiaries served			
Donor			
Project location(s)			
Objectives/activities			
Measures of project/ programme success			
Trends (growth, change in activities, change in donor requirements)			
Project budget			
Percentage of project budget allocated to Emergency Response			
Strategic importance of project to MSF			
Biggest programme challenges			
Year started			
Term of current contract e.g. 2012-2014			
Which organization is the prime contractor?			
Current number of MSF staff			
Current number of open MSF posts			
Total number of Implementing Partners (IPs)			
Number of SCM IPs			
Role of local government/ministries			
Types of items used/distributed:			
In kind commodities			
Locally sourced commodities			
Globally sourced commodities			

Type of supply chain (choose one): Rapid Response - <2mos Short Term – 2-6 mos Long Term - >6 mos			
Biggest SCM Challenges			
- Specific to your circumstances, geography, seasonality			
-Others, e.g. lack of priorities placed on SCM			
Who executes SCM activities (donor, program, MSF SCM, IP, private sector, no one)?			
Forecasting need			
Procurement to prepositioned stock			
Procurement of non-pre-positioned program items			
Transport of items			
Warehousing			
Distribution to beneficiaries			
Disposition of excess or expired materials			
Reporting of stocks on hand			
Reporting of quantities used			
Reporting of quantities distributed			

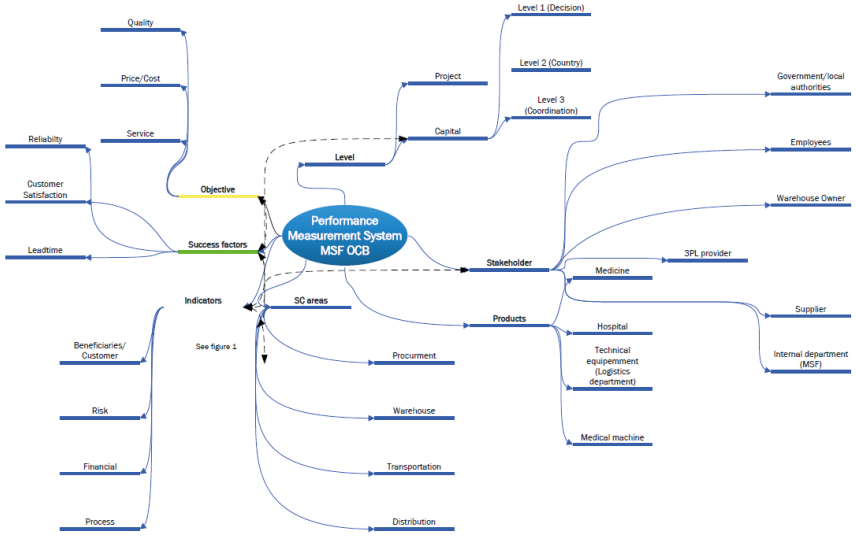
3b. Qualitative Questions (answer for each country):

1. What are the key elements that currently define Value for Money for your projects?
2. What additional elements that define Value for Money should be added?
3. What is important to Programme with regard to supply chains for these projects, and how is it changing?
4. What supply chain design features do you think are most important to meet goals of the project? Why are these the most important features? What is their impact on Programme?
5. Is SCM involved in the planning stages of the project? If not, at what stage of the projects does SCM become involved?
6. How well are your IT systems currently capable of providing the information to track supply chain performance?
7. What would use of a common set of KPIs for SCM across MSF mean for your projects? How would use of a common set of SCM KPIs for the humanitarian sector help your projects?
8. What SC design features do you think are most important to meet goals of the project?“
9. Please list 5 key challenges for your project, ranked from 1 (the most critical of the list) to 5 (the least critical of the list.)
10. Please list 5 key challenges for your supply chain, ranked from 1 (the most critical of the list) to 5 (the least critical of the list.)
11. What would having a common set of supply chain KPIs mean for your projects?

APPENDIX G. WORKSHOP QUESTIONNAIRE AT MSF BELGIUM

Example Indicators	Purpose	Formula	How do we operationalize this kpi?	Can we make a target?	What is an appropriate survey period?	Reg Vs Emergency	Efficiency/ Effectivenes	Note
Headquarter Level / Procurement								
Delivery Lead Time reliability	It expresses Actual delivery Vs Requested delivery	Lead time international procurement (1 month late /1 week late/ 1 week in advance / 1 month in advance No of shipments not delivered in time/total no of delievered items* 100						
		Lead time national procurement (1 month late /1 week late/ 1 week in advance / 1 month in advance No of shipments not delivered in time/total no of delievered items* 100						
Demand accuracy	Measures accurate and timely demand plan	Forecast accuracy: financial value of orders matching with a forecast						
		Demand planning accuracy: to dig…						
		RDD coherent with Agreed Lead time: % of RDD < ALT - 1 week						

APPENDIX H. MIND-MAP AT MSF BELGIUM



APPENDIX I. QUESTIONNAIRE RESEARCH STUDY FOURTH-PARTY HUMANITARIAN LOGISTICS

Questionnaire research study

"Fourth-Party Humanitarian Logistics"

Fourth party logistics business is an extension of third party logistics business. Then the differentiation between the third party logistics and fourth party logistics is the involvement of supply chain management and supply chain integration. This includes the management and integration of several organizations in the supply chain and extended the tasks to the company borders of the customer. The Objective is to establish complete supply chain solution. The fourth party logistics provider monitor the performance and present it to the customer, this includes measurable indicators such as delivery quality, delivery flexibility and delivery reliability. The fourth party logistics provider has to ensure the fulfillment of performance efficiency. The fourth party logistics provider is an enabler; the capabilities encompass a suitable logistics network, IT services and support, process design, information and material flow coordination between the customers, execution of business service such as procurement, distribution, warehousing, and different value added services as well as service and carbon emission monitoring

Objectives of the research study:

- Identification and verification of essential criteria for a fourth party logistics provider in humanitarian logistics
- Development of humanitarian logistics concepts
- Elaboration of coordination and cooperation possibilities in the humanitarian logistics sector

Working instructions:

- The time exposure for filling in is approx. 20 minutes
- The data collected will be dealt with in strict confidence and used exclusively for scientific research purposes. The data will be analyzed anonymously.

The first category is **'architect/integrator'**, which means that the 4PL provider has the competences to design and redesign a supply chain and has the needed skills to lead projects and to manage stakeholders. The second core component is called the '**decision maker/control room**'. This means that a 4PL provider supports as a decision maker to manage the operations including management of 3PL providers and the development of specific logistics concepts for clients. The third core component is **'supply chain infomediary'** and deals with IT system integration, IT infrastructure provision, real-time data capture, convert data to information, provide info to point of need and technical support. This component enables seamless integration of information across supply chains. The fourth core component is '**resource providers**' focusing at asset management of a 4PL provider.

Architect/Integrator

When you consider the 4PL component architect integrator room *which 4PL factor is ……important than the other 4PL factor in humanitarian supply chain?*

	9	7	5	3	1	3	5	7	9	
Comprehensive services										Management of multiple 3PL provider
Comprehensive services										Project management
Comprehensive services										Stakeholder management
Comprehensive services										Supply chain redesigner
Comprehensive services										Supporting in mitigating risks
Comprehensive services										Management of multiple 3PL provider
Continous innovation										Project management
Continous innovation										Stakeholder management

Continous innovation										Supply chain redesigner
Continous innovation										Supporting in mitigating risks
Continous innovation										Management of multiple 3PL provider
Management of multiple 3PL provider										Project management
Management of multiple 3PL provider										Stakeholder management
Management of multiple 3PL provider										Supply chain redesigner
Management of multiple 3PL provider										Supporting in mitigating risks
Project management										Stakeholder management
Project management										Supply chain redesigner
Project management										Supporting in mitigating risks
Stakeholder management										Supply chain redesigner
Stakeholder management										Supporting in mitigating risks
Supply chain redesigner										Supporting in mitigating risks

Decision maker/Control room

When you consider the 4PL component decision maker/control room which 4PL factor is ……important than the other 4PL factor in humanitarian supply chain?

	9	7	5	3	1	3	5	7	9	
Coordination of In Kind donation										Establishment of performance measurement system
Coordination of In Kind donation										Establishment of a quality management
Coordination of In Kind donation										Experienced logistician
Coordination of In Kind donation										Improve communication
Establishment of performance measurement system										Establishment of a quality management
Establishment of performance measurement system										Experienced logistician
Establishment of performance measurement system										Improve communication
Establishment of a quality management										Expereinced logistician
Establishment of a quality management										Improve communication

Supply chain Infomediary

When you consider the 4PL component supply chain infomediary room *which 4PL factor is ……important than the other 4PL factor in humanitarian supply chain?*

	9	7	5	3	1	3	5	7	9	
Improve communication between actor										IT system integration
Improve communication between actor										System and information integrator
Improve communication between actor										Technical support
IT system integration										System and information integrator
IT system integration										Technical support
System and information integrator										Technical support

Resource provider										
When you consider the 4PL component integrator room *which 4PL factor is ……important than the other 4PL factor in humanitarian supply chain?*										
	9	7	5	3	1	3	5	7	9	
Negotiation contracts with fuel provider										Negotiation freight and storage contracts
Negotiation contracts with fuel provider										Procurement and co-packing service
Negotiation contracts with fuel provider										Transportation and warehouse asset provider
Negotiation freight and storage contracts										Procurement and co-packing service
Negotiation freight and storage contracts										Transportation and warehouse asset provider
Procurement and co-packing service										Transportation and warehouse asset provider
		Thank you for your support								

APPENDIX J. PAIR WISE COMPARISON MATRICES OF INDIVIDUAL CRITERIA BY CATEGORIES (FROM ANP STEP 3)

Strategic criteria	**INF**	**INV**	**LTE**	**IT**	**NTW**	**e-vector**	**Normalized e-vector**
Information exchange (INF)	1	2	3	4	6	0.790	0.422
Inventory turnover (INV)	1/2	1	2	3	4	0.482	0.257
Long-term engagement (LTE)	1/3	1/2	1	2	4	0.310	0.166
IT capability (IT)	1/4	1/3	1/2	1	3	0.195	0.104
Network (NTW)	1/6	1/4	1/4	1/3	1	0.096	0.051
Consistency Ratio	0.026						
Organizational criteria	**TR**	**KH**	**CF**	**CMN**	**FB**	**e-vector**	**Normalized e-vector**
Trust (TR)	1	3	4	4	6	0.851	0.475
Know-how (KH)	1/3	1	2	3	4	0.411	0.229
Cultural fit (CF)	1/4	1/2	1	2	3	0.255	0.142
Communication (CMN)	1/4	1/3	1/2	1	3	0.182	0.102
Family business (FB)	1/6	1/4	1/3	1/3	1	0.094	0.052
Consistency Ratio	0.038						
Financial criteria	**CST**	**FST**	**REV**	**SAL**		**e-vector**	**Normalized e-vector**
Costs (CST)	1	2	4	6		0.794	0.483
Financial stability (FST)	1/2	1	5	5		0.573	0.349
Revenue sharing(REV)	1/4	1/5	1	2		0.170	0.103
Sales (SAL)	1/6	1/5	1/2	1		0.107	0.065
Consistency Ratio	0.040						
Operational Performance criteria	**SER**	**QLT**	**DLV**	**GRW**		**e-vector**	**Normalized e-vector**
Service (SER)	1	2	3	6		0.811	0.476
Quality (QLT)	1/2	1	2	5		0.492	0.289
Delivery (DLV)	1/3	1/2	1	4		0.299	0.176
Growth (GRW)	1/6	1/5	1/4	1		0.101	0.059
Consistency Ratio	0.025						

APPENDIX K. PAIR WISE COMPARISON MATRICES FOR INTERDEPENDENCIES (FROM ANP STEP 4)

INF as dependent	**INV**	**LTE**	**IT**	**NTW**	**e-vector**	**Normalized e-vector**
Inventory turnover (INV)	1	1/6	1/4	1/2	0.083	0.047
Long-term engagement (LTE)	6	1	4	3	0.711	0.402
IT capability (IT)	4	1/4	1	2	0.410	0.232
Network (NTW)	2	1/3	1/2	1	0.566	0.320
Consistency Ratio	0.271					
INV as dependent	**INF**	**LTE**	**IT**	**NTW**	**e-vector**	**Normalized e-vector**
Information exchange (INF)	1	5	4	1/2	0.699	0.384
Long-term engagement (LTE)	1/5	1	1/2	1/4	0.126	0.069
IT capability (IT)	1/4	2	1	3	0.485	0.266
Network (NTW)	2	4	1/3	1	0.511	0.281
Consistency Ratio	0.340					
LTE as dependent	**INF**	**INV**	**IT**	**NTW**	**e-vector**	**Normalized e-vector**
Information exchange (INF)	1	1/5	1/4	2	0.177	0.109
Inventory turnover (INV)	5	1	3	4	0.867	0.533
IT capability (IT)	4	1/3	1	3	0.443	0.272
Network (NTW)	1/2	1/4	1/3	1	0.141	0.087
Consistency Ratio	0.077					
IT as dependent	**INF**	**INV**	**LTE**	**NTW**	**e-vector**	**Normalized e-vector**
Information exchange (INF)	1	1/3	1/4	3	0.235	0.140
Inventory turnover (INV)	3	1	1/2	4	0.510	0.303
Long-term engagement (LTE)	4	2	1	5	0.819	0.487
Network (NTW)	1/3	1/4	1/5	1	0.119	0.071
Consistency Ratio	0.071					
NTW as dependent	**INF**	**INV**	**LTE**	**IT**	**e-vector**	**Normalized e-vector**
Information exchange (INF)	1	1/2	4	5	0.532	0.325
Inventory turnover (INV)	2	1	5	6	0.821	0.501
Long-term engagement (LTE)	1/4	1/5	1	1/3	0.110	0.067
IT capability (IT)	1/5	1/6	3	1	0.176	0.107
Consistency Ratio	0.094					
TR as dependent	**KH**	**CF**	**CMN**	**FB**	**e-vector**	**Normalized e-vector**
Know-how (KH)	1	1/5	1/6	2	0.188	0.109
Cultural fit (CF)	5	1	1/2	3	0.565	0.327
Communication (CMN)	6	2	1	2	0.779	0.451
Family Business (FB)	1/2	1/3	1/2	1	0.197	0.114
Consistency Ratio	0.150					
KH as dependent	**TR**	**CF**	**CMN**	**FB**	**e-vector**	**Normalized e-vector**
Trust (TR)	1	1/3	2	1/3	0.291	0.151
Cultural fit (CF)	3	1	1/3	1/2	0.661	0.343
Communication (CMN)	1/2	3	1	2	0.438	0.228
Family Business (FB)	3	2	1/2	1	0.535	0.278

Consistency Ratio	0.277					
CF as dependent	**TR**	**KH**	**CMN**	**FB**	**e-vector**	**Normalized e-vector**
Trust (TR)	1	3	1/4	1/6	0.181	0.111
Know-how (KH)	1/3	1	1/5	1/5	0.103	0.063
Communication (CMN)	4	5	1	1/2	0.519	0.318
Family Business (FB)	6	5	2	1	0.829	0.508
Consistency Ratio	0.069					
CMN as dependent	**TR**	**KH**	**CF**	**FB**	**e-vector**	**Normalized e-vector**
Trust (TR)	1	5	2	3	0.796	0.459
Know-how (KH)	1/5	1	1/4	1/6	0.106	0.061
Cultural fit (CF)	1/2	4	1	2	0.478	0.276
Family Business (FB)	1/3	6	1/2	1	0.355	0.205
Consistency Ratio	0.077					
FB as dependent	**TR**	**KH**	**CF**	**CMN**	**e-vector**	**Normalized e-vector**
Trust (TR)	1	4	1/3	1/2	0.3	0.176
Know-how (KH)	1/4	1	1/6	1/5	0.101	0.059
Cultural fit (CF)	3	6	1	2	0.811	0.476
Communication (CMN)	2	5	1/2	1	0.492	0.289
Consistency Ratio	0.026					
CST as dependent	**FST**	**REV**	**SAL**		**e-vector**	**Normalized e-vector**
Financial Stability (FST)	1	1/6	1/4		0.121	0.085
Revenue sharing(REV)	6	1	3		0.915	0.644
Sales (SAL)	4	1/3	1		0.384	0.270
Consistency Ratio	0.046					
FST as dependent	**CST**	**REV**	**SAL**		**e-vector**	**Normalized e-vector**
Costs (CST)	1	1/4	1/6		0.106	0.079
Revenue sharing(REV)	4	1	1/5		0.285	0.212
Sales (SAL)	6	5	1		0.953	0.709
Consistency Ratio	0.139					
REV as dependent	**CST**	**FST**	**SAL**		**e-vector**	**Normalized e-vector**
Costs (CST)	1	4	1/5		0.272	0.205
Financial Stability (FST)	1/4	1	1/7		0.096	0.072
Sales (SAL)	5	7	1		0.958	0.722
Consistency Ratio	0.104					
SAL as dependent	CST	FST	REV		e-vector	Normalized e-vector
Costs (CST)	1	6	1/3		0.478	0.323
Financial Stability (FST)	1/6	1	1/4		0.132	0.089
Revenue sharing(REV)	3	4	1		0.868	0.587
Consistency Ratio	0.224					
SER as dependent	**QLT**	**DLV**	**GRW**		**e-vector**	**Normalized e-vector**
Quality (QLT)	1	1/4	5		0.333	0.244
Delivery (DLV)	4	1	7		0.938	0.687
Growth (GRW)	1/5	1/7	1		0.095	0.070

Consistency Ratio	0.110				
QLT as dependent	**SER**	**DLV**	**GRW**	**e-vector**	**Normalized e-vector**
Service (SER)	1	1/3	5	0.410	0.288
Delivery (DLV)	3	1	6	0.905	0.635
Growth (GRW)	1/5	1/6	1	0.111	0.078
Consistency Ratio	0.081				
DLV as dependent	**SER**	**QLT**	**GRW**	**e-vector**	**Normalized e-vector**
Service (SER)	1	4	8	0.956	0.717
Quality (QLT)	1/4	1	3	0.274	0.205
Growth (GRW)	1/8	1/3	1	0.104	0.078
Consistency Ratio	0.014				
GRW as dependent	**SER**	**QLT**	**DLV**	**e-vector**	**Normalized e-vector**
Service (SER)	1	5	4	0.947	0.683
Quality (QLT)	1/5	1	1/2	0.162	0.117
Delivery (DLV)	1/4	2	1	0.277	0.200
Consistency Ratio	0.022				

APPENDIX L. QUESTIONNAIRE PARTNER EVALUATION CRITERIA FOR HORIZONTAL COOPERATION AMONG LSPS

Research study

"Partner Evaluation Criteria for Horizontal Cooperation among Logistics Service Providers "

Objectives of the research study:

- Identification and verification of essential criteria for partner evaluation criteria for horizontal cooperation among Logistics Service Providers (LSPs)
- Development of a framework that is capable of supporting decision making in both the monitoring and evaluation of partners within horizontal cooperation among LSPs.
- Elaboration of challenges in this field

Working instructions:

- The time exposure for an Interview is approx. 35 minutes
- The data collected will be dealt with in strict confidence and used exclusively for scientific research purposes. The data will be analyzed anonymously.

24) Do you use an LSP partner evaluation framework?

25) How do you evaluate LSP partner within your network?

26) Could you evaluate five partners of your logistics network using rank 1 (best) to 5?

(1)

(2)

(3)

(4)

(5)

27) Please evaluate the performance of the following partners (*anonimised*) using a scale from 1 (very poor) to 9 (exceptional).

Category	**Criterion**	**Partner**				
		1	**2**	**3**	**4**	**5**
Strategic (STR)						
Information exchange (INF)	INF					
Inventory turnover (INV)	INV					
Long-term engagement (LTE)	LTE					
IT capability (IT)	IT					
Network (NTW)	NTW					

Organizational (ORG)						
Trust (TR)	TR					
Know-how (KH)	KH					
Cultural fit (CF)	CF					
Communication (CMN)	CMN					
Family business (FB)	FB					
Financial (FIN)						
Costs (CST)	CST					
Financial stability (FST)	FST					
Revenue sharing(REV)	REV					
Sales (SAL)	SAL					
Performance (PRFM)						
Service (SER)	SER					
Quality (QLT)	QLT					
Delivery (DLV)	DLV					
Growth (GRW)	GRW					

28) What is your reflection on these questions?

29) Do you wish results of our research study?

YES ☐ NO ☐

Name:

Address:

Emailadress:

Thank you for your support!

APPENDIX M. INTERVIEW PROTOCOL PARTNER EVALUATION CRITERIA FOR HORIZONTAL COOPERATION AMONG LSPS

Interview

Dear participant,
The information obtained from this interview will contribute to the process of developing a evaluation tool that enables decision-makers to structure the decision-making process regarding the evaluation for LSP partners. The purpose of this interview is to identify important evaluation criteria and discuss their relative importance. This interview also supports putting the criteria into practice. All the information obtained from this interview serves as the input for our evaluation framework and will be handled confidentially.

General Information	
Name:	
Job title:	
Department:	
Main responsibility:	
Your role in agent selection process	

Note: Your name will stay confidential and will NOT appear in any documents

Evaluation Criteria

Open question:	If you are evaluating a partner, which criteria would you add to our ANP model? Please mention 5 of them.
1.	
2.	
3.	
4.	
5.	

Why are the following criteria very important for a partnership among an LSP network ?
Please provide us your feedback on each ranking of following criteria (Table 7 including weights).
Why is an LSP partner evaluation framework important? Please tell us the advantage of such an evaluation framework.
Do you use an LSP partner evaluation framework and how do you evaluate LSP partners?

Hella Abidi completed her training as a forwarding clerk (Speditionskauffrau IHK) at Dachser SE in Cologne. During a stay at Dachser SE in Switzerland, she studied a part-time advanced vocational training as “Verkehrsfachwirtin (IHK)” at the Chamber of Commerce and Industry. Hella Abidi adopted various activities in the department of international transport planning, sales and customer service at Dachser SE in Mannheim and Cologne.

In 2007, she started at the FOM University of Applied Sciences a part-time study program in business science, with the main subjects logistics and supply management. 2010, Hella Abidi finished her Master degree with success. For her thesis she was awarded with the BVL Thesis Award 2010.
2011 - 2015, she worked as a research associate in the BMBF project WiWeLo in line with the excellence cluster LogistikRuhr at the Institute of Logistics & Management Services (ild) of FOM University of Applied Sciences in Essen and as lecturer for logistics at the FOM University of Applied Sciences in Germany.

September 2013, she started her PhD at the VU University Amsterdam. 2015 - 2016 Hella Abidi worked as a lecturer at Nottingham Business School, Nottingham Trent University, Nottingham (UK).

Spring 2016, Hella Abidi restarted as a consultant research & development at Dachser SE in Kempten and as a senior lecturer at FOM University of Applied Sciences in Essen.