IMPROVING THE SUPPLY BASE: A NETWORK ANALYSIS FOR A PROCESS-BASED APPROACH

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PHILIPS

PREFACE

To her… my mom, my best friend and my soul mate.

And to all the beautiful souls that in different ways helped me to move forward during my *thesis life*.

Acknowledgements

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SUMMARY

Situation: Traditionally, research in supply management has focused on the linear relationship between buyer and supplier (e.g. Chan & Chan, 2004; Hokey, 1994; Rezaei & Ortt, 2012; Sheth & Sharma, 1997) and on the technical issues faced in Supply Chain Management (SCM) (Fisher, 1997). The linear perspective is useful to manage the mechanics of the transactions between buyer and suppliers (Kim, Choi, Yan, & Dooley, 2011). On the other hand, the technical perspective focus on the flow of raw materials, information and finances between entities, serving the design and management of efficient and lean supply chains. However, as Kim et al. (2011) and Bellamy and Basole (2013) recognized, both perspectives fail to capture the complex and dynamic nature of supply networks. Therefore, it provides managers tools that are based on nonrealistic assumptions. In consequence, researchers are engaged in providing managers a mental map of the supply networks that reflects its dynamism and complexity (Choi, Dooley, & Rungtusanatham, 2001), by using a network-level perspective in the field of supply management.

Bellamy and Basole (2013) published a pioneer paper that proposes a comprehensive framework that identifies three main themes that have characterized the SN research, namely *Structure*, *Dynamics* and *Policy & Control*. The framework combines the SCM research and the theoretical elements of Network Analysis (NA), integrating the main findings on both fields presenting a more realistic representation of the SN. However, they only identified the main elements that characterize the SN, but do not elaborate on which constructs can be used to analyze the processes related to the management of the supply base. Thus, Bellamy and Basole (2013) recommend using this framework as a conceptual guide in supply management studies and encourage the academia to pursue two main aims: First, to develop constructs for each of the elements identified (Structure, Dynamics and Policy & Control) and secondly, to demonstrate the validity of this conceptual guide in the supply management research.

Thus, this thesis aims to contribute with the efforts to expand the application of network level analysis and enrich the theory in the supply management research. For this reason, this thesis proposes to use the conceptual guide proposed by Bellamy and Basole (2013) and enrich it by an extensive literature review, in order to analyze and design a process to optimize the supply base from a network perspective.

Problem: In this regard, supply management is composed by a set of practices that aim to generate and maintain competitive advantage for the focal firm. One of these practices is called supply base

optimization (Burt, Dobler, & Starling, 2003). Despite its strategic importance, frameworks for carrying out the optimization of the supply base are scarce (Talluri & Narasimhan, 2005). Even worse, the frameworks available fail to illustrate the complexities faced by managers, as they are based on simplistic assumptions. For example, Ogden and Carter (2008) assumed that there is an agreement on how to break down the supply base into manageable subsets at the initial stages. Similarly, Sarkar and Mohapatra (2006) assumed that preexistence of a complex supply base, that all decision makers perceive the supply base as complex and additionally that there is an consensus among decision makers that a reduction of the complexity of the supply base is needed. Scholars in strategic decision-making and decision making in networks would actually challenge such assumptions, arguing that at strategic level, such agreements are never reach through trivial means (De Bruijn & Ten Heuvelhof, 2008; Rouse, 2005). In consequence, it is evident that the process to optimize the supply base has not been analyzed from a network-level perspective, as the frameworks provided by the academia focuses in linear relationships and the mechanics of the transactions between buyer and supplier.

Therefore, this thesis aims to answer the following question:

How to optimize the supply base of a firm with a global footprint considering a network-level perspective?

Approach: The present research aims to answer the question posed above by using two main research methods that are literature review and case studies. First, the literature review provides the theoretical foundation from a network level perspective, by incorporating elements from different theories like Complexity Theory, Complex Adaptive Systems, Decision making in network and Network Analysis. The resulting theoretical framework, which is the output of the literature research, serves as input for the development of the case studies, providing the theoretical foundation for their selection and analysis. The theoretical framework and its rational is presented in Chapter 6.

The second part of this research corresponds to the selection and analysis of the case studies in Royal Philips. The starting point of the selection process of the case studies is the database held by the DfX team, which contains a list of initiatives that aimed to optimize the supply base, among other targets as well. Based on three criterion, the list was reduced from 888 to three initiatives, which were selected for further analysis. The selection criteria are Data Availability, Diversity and Problem Formulation. In order to analyze the case studies, two main data sources were used to collect evidence, namely Initiative documentation available in the intranet of Philips and Interviews. In general, the

collection and analysis of evidence is based on the constructs derived from the theoretical framework presented in Chapter 6 (See Appendix A for further details on the constructs). In consequence, the interviews followed a semi-structure approach based on the constructs previously defined. Finally, Section 8.2 and Section 8.3 presents a within-case analysis and cross-case analysis. The within case analysis presents how one convention deals with the different networks associated with the process. On the other hand, Section 8.3 presents a comparison on how each convention dealt with the different networks identified in Chapter 6 and each of their characteristics.

Results: The **first contribution** of this research is to provide a **new definition of supply base optimization from a network perspective**. Based on the input from the experts and the analysis of documentation of the conventions, the definition of supply base optimization is as follows:

"*Supply base optimization is an ongoing process that aims to have the right number of suppliers with the right capabilities and right performance in order to meet current and future business needs*"

The **second contribution** of this thesis is a **theoretical framework** that serves one main purpose: To **provide guidance to analyze the process to optimize the supply base from a network-level perspective**, providing researchers a more realistic mental map of the supply network to analyze its processes. This framework aims to close the gap highlighted in Section 1.1, as this framework contributes to expand the utilization of a network-level perspective in the domain of supply management by identifying three different networks that play a role in the optimization of the supply base. These three networks are *Organizational Network*, *Supply Base* and *Supply Network.* Additionally, the framework identifies and elaborates on three main elements that characterize each network, namely: Structure, Behavior and Control and Policy. In detail, the elements corresponding to the ***Organizational Network*** are complexity (Structure); Behavior and Interest (Dynamics); and procedures and corporate guidelines (Policy and Control). The elements characterizing the ***Supply Base*** are complexity (Structure); behavior and interest (Dynamics), and Contract and agreements with the focal company (Policy and Control). Finally, the elements that characterize the ***Supply Network*** are self-emergence (Structure), unpredictable behavior (Dynamics) and lack of central control (Policy & Control). The complete explanation about the rationale that lead to these definitions is explained in Chapter 6.

On the other hand, the analysis of the data collected in the firm, namely the interviews and the documentation of each convention, lead us to the **third contribution** of this research, which **is the creation of a process to optimize the supply base**. This process takes a network level perspective and acknowledges the interactions of the different actors at each network. It also takes a process-based approach; therefore, it does not assume that all stakeholders perceive the problem of supply base optimization in the same way and agree on one right solution, reflecting how efforts to consolidate the supply base are executed in the practice. The process created answers the main research question of this thesis, by proposing a process that consists of six rounds that aim to coordinate the different stakeholders and commit the resources to implement and evaluate ideas that are expected to improve the conditions of the supply base. The process is presented in Chapter 8.

Relevance: From the academic standpoint, the **new definition of supply base optimization expands the definition given by Choi and Krause** (2006), as they argue that supply base optimization refers to reduce the complexity of the supply base. This definition is limited to the modification of its structure and neglects the three important aspect of an optimize supply base: 1) The behavior of the suppliers, reflected in their performance. 2) The interaction with the organizational, as the ultimate goal is to meet the business needs. 3) The interaction with the supply network, as this is the window that allows forecasting the future business needs by the analysis of the technological and economic trends. Therefore, it can be concluded that the proposed definition takes a network-level perspective and provides a better insight of the different aspects involved in the supply base optimization

Additionally, thesis provides an **innovative framework to analyze the process involved in supply base optimization from a network-level perspective**, incorporating the learnings and developments achieved in different domains into the study of supply management. It combines elements of diverse theories like Complex Adaptive Systems, Complexity Theory, Decision Making in Networks and Network analysis. Researchers claim that this theories present concepts that are less idealized and more close to reality, therefore it provides models that represents the reality more accurately.

From the managerial point of view, the ***process proposed in Chapter 8 is based on realistic assumptions***; considering a network-level perspective therefore, providing managers guidance on how to optimize the supply base. First, it provides a new approach to address the supply base optimization. The frameworks for supply base optimization available in the literature take a project-based approach. However, this thesis takes a process-based approach that could be relevant for situation when multiple a diverse stakeholders are involved. Secondly, it acknowledges the agency of the actors, presenting a

more realistic design, which provides guidance to managers who want to optimize their supply base, based on assumptions that are closer to reality. Third, it acknowledges the interaction between three networks, illustrating the network-level perspective taken during the analysis. Therefore, it acknowledges that the process develops in a landscape where three different subsets of a network are in constant and inevitable interaction.

Recommendations and future research: The recommendation to the academia in the field of supply management and SCM is to apply methodology used in this research to evaluate other activities related it to supply management. A report elaborated by Procurement Leaders (2017), presented a list of activities that are in the agenda renowned CPOs, some of these activities are procurement process enhancement, supplier-enabled innovation, and E-procurement and among others. Therefore, it is urgent that the academia to take a network perspective to understand such activities and design process that could handle the complexities inherent in the interaction and coordination of different networks, providing more realism to their planning, as it could provide procurement managers a better conceptualization of the world around them.

Keywords: supply base optimization, supply management, SCM, supply networks

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List of abbreviations

SN: Supply Network

DfX: Design for Excellence

CAS: Complex Adaptive System

SCM: Supply Chain Management

NA: Network Analysis

PH: Personal Health

HS: Health Systems

SNA: Social Network Analysis

MCDM: Multiple Criteria Decision-Making

PART I: INTRODUCTION

CHAPTER 1: Research Definition

This chapter will provide the reader the definition and motivation of the present research. The research definition presented in this chapter consists of three parts: Section1.1: Defines the scientific problem and its background. Section 1.1: Presents the main objective of this research, which explains how the research problem is addressed and Section 1.2: Describes the scope of this research.

1.1 Research Problem

The first section of this chapter defines the scientific problem of this thesis. The first sub section presents its academic background and the second subsection describes the scientific problem at stake.

1.1.1 Background

Traditionally, research in supply management has focused on the linear relationship between buyer and supplier (e.g Chan & Chan, 2004; Hokey, 1994; Rezaei & Ortt, 2012; Sheth & Sharma, 1997) and on the technical issues faced in Supply Chain Management (SCM) (Fisher, 1997). The linear perspective is useful to manage the mechanics of the transactions between buyer and suppliers (Kim et al., 2011). On the other hand, the technical perspective focus on the flow of raw materials, information and finances between entities, serving the design and management of efficient and lean supply chains. However, as Kim et al. (2011) and Bellamy and Basole (2013) recognized, both perspectives fail to capture the complex and dynamic nature of supply chains. Based on Rouse (2005), supply chains are a complex interconnection of suppliers, workers, raw materials, infrastructure, technology and policies engaged in the conversion of raw materials into finished goods. In this regard, Surana et al. (2005) provide a better definition of supply chain; they define supply chains as networks of different entities, process and resources that interact and depend on each other, which is also known as supply networks (SN).

Unfortunately, the lack of predictability and control over the SN have produced frustration and despair in managers (Choi & Kim, 2008), as managerial decision making is often based on non-complex assumptions that deviate from the reality (Pathak, Day, Nair, Sawaya, & Kristal, 2007). These authors highlighted two elements that are often neglected in the decision making process in SN: The complexity of the interconnections between elements in the supply network and their adaptive behavior. Adaptive behavior means that the suppliers will learn and correct its behavior according to the SN

characteristics and environment, in order to increase its fitness with the environment and therefore its competitive advantage.

As a consequence, researchers have engaged in providing managers a more realistic mental map of the supply networks that reflects its dynamism and complexity (Choi et al., 2001), accentuating the importance of network-level analysis in the field of supply management and SCM. Based on the literature review conducted by Bellamy & Basole (2013), the number of publications engaged in the study of supply networks from a network-level perspective increased notoriously between 2000 and 2011. For example, in 2004 Chen and Paulraj (2004) published a literature review in the field of SCM, highlighting the importance to study the structure of the network and the strength of the linkages between suppliers and buyers. Three years later, Pathak et al. (2007) encouraged the academia to explore the CAS perspective and its applicability in the SCM research. These authors provided a comprehensive list of potential areas for further research in the field of SCM and supply management; however, such list does not provide guidance on how to combine and apply the CAS perspective into the different areas of SCM. Five years later, Bellamy and Basole (2013) published a pioneer paper that proposes a comprehensive framework that identifies three main themes that have characterized the SN research, namely *Structure*, *Dynamics* and *Policy & Control*. The framework combines the SCM research and the theoretical elements of Network Analysis (NA), integrating the main findings on both fields presenting a more realistic representation of the SN. However, they only identified the main elements that characterize the SN, but do not elaborate on which constructs can be used to analyze the processes related to the management of the supply base. Thus, Bellamy and Basole (2013) recommend using this framework as a conceptual guide in supply management studies and encourage the academia to pursue two main aims: First, to develop constructs for each of the elements identified (Structure, Dynamics and Policy & Control) and secondly, to demonstrate the validity of this conceptual guide in the supply management research.

Thus, this thesis aims to contribute with the efforts to expand the application of network level analysis and enrich the theory in the supply management research. For this reason, this thesis proposes to use the conceptual guide proposed by Bellamy and Basole (2013) to analyze the process to optimize the supply base from a network perspective. For this purpose, the literature review will provide the constructs for each of the elements identified, that are Structure, Dynamics and Policy & Control, which results in an enriched framework. Secondly, case studies are used to study the process to optimize the supply base by using the enriched framework, in order to demonstrate the validity of the conceptual guide provided by Bellamy and Basole (2013). Therefore, the network-level perspective is applied to

solve the problem presented in the next section; however, the contribution of the network-level perspective to the problem resolution is shaped along the development of this document.

1.1.2 Problem Definition

As previously presented, the supply management research is starting to recognize the importance to take a network level perspective, however there is still a long way to walk to understand what the contribution of a network-level perspective to the supply management research is. In this regard, the literature recognizes that competition has shifted from single companies to supply networks, as no single organization is capable to deliver value to the customer by its own (Stadtler & Kilger, 2000). Consequently, companies create and maintain their competitive advantage by the efficient coordination of the flows of materials, information and finances of their supply chains and the appropriate integration and management of their suppliers in the supply network. However, two years later Choi and Hong (2002, p. 469) unveiled that "researchers were still trying to understand what a supply network looks like and how it behaves".

Despite the lack of understanding of the supply networks, the literature posed supply base optimization as a strategic activity, arguing that companies should manage their supply base in line with the strategic objectives of the firm (Burt et al., 2003). Burt et al. also stated that the optimization of the supply base could lead to a larger supply base. However, authors like Ogden and Carter (2008) and Sarkar and Mohapatra (2006) argued that supply base optimization focuses on the reduction of the supply base, which is a pre requisite to implement other SCM strategies as supplier development, Just-in-Time, partnership development and strategic purchasing. Alternatively, Choi and Krause (2006), argue that supply base optimization means to reduce the complexity of the supply base. The authors explain the complexity of the supply base by using three dimensions: The number of suppliers, the degree of differentiation and the level of interrelation among them. The authors also acknowledge that managers have more control over the number of suppliers of the supply base in comparison with the other two dimensions. Therefore, supply base optimization is framed as an overarching and preferable approach that envelops supply base reduction or supply base consolidation, as the reduction of the supply base addresses only one dimension of the complexity of the supply base.

Independently, if the aim is to reduce the supply base or optimize it, frameworks for carrying out the processes to improve the supply base are scarce (Talluri & Narasimhan, 2005). Even worse, the frameworks available fail to illustrate the real world complexities faced by managers, as they are

based on simplistic assumptions, as it was explained in Section 1.1. For example, Ogden and Carter (2008) assumed that there is an agreement on how to break down the supply base into manageable subsets at the initial stage of the supply reduction initiative. Similarly, Sarkar & Mohapatra (2006) assumed that a complex supply base exists, that all decision makers perceive the supply base as complex and that there is an consensus among decision makers that a reduction of such complexity is needed. Scholars in strategic decision-making and decision making in networks would actually challenge such assumptions, arguing that at strategic level, such agreements are never reached through trivial means (De Bruijn & Ten Heuvelhof, 2008; Rouse, 2005).

In generally, the optimization of the supply base implies the evaluation and selection of incumbent and new suppliers (Talluri & Narasimhan, 2005). The literature provides a vast number of frameworks to evaluate and select suppliers (e.g Chan & Kumar, 2007; Chen, Lin, & Huang, 2006; Hokey, 1994; Luo, Wu, Rosenberg, & Barnes, 2009), however they focus on the selection criteria and methodology to evaluate and select suppliers. Therefore, such frameworks do not consider all the different activities, agreements and milestones that take place before reaching to the point where the decision to evaluate and select certain suppliers is made (e.g Ogden, 2006). For example, Chan & Chan (2004) and Chen at al. (2006) use a mathematical approach (MCDM) to rank the supplier selection factors such as cost, quality, risk and supplier performance. The authors argue that such approach could help decision makers to structure and organize the decision making process, as this activity has become a key strategic consideration (See Table 4. Summary of publications. Source: This project for a more detailed description of the frameworks reviewed). However, scholars as Pathak et al. (2007) argue that such mathematical approaches (e.g. AHP, ANP and Fuzzy Set) fail to provide managers a realistic picture of the complexities intrinsic in strategic decision-making in supply networks as such mathematical approaches are not able to model the uncertainty and risk implied in the optimization of the supply networks.

Therefore, the research problem is summarized as follows:

Despite the attention given in the literature to the activity to optimize the supply base the acknowledgement of its strategic importance in the supply management practices, frameworks for carrying out the process to optimize the supply base are rare (Talluri & Narasimhan, 2005). Moreover, the existing frameworks fail to illustrate the complex and dynamic nature of the Supply Networks that encloses the process of supply base optimization (e.g Kraljic, 1983; Luo, Wu, Rosenberg, & Barnes,

2009; Ogden & Carter, 2008; Sarkar & Mohapatra, 2006). Therefore, the academia has not provided managers a representative mental model of the complexities implicated in the process to optimize the supply base nor how to manage them. For this reason, this thesis attempts to fill this gap by exploring what the network level perspective offers to the literature in the field of supply base optimization.

In this regard, Royal Philips, the Dutch company founded more than 100 years ago, illustrates how supply management has become a strategic activity in companies with a global footprint. In Philips, each Business Group (organizational division with similar products) has its own Operations Department, thus each division operates autonomously resulting in a collection more than 10 independent business (See Figure 11 for more details). Before 2012, the company had the procurement function under the supervision of the Operations Department. However, in 2012, the executive leaders of Philips recognized the strategic importance of the Procurement function and created an overarching department, eliminating its dependency from the Operations Department. This organizational change revealed that the overall supply base of Philips was complex and redundant, as multiple suppliers were providing the same or similar component to different business at different prices. Since then, this company has embark in activities that could optimize the overall supply base, aiming to achieve more efficient operations. For this reason, this thesis will be developed in Royal Philips, were three study cases will be analyzed. Chapter 2 explains more in detail how the case studies were developed.

1.2 Research Objective

After the description of the background and the academic problem this thesis is dealing with, this section elaborates on the objective of this thesis. In response to the lack of attention to the contribution of a network perspective to the supply management research, explained in Section 1.1, the main objective of this thesis is to propose a process to optimize the supply base from a network-level perspective. First, this thesis aims to create a theoretical framework to analyze the process of supply base optimization from a network perspective, by studying the main theories in the domain of Network Analysis and Supply Networks and evaluating their contribution to the research in the field of supply base optimization. Secondly, this thesis seeks to advice managers on how to optimize the supply base. In summary, the present research has two deliverables: The theoretical framework and the process to optimize the supply base.

1. The theoretical framework: It aims to illustrate the networks involved in the process to optimize the supply base and describe their characteristics. Please note that the framework itself is not prescriptive, as it just describes the main elements of each networks and presents the landscape where the process to optimize the supply base evolves in.
2. The process to optimize the supply base: It aims to instruct how commodity managers of a buying firm can deal with networks involved in the process to optimize the supply base.

In summary the research objective of this research is:

"Design a process to optimize the supply base of a firm with a global footprint founded upon a theoretical framework that takes a network level perspective by analyzing the characteristics of the networks involved in the process to optimize such supply base"

1.1.4 Scope

The scope is this thesis can be summarized in three main points:

The present thesis is Theory-building research: The problem presented in Section 1.1 reveals a scientific gap discovered in the supply management research. Therefore, the scope of this thesis is to enrich the theory by analyzing three case studies, which are described in the next chapter. Even though the present research was developed in Philips, the aim is to use the information available within the company to enrich the theory and close the scientific gap identified in Section 1.1.

Takes a network perspective: The present research takes a network perspective, as it seeks to analyze the process to optimize the supply base from a network-level perspective. Therefore, this thesis goes beyond the analysis of the dyadic relationship between buyer and suppliers, by analyzing the different networks that interact and the different actors involved in the process to optimize the supply base. Additionally, it just considers companies with global footprint, as the network perspective is deemed more relevant to this type of companies than to companies that operate in local markets.

Takes a process design approach: This thesis does not attempt to determine the optimal size of the supply chain nor to prescribe the best method to select the suppliers that would be part of this supply base, yet to design of a process to optimize the supply base from a network perspective.

1.3 Outline of the thesis

The present document contains nine chapters that are grouped in three different parts, namely Part I: Introduction, Part II: Theoretical Foundations and Part III: Analysis & Conclusions. *Part I: Introduction* deals with the general description of the present research. In the first chapter, it describes the problem at stake, the research objective and the expected outcome of this research. In synthesis, it tells the reader what the researcher wants to achieve. The second chapter, called Research Design tells the reader how, where and when the researcher is going to achieve the main objective. *Part II: Theoretical Foundations*, as its name indicates, describes the theoretical foundations used to build the framework regarding supply base optimization, which is composed by the contributions of the different theories analyzed during the literature review. Four chapters form Part II, that is to say Chapter 3: Supply Management and Supply Networks, Chapter 4: Supply Networks as Complex Adaptive Systems, Chapter 5: Decision Making in Supply Networks and Chapter 6: Theoretical Framework. Each chapter investigates different theories relevant to the process to optimize the supply base and Chapter 6 presents the final theoretical framework elicited from the combination of the different theories. Finally, *Part III: Analysis & Conclusions* presents the case studies, its analysis and the conclusions extracted from such analysis. Three chapters conformed third part of this research, specifically Chapter 7: Company Description, Chapter 8: Analysis of Case Studies and Chapter 9: Conclusions and Recommendations. The first chapter of this section, Chapter 7, presents a background of Philips and its procurement department. Subsequently, Chapter 8 describes the selection process of the case studies and the analysis of the case studies. Lastly, Chapter 9 presents the conclusions elicited from the analysis of the case studies and provides recommendations for further research and for Philips, based on the reflection of the research process and findings.

CHAPTER 2: Research Design and Methods

The previous chapter described the scientific problem and the objective of this research. Subsequently, this chapter aims to clarify how, where and when the research objective explained Section 1.2 is going to be achieved. This chapter consists of three main parts: Section 2.1 presents the overall research design, illustrating the steps taken to answer the main research question. Section 2.2 describes the research methods used to collect and analyze the data. Finally, Section 2.3 elaborates on the research limitations related to the methodology and design, described in Section 2.1 and Section 2.2 respectively. By the end of the chapter, the reader will have a broad picture of how, where and when the researcher answered each research sub question in order to achieve the research objective.

2.1 Research Design

The research framework is defined as the sequence of steps that the researcher take to fulfil the research objective. The aim of the research framework is to clarify the research plan, representing the internal logic of the research (Vershuren & Doorewaard, 2010). As mentioned it before, this thesis aims to build theory from case study research, thus, it is important to highlight that:

1. Theory building roadmap: This thesis follows the roadmap for theory building from case study research given by Eisenhardt (1989). This is a guide to build the content of the case study, meaning the concepts to be analyzed during the development of the case studies.
2. The design of the case study follows the principles stated by Yin (2014), which represent a guide to build the structure of the case study. Refer to Section 2.2 for more details.

2.1.1 Research Questions

Section 1.2 described the main research objective, which is divided in two deliverables, to be specific *theoretical framework* and *process to optimize the supply base*. Therefore, the following research questions and sub questions are formulated as a guide to develop this thesis and achieve the research objective. As a recap, the main objective of this research aims to provide managers a more realistic mental model of the process to optimize the supply base by incorporating a network level perspective into the supply management research, hence the main research question of this thesis is:

> *RQ: How to optimize the supply base of a firm with a global footprint considering a network-level perspective?*

In order to answer the main research question, the following research sub questions must be answered. Firstly, it is important to determine the state of art research in the field of supply management, which is the core domain of this research. In addition, it is important to understand how the focal firm manages the supply network. In this regard, the understanding and analysis of the main concepts will provide a solid theoretical baseline for this thesis. For this reason, the first research sub question is formulated as follows:

RSQ1: What is supply management and how the supply networks are related to it?

Secondly, after acquiring a clear understanding of what supply base management and the networks within its scope, it is relevant to understand how the dynamics of the supply network affects the process to optimize the supply base. Hence, the second research sub question is:

RSQ2: Why is it important to analyze the dynamics of the supply network?

Thirdly, there is an underlying assumption that the process to manage the supply base is a sequence of decisions that evolve in networks. However, it is important to make explicit which elements of decision making in networks are present in the process to improve the supply base.

RSQ3: How does the process of decisions making develops in supply networks and organizations when optimizing the supply base?

Fourth, due to the lack of comprehensive literature on frameworks to optimize the supply base, which was explained in Chapter 1, it is important to present a theoretical framework that takes a network-level perspective and incorporates the main elements of Supply Management, Complex Adaptive Systems and Decision Making in Networks. Thus, the fourth research sub question is formulated as follows:

RSQ4: What are the main elements to deal with when optimizing the supply base?

The resolution of this question will provide the first part of the thesis objective, which is the theoretical framework that provides the foundation to analyze the process to optimize the supply chain from a network-level perspective. As this theoretical framework describes the main elements to consider when optimizing the supply base, the next steps is to collect evidence on how the different elements are managed in the practice. Thus, the fifth research sub question is presented below.

RSQ5: How is the process of supply base optimization executed in the practice?

RSQ5a: How does the supply base optimization process relates with the firm?

RSQ5b: How does the supply base optimization process relates with the supply base?

RSQ5c: How does the supply base optimization process relates with the supply network?

In conclusion, the resolution of the research sub questions defined in the previous paragraphs will contribute to answer to the main research question, which is:

RQ: How to optimize the supply base of a firm with a global footprint considering a network-level perspective?

2.1.2 Research Framework

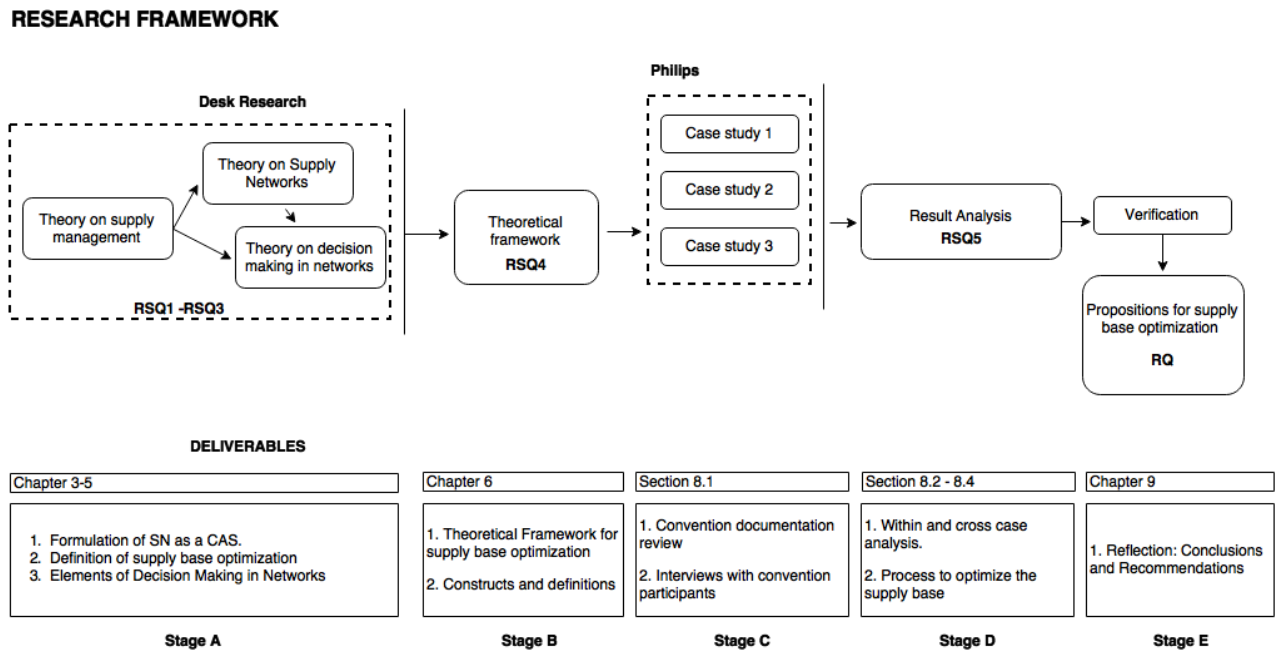


Figure 1. Research Framework. Source: This project.

The previous sub section explained the research question and sub question that will guide the development of this research towards the achievement of the research objective. Subsequently, this subsection presents a graphical representation of the plan followed to execute this research. The figure

below shows the linkage of the research question and sub question and the stages of the research, by explaining when each research question is answered.

The following paragraphs explains each stage and their relationship with this document, by stating which chapters and sections present the development and outcomes of each stage of the development of this research.

- *Stage A*: In this stage, the researcher conducted the literature review and provideed the theoretical baseline for this thesis. The literature review covered three main domains: supply management, Complex Adaptive Systems (CAS) and decision making in networks. The methodology used is explained in the Section 2.2: Research Methods. The outcome of this stage is presented in Chapter 3, 4 and 5, which corresponds to the analysis of the main theoretical elements that are relevant for the development of the this thesis. These three chapters are the foundation of the Theoretical Framework formulated it in the next stage. Please note that the analysis of the theory in supply management (Chapter 3) calls the attention to deficiencies found in this field that are addressed by the exploration of the theory of Supply Networks (Chapter 4) and Decision Making in Networks (Chapter 5).
- *Stage B*: Based on Eisenhardt (1989), it is advisable to specify the constructs before entering the field. For this reason, in this stage, the researcher created a theoretical framework and constructs based on the literature review conducted in Stage A. For this purpose, the theories reviewed during Chapter 3, 4 and 5 were combined to create a theoretical framework to analyze the process to optimize the supply base from a network perspective. The methodology and reasoning used to create this overarching framework is explained in Section 6.1. The resulting Theoretical Framework is presented in Section 6.2. The list of constructs elicited from this stage are presented in Appendix. A, which was the baseline to create the semi-structure interviews conducted in the case studies, which lead us to Stage C.
- *Stage C*: The key activity of this stage is the development of the case studies in Royal Philips. This stage has two main inputs: 1) Case Study design (Section 2.1) and 2) Theoretical framework (Section 6.2) and constructs (Appendix A). The first input follows the design principles given by Yin (2014), providing a description of the general design of the case studies. The second input provides the theoretical framework and constructs, representing the content of the case study, which helps to concentrate the efforts when collecting evidence in the field. Finally, the development of the case selection, which is the output of this stage, is presented in Section 8.1.

- *Stage D*: Based on Eisenhardt (1989), in this stage the evidence is analyzed and the propositions are shaped. Firstly, the researcher conducts a within-case analysis (Section 8.2) and a cross-case analysis (Section 8.3). Subsequently, the insights obtained from these analyses generates the process to optimize the supply base presented in Section 8.4, which is the second outcome of this research.
- *Stage E*: This stage presents the verification of the process proposed and the conclusions generated during the development of this research and the reflections that leads to recommendations for Philips and for further research. These reflections are presented in Chapter 9.

2.2 Research Methods

After acquiring a clear picture of the overall planning of this thesis, this section explains the research methods used for the development of this thesis. Table 1 shows a summary of the research methods and data collection techniques used. The following sections explains each research method and its corresponding data collection technique.

Table 1. Activities per stage based on research framework. Source: This Project

STAGE	**A & B**	**C**	
Research Method	Literature Review	Case Study	
Data collection technique	Desk Research	Desk Research	Interviews

2.2.1 Literature review

The literature review will provide the theoretical baseline for this thesis. Thus, a desk research was conduct, which means that a list of secondary data like peer reviewed journals and book were reviewed. In the present desk research, there are three main domains involved: Supply Networks, Supply Management and Decision Making in Networks. The domain of supply management was investigated first, using the following terms in different combinations:

"Supply management", "Supply base management", "supply base consolidation", "supply base reduction", "supply base rationalization" and "supply chain management".

For this research, Scopus was the initial database used. As expected, the search in Scopus resulted in a large list of papers. In order to limit the amount of papers to be review, the results of each search

were sorted from the most cited papers to the less ones. The title and abstract of the first one hundred to two hundred papers of the list were examined. Based on scientific judgement, the main three to ten papers were selected for further reading. Usually, Scopus will redirect the search to a second database as Science Direct or to different journal's websites like Emerald Insights and Wiley, where the researcher downloaded the academic papers that were selected for reading.

During the literature review about supply management, it was clear that, in the last 20 years, the academia has investigated the complex and dynamic nature of the supply networks and how to deal with it. Hence, there is a rising interest in the relationship between supply networks and supply management and the implications of such relation. Therefore, I conducted a second round of literature review using the following terms using different combinations:

"Supply network", "Network Theory", "Networks", "Complex Adaptive Systems", "Complexity" and "Supplier Network"

Scopus was again the initial database used for the investigation conducted in the domain of Complex Adaptive Systems and Supply Networks. Again, the Scopus provided a vast list of papers. In order to review the most important papers, the list was sorted based on the number of citations, from the most cited article to the less cited article. The researcher checked the abstracts of the first hundred articles, selecting the most relevant publications. The main three to ten papers were selected for further analysis. After a throughout reading, the main articles were selected.

At this point, it was clear that the process of supply base optimization could be related to the domain of decision making in networks, thus for this domain I followed a snowball approach that started with literature organizational decision making. Therefore, the first point of consultation was the book Management in Networks by De Bruijn & Ten Heuvelhof (2008). The authors reference papers related to public and private administration, thus the ones concerning private administration were reviewed.

As mentioned in Section 2.1.1 , the outcome of the literature review is a theoretical framework that supports the analysis of the process to optimize the supply base from a network perspective. The reasoning followed to create this framework is presented in Section 6.1.

2.2.2 Case Study

The previous sub section explains how the Literature Review was executed, and it mentions that the outcome is the creation of a Theoretical Framework to analyze the process to optimize the supply base, which represents the content of this research. The second input needed to develop the case studies is its structure and design, which follows the principles given by Yin (2014) and is presented in this sub section. In his book, he recommends to use case studies as a research method when the research questions is formulated as "How" question, which is the case for this thesis. For this reason, the study case was considered an appropriate research method to answer the main research question of this thesis. Below, the overall design is explained.

Case Study Design

In section, I will explain the design of the case study used for the development of this thesis. The main design characteristics are:

1. *Type of case study*: Multiple case design
2. *Unit of analysis*: Supply base optimization initiative (Convention)

Figure 2 shows an illustration of the overall case study design.

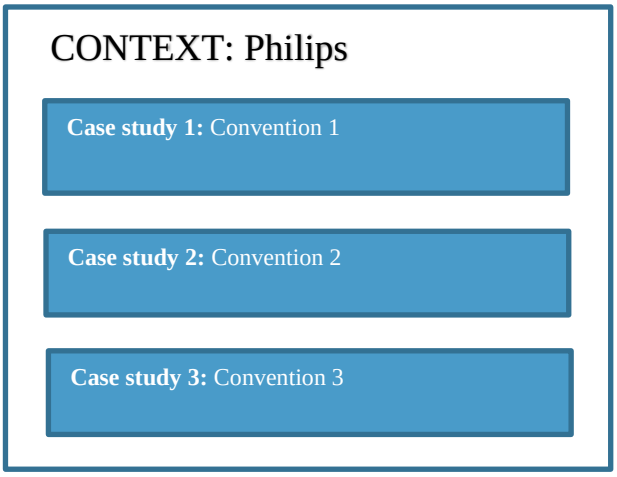


Figure 2. Embedded single case study design. Source: This Project

Based on Yin (2014), there are five rationales that explains when a single case design is more appropriate: Critical, unusual, common, revelatory and longitudinal. This section does not provides a description of each rationale, but it focuses in the one rationale that matters for this case: *common*. The objective in this setting is to capture the situation and conditions of an everyday situation. Fortunately, the researchers found in Philips a department of internal consultant that work with interdisciplinary teams to reduce the complexity of the supply base. Their day-to-day work represents an opportunity to analyze common cases about how to reduce the complexity of the supply base. The DfX team calls *convention* each initiative to reduce the complexity of the supply base. Moreover, each convention will be assigned a "DfX coach", role taken by one of the member of the DfX Team. Please refer to Chapter 7 for more details about Philips and the DfX Team.

When the aim of the research is to build theory from case studies, Eisenhardt (1989) recommends to use theoretical sampling to select the case studies. Therefore, the selection will be based in theoretical sampling to ensure that the most representative conventions are part of this thesis. Table 2 provides an overview of the selection criteria and the rationale behind it. Note that three elements of the selection criteria are based on literature review presented in Chapter 3, 4 and 5, as this thesis uses theoretical sampling to select the cases. In the next paragraph provides a brief description of the theoretical categories defined for the selection of the cases.

Data availability

The usage of multiple sources of evidence is considered by Yin (2014) as a tactic to increase construct validity when doing case studies. Therefore, the availability of data documented in a standard format was considered a selection criteria for the cases that will be analyzed. Fortunately, the DfX team follows a standard template to document the convention, hence just the conventions with data available in the DfX database will be considered as possible candidates. Based on the feedback of a DfX coach, the most relevant documents are the presentation for the kick-off and closure meetings, thus only conventions with such documents available in the DfX database will be considered for further analysis.

Diversity

There are two arguments that explain why diversity is used as selection criteria for the case studies. First, based on De Bruijn and Ten Heuvelhof (2008), an arena is defined as a place where an activity occurs. Moreover, they state that decision making in networks occurs in several arenas (See Chapter

5 for more details). Since this thesis follows a theoretical sampling and the core of this research is to analyze the process of supply base optimization from a network perspective, it is relevant to analyze cases that involve multiple arenas. In the particular context of Philips, arena is defined as a business group (BG). The reason is that every business group has its own business leader and strategy, therefore the targets of the convention might conflict with the strategy or targets of the BGs involved. Therefore, it is interesting to understand how the convention process must deal with such contradictions. Secondly, Eisenhardt (1989) pointed that one of the weakness of building theory from case studies is that the resulting theory may be narrow and idiosyncratic. In order to reduce such risk, it is important to analyze conventions that involve different BGs. Each BG groups products of similar categories and technology, therefore it is argued that more BGs involved in the convention, the less idiosyncratic the results are. In summary, the number of BGs involved in the convention will determine the number of arenas for each case.

Problem formulation

De Bruijn and Ten Heuvelhof (2008) make a distinction between structure and unstructured problems. A structured problem represents a problem for which there are few solutions; therefore, the solution is quite straightforward, whereas an unstructured problem never has one right solution. In decision making in network, problems are defined as unstructured problems, giving the actors freedom to act. In order to replicate the emergent theory, it is advisable to analyze conventions where the problem is formulated as an unstructured problem.

Table 2. Criteria used to select the embedded unit of analysis. Source: This project

CRITERIA	DEFINITION	RATIONALE
Data availability	Convention kick-off and closure documentation available	- It increases the construct validly of the research
Diversity	More than one BG involved in each convention	- Reduces the risk to develop idiosyncratic theory as it considers different technologies. - Replicates the theory of decision making in networks, so the case is considered theoretically useful.
Problem Formulation	The problem of the convention should be unstructured	- It replicates the theory of decision making in networks, so the case is considered theoretically useful.

Desk research

The desk research conducted during the case studies refers to the analysis of the secondary data available for each case study and the process. As explain previously, one of the criteria to select the case studies is data availability. For this thesis, the official presentation of the kick-off and the closure meeting must be available in the standard format of the convention. Thus, the analysis of this standard documentation will feed the analysis done during the desk research. The aim is to be acquainted with the main aspects of the convention, obtains pertinent information to elicit insgiht and have efficient interviews later on.

Interviewee Selection

The selection of the interviewees starts from the people in the list of team members for every convention, which is documented in the presentation prepared for the convention kick-off. The first point of contact is the DfX Coach, as the person who is involved in the process from end-to-end. The DfX coach and the researcher reviewed the list to rule out people that were not part of the organization anymore or moved to another job position recently. From the remainder people, the DfX Coach recommended a list of interviewees for each convention, based on their participation and content knowledge. The result is a list of 14 people, whom were invited to participate in the interview, however just 6 accepted the interview. Do note that the number of interviewees is not equal among the cases, as the size and availability of the interviewee is different for each case study. If the reader wants to know more details about the roles and responsibilities of the convention, refer to Chapter 7.

All interviews follow a semi-structured format (Refer to Appendix B. Interview Protocol). A set of questions was prepared for each construct elicited from the Theoretical Framework. However, during the development of interview, the interviewer tried to keep a fluid conversation with the interviewees. In order to enhance this fluidity, the interviews were recorded. The computer provided by Philips to the interviewer served as sole recording device, and the software used is called Camtasia. Camtasia is the only recording software allowed within Philips, which is provided by the IT Service Portal. The interviews will be transcribe to allow the researcher to deep-dive into the information provided. The transcription will be documented in Word. Due to the length and type of the documentation, the audio and transcriptions of the interviews are not included in this report; however, they are available upon request. Additionally, the names of the interviewees are confidential. Finally, The interviews took place from June 6th, 2017 to June 21st, 2017. The average time of the interviews was 50 minutes. All

interviews were online interviews because the location of the interviewees did not allow meeting face to face. Refer to Appendix C for more details about the interviewees.

2.2.3 Data Collection

Table 3 shows an overview of the research method and the data source utilized to answer the main research questions. As described in this chapter, this thesis is based on literature review and case study research. The revision of papers from peer reviewed journals and books was the main data source to answer the first four questions, providing the theoretical framework proposed in this thesis. Consequently, the case study is used to analyze how the constructed elicited from the theory might be related. The main two data sources used for this purpose are company's documentation and semi structure interviews. The combination of multiple data sources increases the construct validity of the present research.

Table 3. Description on the research method and data source used to answer each research sub question. Source: This Project.

RESEARCH SUB QUESTION	RESEARCH METHOD	DATA SOURCE
RSQ1: What is supply management and how is it related with supply networks?	Literature Review	Peer reviewed journals and books
RSQ2: Why is it important to analyze the behavior of the supply base?	Literature Review	Peer reviewed journals and books
RSQ3: How does the process of decisions making develops in supply networks and organizations when optimizing the supply base?	Literature Review	Peer reviewed journals and books
RSQ4: What are the main elements to deal with when optimizing the supply base?	Literature review	Peer reviewed journals and books
RSQ5: How is the process of supply base optimization executed in the practice?	Case Study	Semi-structured interviews and company documentation
RSQ5a: How does the supply base optimization process relates with the firm?	Case Study	Semi-structured interviews and company documentation
RSQ5b: How does the supply base optimization process relates with the supply base?	Case Study	Semi-structured interviews and company documentation
RSQ5c: How does the supply base optimization process relates with the supply network?	Case Study	Semi-structure interviews and company documentation

2.3 Research Limitations

- ✓ Lack of generalizability: This thesis aims to build theory; therefore, the limitations of this type of research are also applicable for this thesis. One of the most prominent weakness of theory building research, is the that theory building using inductive reasoning from specific empirical events might result in narrow and idiosyncratic theory Eisenhardt (1989), which compromise the generalizability of the emergent theory.
- ✓ Egocentric view: The supply network perspective is considered an ego centric view (Kim et al., 2011), centered in the focal company, therefore the suppliers of the supply bases under analysis were not contacted.
- ✓ Interviewees: The list of interviewees was limited to the participants of the convention only; therefore, it could produce biased outcomes as the interviewees were engaged during the development of the convention and favor this type of initiatives.
- ✓ Initiative: As it will be explained in Section 8.1, there are two type of conventions: Product and Commodity conventions. Based on the feedback of the company advisor, Steven Prins, the Product conventions are relatively simpler, as less stakeholders are involved. Therefore, this thesis only considers the commodity convention, in order to represent a process where diverse stakeholders are involved.
- ✓ Philips served as the only company analyzed during the development of the present research.

The implications of the research limitations will be examined broadly in the Chapter 9, where the conclusions and recommendations for further research will be explained.

2.4 Summary

This chapter explained to the reader how, where and when the research objective is going to be achieved and the research questions will be answered; therefore, this chapter presented the overall research design. First, it introduced the research framework as a schematic representation of the logic of the research. The research framework shows an overall picture this research, by demonstrating which research sub questions are answered and the deliverables by stage. Secondly, it presented the research strategy, namely a *study case*. Moreover, it described the data collection methods used. Finally, it shows a visualization of the expected deliverables and the activities' schedule. At this point, the reader is expected to have broad picture of how, where and when the student is planning to develop this research proposal.

PART II: THEORETICAL FOUNDATIONS

CHAPTER 3: Supply management and Supply Networks

Part I: Introduction presented the research definition, by describing the problem at stake and the overall plan to address it. Subsequently, Part II: Theoretical Development presents the Literature Review that will generate the Theoretical Framework, as explained in Section 2.1. Chapter 3 and the following two chapters deal with the main theories related to supply management and network. The outcome of the literature study is presented in Chapter 6, which is the final chapter of Part II.

More in detail, this Chapter aim to answer the first research sub questions, which reads as: *What is supply management and how the supply network are related to it?* Three sections composed this chapter, that is to say Supply Management (Section 3.1), Supply Base Optimization (Section 3.2) and Summary (Section 3.3). Section 3.1 presents a general introduction to the domain of supply management, which defines the supply base as the element of interest of supply management. Next, Section 3.2 presents the academic definition of supply base optimization, the key areas of managerial interest when aiming to optimize the supply base and a review of the different frameworks available in the literature to optimize or consolidate the supply base. Finally, Section 3.3 presents a recapitulation on how the literature review presented in this chapters answers the first research sub question.

3.1 Supply management

Before going into the details regarding supply base management, I would like to highlight the difference between *supply management* and *supply chain management*. Based on Chen and Paulraj (2017), the main difference between both concepts lies on its focus: Supply Management focuses on managing the relationship the buyer holds with each of the different suppliers, whereas Supply Chain Management focuses on managing the direct aspects that affect the delivery of products or services to the customer within the supply chain. In other words, the supply management focuses on the interaction between the different players within the supply base, whereas the supply chain focuses on the management of the flow of materials, information and financials of the different players within a specific supply chain. Thus, both concepts are complement of each other. However, it is important to keep this distinction in mind, as the supply base optimization, which is the main topic of this thesis, follows a supply management approach, focusing on the relationship and interaction between the focal firm and its suppliers. As an additional clarification, for this thesis, supply management and supply base management are considered equivalent terms.

The target element of the supply management is the supply base. Based on Choi and Krause (2006), the supply base is the portion of the supply network that is actively manage by a focal company trough contracts and formal agreements. Consequently, the supply base is embedded in a SN that self-emerges and lacks of any central control. As I will explained in the next chapter, the self-emergence nature of the SN and the lack of a central entity allow us to frame the SN as a CAS. Therefore, the embeddedness of the supply base in a complex SN makes the supply base management a challenge. The evaluation of the different scenarios often involves uncertainty, dynamism and risks that are difficult to quantify, posing a challenge to manager to coordinate and integrate their supply base.

Therefore, many authors have suggested that supply management should focus on the entire network, rather just on dyadic relationship between focal company and suppliers (Choi et al., 2001; Pathak et al., 2007; Surana et al., 2005; Yan, Choi, Kim, & Yang, 2015), as the network perspective captures the complexity needed to understand the challenges faced in supply management. As supply chains grow more complex and dynamic, a network perspective is more suitable to manage the supply base of focal firms.

3.2 Supply base optimization

In the literature, there is a lack of consensus about the different terminology used in the domain of supply base optimization (e.g. Chen & Paulraj, 2004; Choi & Krause, 2006; Cousins, 1999; Sarkar & Mohapatra, 2006; Talluri & Narasimhan, 2005). Therefore, supply base reduction, supply rationalization, supply base consolidation and supply base optimization are used as equal terms, when they are not. For this reason, it is important to create a common understanding about the different definitions. Firstly, supply base *reduction* is considered as the practice to reduce the number of suppliers of an specific supply base (Cousins, 1999), therefore it assumes the existence of a large supply base (Sarkar & Mohapatra, 2006). Sarkar & Mohapatra (2006) defines supply *rationalization* as the practice that, firstly, defines the optimal size of the supply base, secondly, decides which suppliers should be part of it. Based on Chen and Paulraj (2017), supply base *consolidation* is the activity to allocate the majority of the required materials to a single source, leading to a reduced number of suppliers within the supply base. The three definitions described before have been widely criticized, as they single-minded focus on cost savings by decreasing the transaction and supplier management costs (Choi & Krause, 2006; Cousins, 1999). Thus, Choi and Krause (2006) proposed a more holistic definition, arguing that supply base *optimization* is the practice of reducing the *complexity* of the supply chain. Talluri and Narasimham (2005) also refers to supply base consolidation as set of activities that

reduces the number of suppliers for better coordination, reconfigures (but not necessarily reduces) the current supply base by selecting new high performing suppliers and engaging in supplier development activities. In synthesis, supply base optimization takes a more holistic overview of the supply base, for this reason, the present thesis will focus on the creation of a process for supply base *optimization*.

Based Choi and Krause (2006), when firms are playing in competitive markets, they are obliged to focus on the *optimization* of the supply base rather on reduction of supply base as sole objective. As mentioned before, this comprehensive perspective proposes to reduce the complexity of the entire supply base as a mean to lower transaction costs and risk, but increase the supplier responsiveness and innovation. This perspective is derived from the conceptualization of the supply network as a CAS, therefore the optimization is at network level. Choi and Krause (2006) defined three dimensions to define the complexity of the supply base, which are based on the *NK* model of complex systems proposed by Kauffman (1993). The first dimension refers to the number of suppliers in the supply base; the second dimension refers to how different those suppliers are from each other. The differentiation is represented by the different characteristics of the suppliers in terms of cultural environment, operational practices, technological capabilities, location, IT infrastructure, and so on. The last dimension refer to the relationship supplier – supplier. This relationship is of special interests to the focal company as it represents the flow of information, materials and financial among suppliers, which cold form coalitions to increase their bargain power.

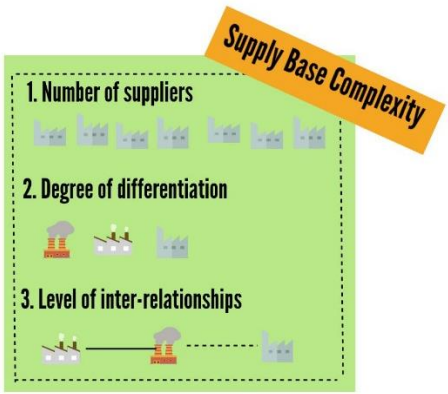


Figure 3. Supply base complexity dimensions. Source: Adopted from Choi & Krause (2006)

Even though the complexity of the supply base has three dimensions, the most commonly observed supply management practice focuses on the reduction of the number of suppliers (Choi & Krause,

2006; Talluri & Narasimhan, 2005). From the perspective of the focal company, the number of suppliers is the immediate area in the supply base. The narrow focus to reduce the number of suppliers in the promise to reduce transactional costs has had negative impact in some firms. For example, Cousins (1999) studied 174 firms representing ten different industries across UK. Surprisingly, 77% of the firms were actively pursuing the reduction of the supply base. However, he also found evidence demonstrating that some firms were increasing the size of the supply base again in order to mitigate the unforeseen problems.

On the other hand, the literature explores broadly the benefits experienced by firms that optimized or consolidated their supply base. For example, Talluri and Narasimham (2005) reports that companies that reduced their supply base improved their product development process due to higher levels of supplier integration. Sarkar and Mohapatra (2006) argues that an optimize supply base is a pre requisite to develop effective partnerships with suppliers. Ogden and Carter (2008) states that a reduced supply base supports the focal company on dealing with different supply management strategies as supplier development, Just-in-Time, partnership development and strategic purchasing. Thus, supply base optimization has become part of the strategic activities use as a tool to increase the competitive advantage of the firms.

Additionally, Choi and Krause (2006) summarizes that there are four elements for managerial attention when a firm aim to optimize the supply base: cost, risk, innovation and responsiveness. First, cost refers to the cost that the focal firm incurs when doing business with suppliers. Besides the cost of the material good purchased and the logistics involved, this category also includes the frictional costs that arises when doing business with a supplier. Some examples of these frictional costs are example cost of non-quality, higher prices due to opportunistic behavior of the supplier, correction or orders, inspection of goods and so on. Secondly, the risk refers to the events that might happen in the supply base and hinder the ability of the focal firm to meet the demand. Third, innovation is understood as the ability of the supplier to contribute with ideas and resources in the development of new innovative products. Finally, responsiveness is how fast and efficient the supplier can meet the changing request of the focal firm on time. Hence, it is logical to assume that efforts to optimize the supply base could reduce the costs or the risk or increase the responsiveness or the innovation of the supplier.

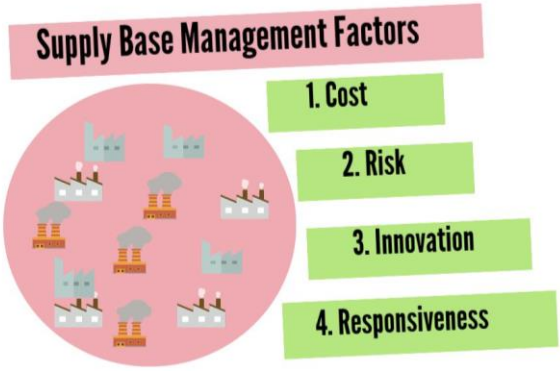


Figure 4. Supply base management factors. Source: Adopted from Choi and Krause (2006)

3.2.1 Frameworks to optimize the supply base

In spite of the numerous benefits that focal firms reap from an optimized supply base, little research has been conducted on how to achieve it. Table 4 provides an overview of the main papers reviewed during the literature review and describes the main pros and cons of the few frameworks found that are related to the supply base optimization. The first observation is that most of the frameworks found focus on the reduction of the supply base, as it was already mentioned this approach addresses just one dimension of the complexity of the supply base. Secondly, the frameworks reviewed focus on the dyadic relationship between buyer and supplier, neglecting the fact that the supplier is embedded in a network that influences its behavior. Thirdly, most of the frameworks focuses on the supplier selection criteria, disregarding the process that is happening and its implications (e.g Amin & Razmi, 2009; Luo et al., 2009) . Lastly, the frameworks reviews are not prescriptive, thus they lack of practical relevance (e.g. Chen et al., 2006). The table shown below presents a summary of the findings during the literature review.

Table 4. Summary of publications. Source: This project

FRAME-WORKS	REFER-ENCE	DESCRIPTION	PROS	CONS
Supply base optimization	(Talluri & Narasimhan, 2005)	Mathematical framework to evaluate the capabilities of potential suppliers with respect of the strengths of existing suppliers.	- Focus on the reconfiguration of the supply base, and not only in the reduction of the number of suppliers	- It is not prescriptive for procurement managers, as it has a strong focus on the mathematical development of the framework
Supply base reduction	(Ogden & Carter, 2008; Sarkar & Mohapatra, 2006)	Step-by-step process that aims to reduce the number of suppliers of the supply base.	- Prescriptive framework that guides commodity managers to reduce their supply base	- Neglect the process to optimize the supply base and focuses on the method to select the suppliers
Supplier Selection	(F. T. S. Chan & Chan, 2004; C. T. Chen et al., 2006)	Mathematical framework to select suppliers based on quantitative and qualitative factors.	- Give insights on the relevant aspects to consider when evaluating a supplier	- Considers only the dyadic relationship between supplier and buyer. - Focuses on the supplier selection criteria, neglecting most of the aspects relevant to the process. - It is not prescriptive for procurement managers, as it has a strong focus on the mathematical development of the framework
Supplier Segmentation	(Fisher, 1997; Kraljic, 1983; Rezaei & Ortt, 2012)	Qualitative framework to classify and segregate suppliers	- Provides guidance to commodity managers on how to segregate the supplier for a better supply management - Provides a map of the supply base	- Considers only the dyadic relationship between supplier and buyer - Do not consider the opportunistic behavior of suppliers - Does not consider the aspects related to the process
Research Framework	(I. Chen & Paulraj, 2004)	Theoretical framework that provides unidimensional measurements for theory building in SCM	- Defines the concept of supply network structure in SCM and the importance to analyze it.	- It does not provide guidance on how to apply those concepts to the activities in the supply base management

3.2.1 Supply base reduction approaches

As mentioned before, even though the complexity of the supply base has three dimensions, the most commonly observed supply management practice focuses on the reduction of the number of suppliers (Choi & Krause, 2006; Talluri & Narasimhan, 2005). In this regard, Ogden and Carter (2008) argue that there are three main approaches to reduce the supply base, namely Standardization, Systematic Reduction and Tiering. The different approaches are not mutually exclusive; therefore, most of the firms use a combination of them. Standardization refers to the reduction of suppliers by the simplification of the product or service purchase from the supplier, which leads to a reduction of the number of the parts needed. Secondly, systematic elimination is achieve in various way, however the basic principle is to segregate desirable suppliers from non-desirable suppliers and eliminate the non-desirable suppliers. The segregation could be based on spend (long tail elimination), performance (Eliminations of non-performing suppliers) or behavior (Suppliers displaying opportunistic behavior). Finally, Tiering means that the focal company delegates control over components, subassemblies or commodities to Tier 1 supplier. Even though the scope of this thesis is broader than just the reduction of the supply base, I consider important to understand the different approaches used to reduce the complexity of the supply base by focusing on the reduction of the number of suppliers.

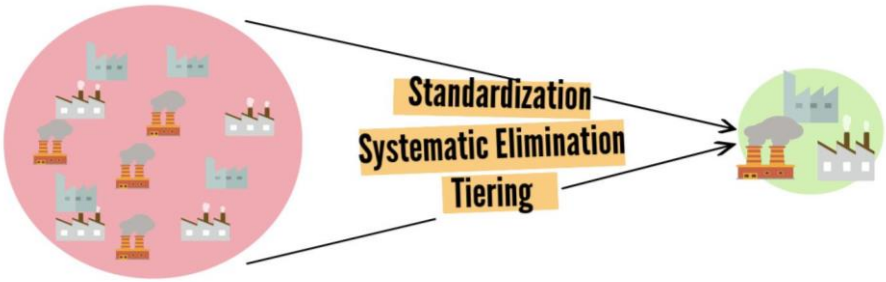


Figure 5. Different approaches to consolidate the supply base. Source: Adapted from Ogden and Carter (2008)

3.3 Summary

As explained in the introductory paragraph of this chapter, this chapter aims to answer the first research sub question: *What is supply management and how the supply networks are related to it?* After the analysis of the literature, the conclusion is that supply management is the action to manage the supply base, which is the subset of the supply network that is controlled by the buying firm, which is also known as the focal firm. Therefore, the supply base is a subset of the supply network that is in direct control of the focal firm. On the other hand, researchers claim that the optimization of the

supply base is key factor to generate and maintain the competitive advantage of the focal firm, therefore is should be in the managerial agenda. The more holistic definition of supply base optimization is given by Choi & Krause (2006), whom argue that supply base optimization means to reduce the complexity of the supply base. Furthermore, they define complexity in terms of the elements that characterize its structure, that is to say Number of suppliers, degree of differentiation and the interrelation among them. The following table shows the main terms elicited from the literature reviews during the elaboration of this chapter.

Table 5. Summary of main concepts of Chapter 4. Source: This project

CONCEPT	DEFINITION
Supply Management	It is the action to manage the supply base. It focuses on the management of the relationship the buyer holds with each of the different suppliers
Supply Chain Management	It is the action of managing the supply chain. It focuses on the management of the flow of materials, information and financials of the different players within a specific supply chain.
Supply Base	Portion of the supply network that is actively managed by a focal company through contract and formal agreements.
Supply base complexity	Composed by three dimensions: The degree of differentiation of the focal firm's suppliers, their total number and the degree to which they are interrelated.
Supply base optimization	Despite the mathematical connotation of the term optimization, supply base optimization is the practice of *reducing* the *complexity* of the supply chain. It could reduce the number of suppliers for better coordination or reconfigure the current supply base by also considering new high performing suppliers.
Supply base consolidation and supply base reduction	Practice of reducing the complexity of the supply base by focusing in the reduction in the reduction of suppliers only. Hence, the other two complexity dimensions are neglected.

Finally, there are two important remarks about supply base optimization that are important to highlight. First, this chapter presented the main frameworks and approaches to optimize the supply base by tackling its complexity. However, it is relevant to explore how the supply network affects the management of the supply base, considering that the supply base is a subset of it. For this reason, next chapter explores the dynamics of the supply network and its effects on the management of the supply base. Second, the frameworks fail to illustrate the real world complexities faced by managers, as they are based on simplistic assumptions, as it was explained in Section 1.1. For example, the frameworks to consolidate the supply assume that a large supply base exists; that all decision makers perceive the supply base as large and additionally, that there is a consensus among decision makers

that a reduction of such supply base is needed. Scholars in strategic decision-making and decision making in networks would actually challenge such assumptions, arguing that at strategic level, such agreements are never reached through trivial means (De Bruijn & Ten Heuvelhof, 2008; Rouse, 2005). For this reason, Chapter 5 provides an overview of the main elements of decision making in networks.

CHAPTER 4: Supply Networks as Complex Adaptive Systems

The previous chapter explained the main concepts about supply management and supple base, where the supply base is the focal point of the supply management and the reduction of the complexity should be included in the managerial agenda if the aim is to generate and maintain competitive advantage for the focal firm. However, the final remark of the previous chapter highlights how the dynamics of the supply network affects the management of the supply base is still unexplored, considering that, the supply base is a subset of it. For this reason, this chapter explores the dynamics of the supply network and its effects on the management of the supply base. Therefore, the aim of this chapter is to answer the second research sub question: *Why is it important to analyze the dynamics of the supply network?* Four sections composed this chapter, namely Supply Networks (Section 4.1), Complex Adaptive Systems (Section 4.2), Framing Supply Networks as Complex Adaptive Systems (Section 4.3) and Summary (Section 4.4). Section 4.1 defines what a supply network is and exposes how the literature is relating the Supply Networks as a CAS, therefore Section 4.2 explains what a CAS is and its main characteristics. Subsequently, Section 4.3 frames the Supply Networks and CAS and finally Section 4.4 summarizes the implications of framing the SN as CAS to the management of the supply base.

4.1 Supply Networks

The literature defines a network as a set of ties among actors, commonly also known as nodes. The actors are discrete individual or collective social units that have any instance of connection of interest between them. Such interconnection could take the form of friendship, formal relation, material transfer, physical connection and so on. For example, an employee could be an individual actor of the network within the company, which is linked by other colleges by materials and knowledge transfer. In this example, the network is composed by all the employees the work for the organization. However, the organization can represent, at the same time, a collective social unit within a network form by braches of the same parent company, which are tie together by the transfer of materials and a contractual relationship. The definition of the boundaries of the network and the type of ties will determine the elements that the network will contain. This thesis focuses on supply networks, which will be defined in the following paragraphs.

Even though the literature provides different definitions for Supply Network (SN) (Choi et al., 2001; Pathak et al., 2007; Stadtler & Kilger, 2000; Surana et al., 2005; Yan et al., 2015), most of the authors

agree that a supply network is a set of interconnected and related firms. For example, Surana et al. (2005) uses the term supply chain to refer to a complex network with a vast number of interconnections and interactions among diverse entities, processes and resources. Similarly, Choi and Krause (2006, p. 638) defines a supply network as "all inter-connected firms that exist upstream to any one company in the value system". On the other hand, Stadtler & Kilger (2000) states that a SN is a set of firms interconnected by forward flow of materials (raw, finished goods, tooling equipment, etc.), backwards flow of information and financial exchange between organizations. Finally, Pathak et al. (2007) emphases that firms of interrelated industries compose the supply network. The aim of the supply system is to create value for the company and for the customer, thus the management of the supply system aims to create and sustain competitiveness for the organization by engaging in the distribution, transportation, utilization and transformation of raw materials to provide goods and services of related industries (Kim et al., 2011).

However, as Kim et al. (2011) stated, Supply Chain Management has focused on linear relationships between buyers and suppliers, failing to capture the complexity needed to understand a firm strategy and behavior. Therefore, I propose to follow the reasoning of Choi et al. (2001) and Surana et al. (2005) by positing the Supply Network as a Complex Adaptive System (CAS). For this reason, the next section explains the main elements of the CAS. Subsequently, the next section makes the relation between the CAS and Supply Networks explicit.

4.2 Complex Adaptive Systems

In the literature, the definition of complex system is not delineated without conflict as it is considered an emerging theory (Surana et al., 2005). First, there is a confusion about the distinction between complexity and complicatedness. Pathak et al. (2007) defines complicated as a situation that is intricate, but the relationship between the components is fixed and predictable. One example of a complicated system is the assembly of an aircraft, which has millions of pieces interconnected. On the other hand, Pathak at al. (2007) describes complexity as the unpredictable relationship between the components of a system, therefore it is characterize the interaction between the parts in nonlinear and dynamic. Secondly, some authors define the concept of CAS by stating its distinctive characteristics. For example, Surana et al. (2005) highlights the emergence of collective behavior from the interaction without any centralized control is the most remarkable phenomenon exhibit by a CAS. , Surana et al (2005) also adds that this type of system has the ability to co-evolve with the changing environment,

adapting itself to the environment but, at the same time, the individual behavior of its entities influences and shapes such environment. However, for the sake of clarity, the working definition of Complex Adaptive System is the one given by Holland (1995): "*A CAS is a system that emerges, adapts and organizes itself over time without any particular entity organizing or directing it*".

Based on Choi et al. (2001), there are three main focal points that emerge when dealing with a CAS: Internal Mechanism, Co-evolution and Environment. The internal mechanism of a CAS consists of agents that interact with each other and with the environment following shared and simple behavioral rules. The landmark is that agents have the ability to evolve as they learn from such interactions, thus they have the ability to make decisions in response to the environment and the actions of other agents. Secondly, the external conditions and events to the system that influence the behavior of the agents defines the environment where the CAS evolves in. Third, there is a complex interaction between the environment and the agents, as they Co-evolve. It means that a CAS reacts to and creates its environment. Moreover, the actions and reactions of the agents are triggered by external events or the actions of other agents.

This section defines a CAS and describe its main characteristics. The next section makes the bridge between CAS and SN by framing the SN as a CAS.

4.3 Framing Supply Networks as Complex Adaptive Systems

The pioneering article by Choi, Dooley and Rungtusanatham (2001) proposes to recognize supply networks as CAS, arguing that they emerge rather that being the result of a central force that designs them purposely. Since its publication, the academia has shown an increasing interest in the contribution of the theory of CAS in the domain of supply management. For example, Surana et al. (2005) proposes a set of tools and techniques based on nonlinear dynamics and Complexity Theory, in order to improve the efficiency of Supply Chain Management models. Similarly, Pathak (2007) proposes a theory that integrates the complexity theory into the supply chain management research by the creation of a framework for the generation and validation of new theories. Even though Pathak et al. (2007) conducted a thorough study, his framework is lack of clarity on how a SN compares to a CAS. Some of the latest publications that integrates complexity theory into supply chain management (SCM) research focus their attention to the behavior of the supplier. For example, Choi and Kim (2008) highlight the importance to recognize that supplier are embedded in a network, therefore the performance of the supplier not only depends on the individual capabilities but it is also influenced

by the network. In summary, these are just examples of how the has been used by scholars to enrich the SCM research.

Table 6. Framing Supply Networks (SN) as Complex Adaptive Systems (CAS). Source: Adaptation of (Choi et al., 2001; Pathak et al., 2007; Surana et al., 2005)

FOCAL POINT OF CAS	DESCRIPTION OF CAS	SN ILLUSTRATION
1. Internal Mechanisms	***The interaction of the agents within the system follows shared mechanisms***	***It explains the internal structure of the SN and the mechanisms present in the interaction between suppliers***
1.1 Agents and schema	Agents interact with each other and with the environment following shared and simple behavioral rules in order to increase their "fitness". Moreover, the agents have the ability to evolve as they learn from such interactions	Firms work together based on shared economic incentives Suppliers behave strategically in order to maximize their gains
1.2 Self-organization and emergence	New structural, properties and patterns are created through simultaneous actions of multiple agents. No central entity controls or imposes new structures, properties or behaviors to the whole system	The SN emerges without any central entity that organizes or controls it The binding force is the flow of materials, information or financial exchange between suppliers of related industries.
1.3 Connectivity	Agents are inter-related at different levels, leading to emerging interdependencies	There is a co-existence of competition and cooperation among suppliers: Different suppliers act autonomously based on own interests, and they might even compete for scarce resources. However, when it comes to price reduction, development of new technologies or performance improvement, they become highly dependent of each other

Table 7. Framing Supply Networks (SN) as Complex Adaptive Systems (CAS). Source: Adaptation of (Choi et al., 2001; Pathak et al., 2007; Surana et al., 2005) *(Continuation).*

FOCAL POINT OF CAS	DESCRIPTION OF CAS	SN ILLUSTRATION
2. Environment	***External conditions and events to the system that influence the behavior of the agents***	***The environment around SN includes consumer markets, global economics, technological landscape, geographical regions, etc.***
2.1 Dynamism	The only thing that is constant is change	Suppliers enter and exit the SN constantly
2.2 Rugged Landscape	To determine global optimization in rugged landscapes is complex. Hills and deep valleys compose rugged landscapes, where hills represent optimal states. To determine the global optimum is analogous to visualize the highest mountain from any middle point within the landscape	There is no global winner. The most feasible solution is to achieve local optima. In SN, local optima is represented as win-win solution, as different suppliers achieve good results overall, but none of them achieve the optimal results of a particular deal.
3. Co-evolution	***A CAS reacts to and creates its environment. The actions and reactions of the agents are triggered by external events or the actions of other agents***	***It refers to how the SN co-evolves with new customer markets, new technological developments, economic trends or even natural disasters***
3.1 Quasi equilibrium	Edge of Chaos: A CAS balances between complete order and incomplete disorder	SN tend to maintain their configuration, however, they can undergo a radical structural change when they are stretched from equilibrium.
3.2 Non-Linear changes	There may be small changes that lead to a dramatic reorganization within the system; conversely, there may be large changes with relative small influence over it	Massive efforts of supplier development and innovation leads to random results.
3.3 Non-random future	Underlying common behavioral patterns are observable.	Bullwhip effect: A small inaccuracy in the demand forecast might cause amplified changes as one moves upstream in the supply chain.

In this sense, the academia argues that framing the supply networks as CAS captures the complexity needed to recognize the suppliers' behavior as an important element that should be factored in the analysis of supply networks (Choi & Kim, 2008). In the past decades, managers have also realized the importance of a complex system perspective, as they struggle with the dynamic nature of the supply network on daily bases. As Pathak (2007) pointed out, when decision-making is based on non-complex assumptions, managerial frustration rises. For example, it is common to find cases where a thorough analysis of the supply chain is done, however it is never implemented, as the preliminary assumptions does not hold true when the implementation phase is due to start (Choi et al., 2001). Therefore, by thinking of SN as a CAS, managers and researchers could understand and control the behavior in a more timely and effective manner, thus the interventions planned are more likely to be effective. In the light of the new body of knowledge created about Complex Adaptive Systems, supply networks are posit as Complex Adaptive Systems, therefore they must be managed as such (Choi et al., 2001; Surana et al., 2005).

Table 6 posits a detailed description of each element of a CAS and how it is illustrated in a SN. The content of the table is self-explanatory, and integrates the main arguments that supports the reasoning behind the formulation of a SN as a CAS. Three representative papers are included in the analysis, however, the main contribution to the table is attributed to Choi at al. (2001), as they proposed the main categories explained there. Finally, Choi at al. (2001, p. 365) provides a holistic definition of the SN that incorporates the complexity theory, which reads as:

"*A supply network is a collection of firms that seek to maximize their individual profit and the livelihood by exchanging information, products and services with one another. Therefore, the nature of interactions among firms adjacent in a SN determines the type of behavior the network as a whole exhibits and the level of control that any one firm has over another*"

4.4 Summary

As mentioned in the introductory paragraph, this chapter answers the second sub research question: *Why is it important to analyze the dynamics of the supply network?* As mentioned in Chapter 3, the supply base is the portion of the supply network that the focal company actively manages; it also suggests that the optimization of the supply base should aim to reduce its complexity. However, it neglects the agency of the suppliers, which means that suppliers behave strategically in order to maximize their gains, evidencing competition among them. Nevertheless, competition among supplier

co-exists in the supply network along with cooperation as when it comes to price reduction, development of new technologies or performance improvement, they become highly dependent of each other. Therefore, I argue that to actively manage the supply base means to implement the right control mechanisms to mold the behavior of the suppliers according with the interests of the focal firm. Moreover, focusing on complexity reduction when optimizing the supply base is a simplistic approach, as it neglects the behavior of the suppliers and do not suggest how to control it. Additionally, framing SN as CAS highlights the fact that the actors involved in the process to optimize the supply base have the power to make their own decision; however, the theories review in this Chapter does not provide any insights on how this decision making process evolves. It is assumed that the focal firm would like to influence such process, aiming to obtain the best outcomes. Therefore, the next chapter dives into the theories of decision making in network, attempting to understand how the decision making process in networks develops and which strategies are useful for the focal firm to obtain the desired results.

As a summary, Table 8 shows the main concept elicited from the literature reviewed during the development of this chapter. Additionally Figure 6. Visualization of the supply network and supply base provides a graphical representation of the supply base and the supply network.

Table 8. Summary of concept of Chapter 3. Source: Adaptation of (Choi et al., 2001; Pathak et al., 2007; Surana, Kumara, Greaves, & Raghavan, 2017)

CONCEPT	DEFINITION
Network	A set of discrete individual or collective social units that have any instance of connection of interest between them
Complex Adaptive System (CAS)	A CAS is a system that emerges, adapts and organizes itself over time without any particular entity organizing or directing it
Internal Mechanisms	The interaction of the agents within the system follows shared mechanisms
Environment	External conditions and events to the system that influence the behavior of the agents
Co-evolution	A CAS reacts to and creates its environment. The actions and reactions of the agents are triggered by external events or the actions of other agents
Agency	The ability of an element of a network to make choices and influence the course of events
Supply Network	A complex adaptive supply network is a collection of firms that seek to maximize their individual profit and the livelihood by exchanging information, products and services with one another. Therefore, the nature of interactions among firms adjacent in a SN determines the type of behavior the network as a whole exhibits and the level of control that any one firm has over another"

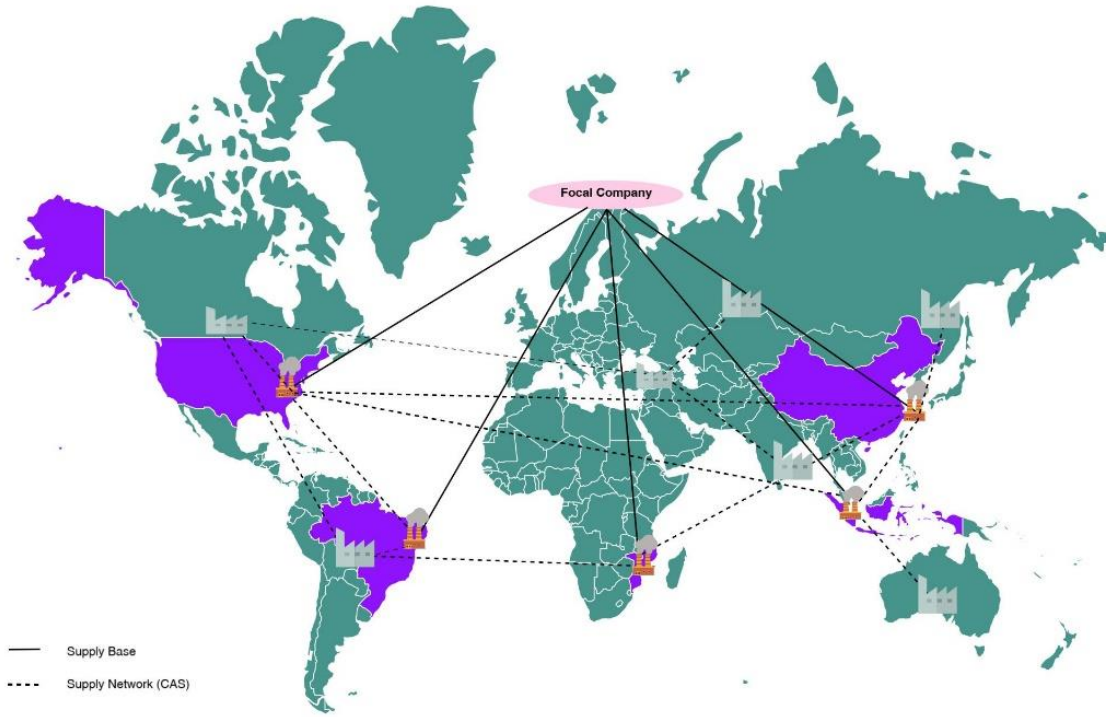


Figure 6. Visualization of the supply network and supply base. Source: This project

CHAPTER 5: Decision Making in Supply Networks

As discussed in the previous two chapters, there are two main reasons to explore the theory of decision making in networks. First, Chapter 3 made prominent the lack of attention the existing frameworks paid to the decision making process that happens in the organization prior initiating a project to optimize the supply base. On the other hand, Chapter 4 concluded that framing SN as CAS acknowledges the fact that the actors involved in the process to optimize the supply base have the power to make their own decision; however, the theories review in Chapter 4 does not provide any insights on how this decision making process evolves in the supply network. For this reason, this chapter presents the main elements of the theories of decision making in networks. Five sections form Chapter 5, that is Organization are networks (Section 5.1), Decision Making in Networks: Project Based versus Process Based (Section 5.2), Strategies in the Process-based approach (Section 5.3) and Summary (5.4). Specifically, Section 5.1 explains how organizations are frame as networks even though there is a hierarchical structure in place. Section 5.2 describes how the decision making process develops in networks and its main characteristics. Section 5.3 describes some of the strategies provided by the literature on how to steer the decision making process in networks, with the ultimately goal to explore which of such strategies could help the focal firm to achieve the desire outcome when optimizing the supply base. Finally, Section 5.4 presents a reflection of the chapter and summarizes the key learnings. By the end of this chapter, the third research sub question is answered, which is: *How does the process of decisions making develops in supply networks and organizations when optimizing the supply base?*

5.1 Organizations are networks

In order to organize its operations, firms place hierarchy structures using different levels of authority and a vertical link of chain of command. Even though organizations have a hierarchical structure in place, De Bruijn and Ten Heuvelhof (2008) argues the different interdependencies and interests result in a network-like organization. For example, a company consists of many departments, which might have different interests and at the same time each department also depend upon each other and rely on each other's support, at least because they are part of the organization. The complexity of the relations between departments and the different interests result in an organizational structure that reassembles more a network than a hierarchy does. Moreover, a company and its internal network is also part of an external network that is composed by other companies, thus for a company to create

and maintain its competitive advantage, it should serve not only the interests of its shareholders, but also the concerns and interests of its stakeholders situated in the external network.

The closedness towards an intervening actor is more prominent in a network than in a hierarchy (De Bruijn & Ten Heuvelhof, 2008). In a hierarchy, intervening actors are able to use their power to impose their will to its subalterns, and the subaltern is open to the intervention. In a network, actors are not always sensitive to intervening actors. The closedness of a network will depend on the core values of the organization, those values that are printed in the organizational DNA. For some companies, "Safety is always first" or "Quality is our differentiator". Another characteristic of networks is its dynamism. Actors change and adapt they behavior and beliefs, join and leave without any apparent pattern and behave strategically.

The previous two paragraphs elaborated on the four elements that characterize the organizational networks. First, variety represents the different interests of the departments of the company. Second, it elaborated on the mutual dependencies between the different bureaus that compose a company. Third, describe how actors might be closed to hierarchical intervention of other actors. Finally, it acknowledges the dynamic nature of the network. Table 9 shows a summary of these characteristics and compare it with the antagonist element that characterize a hierarchy.

The network-like structure of the organizations nurture complex problems, where the information to solve it is questionable and decision makers disagree on the norms that rule within the context of the problem. In this sense, the supply base optimization can be framed as a complex problem that managers must dealt with. Chapter 6 explains in detail this relationship, however, in the meantime, the next section will elaborate on the approach for decision making in networks.

Table 9. Characteristics of a hierarchy and a network. Source: Adaptation of (de Bruijn, ten Heuvelhof, & in 't Veld, 2010)

HIERARCHY	**NETWORK**
Uniformity	Variety: Different interests
Dependence on superior	Mutual Dependencies: Different departments that depend on each other's support.
Receptiveness to hierarchical signals	Closedness to hierarchical signals
Stable – Predictable	Dynamic – Unpredictable

5.2 Decision making in networks: Project-based approach versus Process-based approach

The previous section defined two structures found in companies: hierarchical and network. Interestingly, the decision making process in hierarchies is different from the decision making process in networks. In hierarchies, the most common approach is called the analytical or project-based approach, where there is a delineated problem, a finite set of solutions and decision makers make their informed decisions based on complete information. However, decision making in networks is different. Managers are often confronted with unstructured problems, which means that problems do not have one right solution, as there is no problem, but problem perceptions; thus, the approach followed in networks is called process-based or negotiation approach. The following paragraphs elaborate more on the characteristics of the process-based approach in comparison with the project-based approach.

As a starting point, the process-based approach follows a counter-intuitive order: it does not begin with the problem and goal formulation. The goal is a byproduct of the process and there are no problems, but problems perceptions. As mentioned before, the process-based approach is also known as negotiated approach, as it focuses in the creation of negotiated knowledge to achieve a result that satisfices most of the parties involved, becoming partial winners, therefore it is characterized as a process of give-and-take among the participants. Another relevant aspect of the process-based approach, is the definition of "successful outcome". In the project based approach, decision makers called an outcome successful when the predefined goal is achieved at the lowest goal possible, whereas in the process-based approach, a successful outcome is when the participants believe there was a fair process in place and the goals and new goals were achieved. Table 10 summarizes the main attributes of the process-based in comparison with the project-based approach.

On the other hand, the experts in the domain of decision making in networks have studied this process and elicited strategies to deal with the decision making processes within networks. The next section will explore some of these strategies.

Table 10. Decision making in a hierarchy and a network. Source: Adaptation from (de Bruijn et al., 2010)

PROJECT-BASED APPROACH	PROCESS-BASED APPROACH
Regular: Clear starting and ending point	Irregular: No isolated starting point
Phases or defined steps	Rounds | Different arenas
Actors are stable	Actors join and leave, behave strategically and there are winners and losers when the problem is formulated
Goal formulated in advance	Goal formulation is a "ongoing process"
Right information leads to the right decision	Right process leads to the right decision
Find means to select the optimal alternative	Uses interests to create negotiated package deal
There is a problem, then a solution is formulated	Solutions looking for problems. Incentive to regard the problem as structured.
Evaluation depends on the realization of goals at the lowest possible cost.	Evaluation depends on the realization of goals (including new goals) by using a fair process.

5.3 Strategies

Some of the strategies used in the Process-Based approach are summarized in the table below. The previous chapters framed the supply base optimization as a process that evolves in networks with different characteristics; therefore, the supply base optimization process is a combination of decisions made in network. Thus, it is important to review the different strategies used by the actors during the process. In general, due to the ambiguity and diversity often faced in decision making in networks, the literature offers some strategies to get commitment from the main stakeholders and achieve good enough results. The strategies describe below could serve two purposes: Obtain collaboration of relevant stakeholder or delay or block the initiatives. Thus, it is relevant to explore them more in detail. For example, problem formulation and goal formulation are strategies that help to gain the interests of stakeholders, in other words it invites actors to sit at the negotiation table. On the other hand, the achievement of negotiated knowledge creates a common baseline to progress, however the lack of it could drastically delay the development of any initiative due to lack of commitment. Delays in the implementation of any idea to solve the problem can be also cause by changes of pace of powerful actors or by focusing on the process and rules only, and not on the content of the solution. On the contrary, strategies like managing the frontstage and the backstage, priming or framing could help to engage actors with the resources needed to push forward specific solution. It is good to mention that

not all the strategies are suitable for any situation. Each situation must be evaluated and strategies should be applied accordingly.

Table 11. Strategies used in decision making in networks. Adaptation of (De Bruijn & Ten Heuvelhof, 2008; de Bruijn et al., 2010; Lakoff, 2004)

STRATEGY	DESCRIPTION
Problem Formulation	Broad problem formulation
Goal Formulation	Broad aims
Information	Pursue negotiated knowledge
Changes of pace	Freezing and unfreezing the process (Window of opportunity), non-decisions
Backstage | Frontstage	Process-based actions, project-based communication
Process Orientation	Agreement on substantive norms (Agree on the process you are going to follow).
Priming	Creation of a burning-platform
Framing	Do not give just facts, give the public a framework (Lakoff, 2004)
The language	Listen, consult, keep an open position for discussion , involve parties in the discussion
Stakeholder Analysis	Analyze the power, resources and influence of the actors impacted by the initiative

5.3.1 Stakeholder analysis

A single actor cannot solve most of the problems faced in networks, therefore the understanding of the interests, influence and resources of the actors implicated in the analysis help to steer the decision making process towards an outcome that benefit more of the parties involved. For this reason, the literature strongly suggest to create a stakeholder inventory or stakeholder analysis. The stakeholder analysis is map of the actors that are involved or impacted by the problem at hand and their most relevant characteristics as interests, perception of the problem, resources and networks (De Bruijn & Ten Heuvelhof, 2008; Enserink et al., 2010). Based on power and interests, there are four types of stakeholders, namely subject, crowd, context setters and players Enserink et al. (2010). On the other hand, De Bruijn and Ten Heuvelhof (2008) defines three types of power: Production, blocking and diffuse. Production power means that the actor owns the resources to make something happen; whereas blocking power means that an actor can only halt the initiative. On the other hand, diffuse power means that it is not clear how the actor might utilize its resources with respect to the initiative.

The stakeholder analysis is relevant to understand who will be part of the process of decision making at stake, and the strategies to be used in order to achieve the best outcome out of the process.

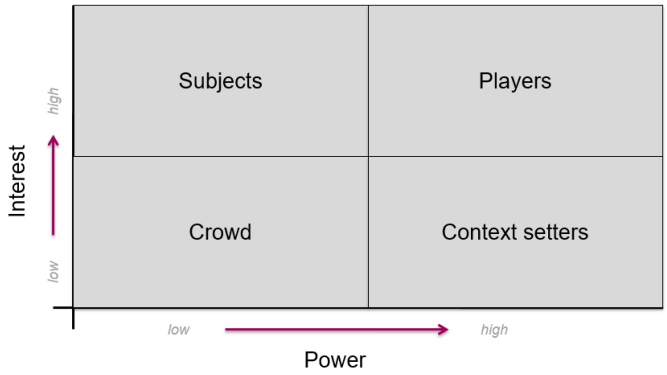


Figure 7. Power – Interest grid for stakeholder analysis. Source: adopted from Enserink et al. (2010)

5.4 Summary

As mentioned in the introductory text, this chapter aims to answer the third research sub question, which reads as, *How does the process of decisions making develops in supply networks and organizations when optimizing the supply base?* In this regard, Section 5.1 explained how firms have a network like organization, embedded in an external network composed by other companies. Therefore, it adds a third network involved in the process to optimize the supply base, which was named the *organizational network*. The resulting landscape is presented in Figure 8 that provides a visualization of the three networks involved in the process to optimize the supply base, namely the supply network, a subset called the supply base and an embedded organizational network that represents the focal firm. Secondly, Section 5.2 describes the process of decision making in networks, which follows a process-based approach. Different from the project-based approach, the process-based approach has no clear goal, as the solution of the problem at stake is an outcome of the process itself. This approach differs from what the frameworks explained in Chapter 3 proposes, as they emphasizes that clear goal setting is a key element to optimize the supply base (Ogden, 2006) and that a reduction of the supply base is the ultimate desirable goal (Ogden & Carter, 2008; Sarkar & Mohapatra, 2006). Therefore, this chapter concludes that based on the literature analysis, the process based approach is suitable to address the problem posed by the optimization of the supply base and to manage the three interconnected networks involved in the process. In this sense, the next chapter consolidates the findings of the previous chapters and presents a theoretical framework to analyze the process to optimize the supply base from a network-level perspective, which is the baseline to analyze the data elicited from

the case studies. Finally, Table 12 shows a summary of the main concepts reviews in this chapter and Figure 8 presents the landscape of networks involved in the process to optimize the supply base.

Table 12. Summary of Chapter 5. Source: Adaptation of (De Bruijn & Ten Heuvelhof, 2008; de Bruijn et al., 2010)

CONCEPT	DEFINITION
Organizations are networks	A company consists of many different departments and bureaus, which might have conflicting interests, both within and between themselves. However, each of these bureaus also depend upon each other and need each other's support, at least because they are part of the organization. These interdependencies and different interests result in a network-like organization.
Project-based approach	Approach used in situations where the problem at stake has few possible solutions, from which the decision makers choose.
Process-based approach	Approach used in situations where the problem is regarded as unstructured, meaning that it does not have one right solution, giving the actors the freedom to act and behave strategically.
Strategies for decision making in networks	When using process-based approach, actors use different strategies to achieve fulfil their interests. For example, broad problem and goal formulation, seek for negotiated knowledge, changes of pace, manage the front and back stage, focus on obtaining process agreements.

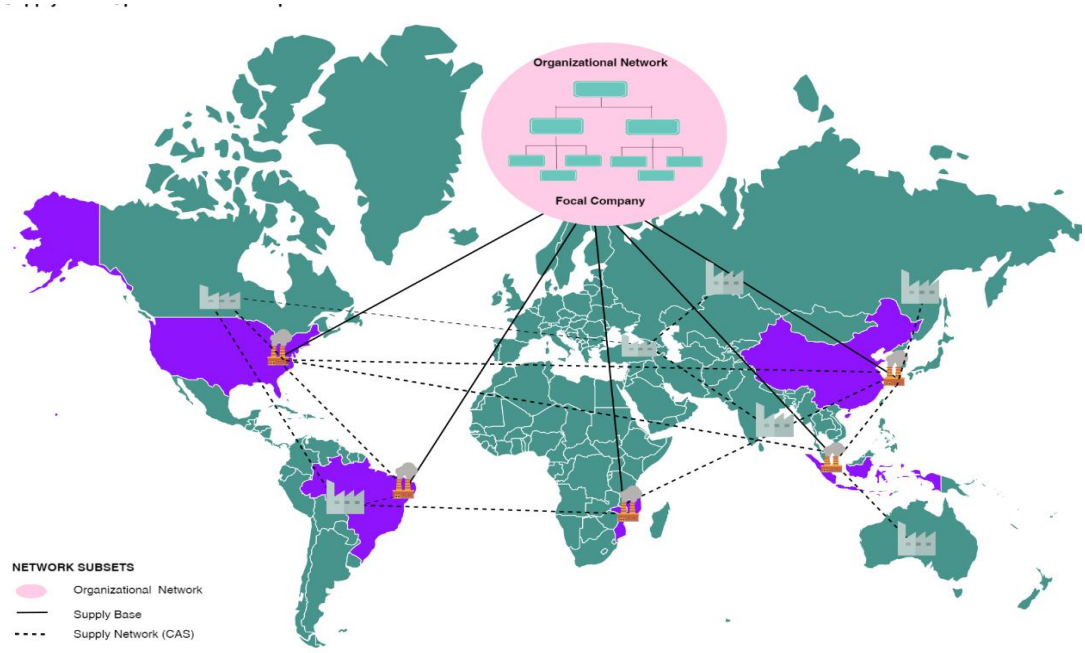


Figure 8. Visualization of the Supply Network, Supply Base and Organizational Network. Source: This Project

Chapter 6: Theoretical Framework

The previous three chapters discuss the theoretical foundations of the framework is presented in this chapter. Chapter 3 presents the focal firm as the entity that actively manage the supply base. Chapter 4 presents the supply base as a subset of the supply networks, which is framed as a CAS and discuss the implication of it. Chapter 6 describes how the process of decision-making develops in networks and concludes that the process-based approach is suitable approach to develop the optimization of the supply base. Finally, this chapter consolidates the previous analysis into one framework that will be the baseline to analyze the case studies in Philips, which is presented in the next part of this thesis that is Part III: Analysis & Conclusions. The structure is this chapter is as follows, Section 6.1 presents an in depth analysis of the literature presented and shows the reasoning the leads to the theoretical framework presented in Section 6.2. By the end of this chapter, the fourth research sub question is answered, which is *RSQ4: What are the main elements to deal with when optimizing the supply base?* Creating the theoretical foundations to investigate how the optimization of the supply base is executed in the practice from a network-level perspective.

6.1 Analysis of the literature review

The previous chapters presented the different networks that are involved in the process that a firm undergoes when optimizing the supply base. Chapter 3 refers to Choi and Krause (2006) to describe the supply base as the network that is managed by the focal firm. Subsequently, Chapter 4 poses the SN as a CAS based on the papers by Choi at al. (2005) and Surana et al. (2017), acknowledging that the SN is a self-emergent system that co-evolves with the environment. Lastly, Chapter 5 recognizes the firm that aims to optimize the supply base as a network-like organization, based on De Bruijn and Ten Heuvelhof (2008). Concisely, the previous chapters describe the networks involved in the process to optimize the supply base, however does not provide guidance on how to deal with them. On the other hand, traditional operation management approaches have primarily focused on technical issues, thus this approaches does not effectively capture nor describe the structural and behavioral complexities inherent in SNs.

Therefore, it is proposed to use the network analysis to decompose the characteristics of each network at stake, as a first step to build theory on how to optimize the supply base. Network Analysis is posed by Bellamy & Basole (2013) as promising approach to overcome this theoretical and methodological gap experienced in traditional operation management. After an extensive literature review, the authors

identified three fundamental themes to analyze the SN: Structure, Dynamics and Strategy. He uses his framework to analyze the SN as a whole, this thesis uses the same framework as a starting point to analyze each network identified in previous chapters and that are involved in the process to optimize the supply base. The overview of the integrated framework proposed by the authors is shown in Figure 9.

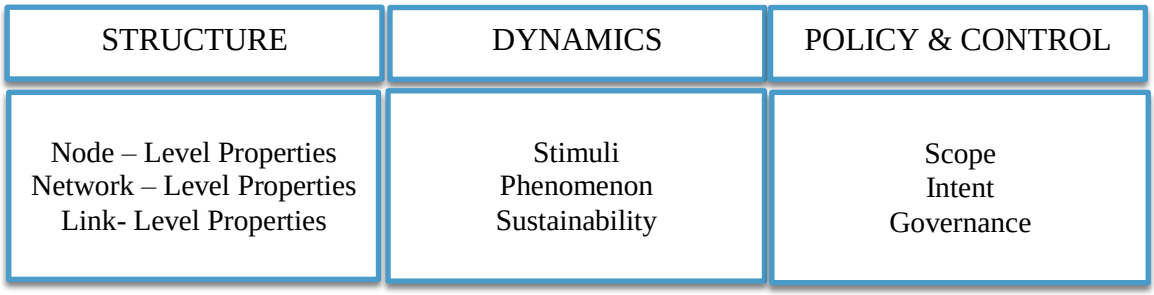


Figure 9. Integrated framework. Source: Adopted from (Bellamy & Basole, 2013)

As mentioned, each theme identifies a different element of a network, namely Structure, Dynamics and Policy & Control. The following paragraphs explain how the theories reviews in the previous three chapters fit into the framework proposed by Bellamy and Basole (2013) and create the theoretical framework to be used in the analysis of the case studies. Therefore, it explains the theoretical base line to characterize the structure, dynamics and policy & control of the three networks identified, that is to say, organizational network, supply base and supply network.

First, the ***structure*** of a network refers to the organization its components, their relationship to each other and to the environment and the guidelines directing their evolution. Bellamy & Basole (2013) identified three sub topics, that is Node-Level properties, Network-Level properties and Link-Level properties. First, Node-Level properties refer to the metrics used in Social Network Analysis (SNA), as closeness, brokerage and degree. The determination of such properties requires a quantitative analysis based on the guidelines and tools used in SNA, therefore, this sub topic was not included within the scope of this thesis. Secondly, Link-Level properties refer to the linear connections between buyer and supplier, which Chapter 1 posed as the traditional focus of supply management research, therefore this sub topic was also excluded from the scope of this thesis. Finally, Network-Level properties describes the architecture of the network, as it names indicates. One of the most important measurement within this sub-topic is the complexity, which was defined by Choi at al. (2001) as the structural differentiation that exist in a network, which is associated with the number of elements within the network and how different such element are form each other.

Based on the previous description analysis, the complexity of the network was chosen as the network-level construct that best describes the structure of the network based on the scope of this thesis. Therefore, the complexity of the organizational network is defined as the number of business units involved in the optimization of the supply base, the degree of differentiation and the level of interrelationships among these. Similarly, following this reasoning, Choi and Krause (2006) defined the complexity of the supply base as the number of suppliers, the degree of differentiation and the interrelation among them. On the other hand, the definition of the structure of the supply network is not so straightforward. As mentioned in Chapter 4, the supply network is a self-emergent network that lack of a central control, which balances between the edge of chaos and perfect order (Surana et al., 2017), in consequence, its structure is in constant change. For this thesis, the scope is to study this dynamic behavior and how understand how it affects the process to optimize the supply base.

Secondly, the ***dynamics*** of the network refer to the formation, change and evolution of the network over time, including the understanding of the drivers for formation and evolution (Bellamy & Basole, 2013). These authors defined three main sub themes that are stimuli, phenomena and sustainability. Stimuli relates with the drivers of formation and change, defining agency as the ability of the actors to make decision to adapt to the environment and maximize their gains, as it was describe in Chapter 5. In simple terms, stimuli refers to the interests of each actor, which is considered a key element to understand the behavior of each agent, therefore it is included in the framework presented in the next section. Phenomena refers to the nature of change and sustainability as the ability of a firm its supply chain to remain robust and responsive. Since the scope of this thesis is not to determine the best supply base, both sub themes are out of the scope this thesis.

Based on the previous description analysis, the stimuli of the organizational network is defined as the interest of each business unit. Subsequently, the stimuli of the supply base is defined as the specific interests of the suppliers within the supply network and the behaviors they show to achieve them. Similarly, the suppliers in the supply network have their own interests and behaviors. The behavior of the suppliers was explained in Chapter 5, where the SN was frame as a CAS. The only difference between the behavior of the suppliers within the supply base and the suppliers that are not, is that the former case, the focal firm has the power to constraint such behavior, whereas the latter case has no external control, therefore their behavior is unpredictable. However, the focal firm does not have any active control over such behaviors, unless they become part of the supply base.

Thirdly, the ***Policy & Control*** of the network refers as the mechanism in place to devise, adapt and control in order to meet the desired objective of the firm (Bellamy & Basole, 2013). At this point, it becomes prominent the egocentric view this thesis takes (explained in Chapter 2), as it is centered in the focal company. Therefore, the focal firm is the entity imposing the control mechanism. Bellamy and Basole (2013) defines this theme in general terms as shift of focus in supply management research from the dyadic relationship between buyer and supplier to a holistic understanding of the overall value of the supply network, which is more relevant for large-scale firm that operates globally. Therefore, for this reason the definition by Choi and Krause (2006) is more precise, in the sense that they argue that the active management of the supply base is through contracts and agreements that regulates the relationships with the suppliers in the supply base. On the other hand, the active management of the organizational network is impose by the governance of the firm itself by the creation of a hierarchy and procedures that aim to structure its operations.

Finally, the **optimization the supply base is posed as a process-based approach**, which was explained in Chapter 5. This means, the ultimately goal of the process is an outcome of the interaction of the different actors involved in the process, and not the starting point of a project, as stated by Ogden and Carter (2008). It also means that optimizing the supply base is an activity that should also create a set of rules that guide the process, activity that was neglected in the frameworks reviewed in Chapter 4. Based on this analysis, the next section presents the final framework that will support the analysis of the optimization of the supply base in Philips.

6.2 Theoretical framework based on the literature review

The previous section discussed the line of reasoning followed to create the theoretical framework presented in this section. As previously mentioned, it is based on the literature analyzed in Chapter 3, 4 and 5. Additionally, the main elements of the theories studied are organized following the integrative framework proposed by Bellamy and Basole (2013), which was discussed in Section 6.1. The outcome of such extensive scientific analysis is presented in Table 13. Additionally, the full picture of the landscape where the process to optimize the supply base evolves is presented in Figure 10.

Table 13. Theoretical framework to analyze the process to optimize the supply base. Source: This project

NETWORK SUBSET	NETWORK STRUCTURE	NETWOKR DYNAMICS[8]	NETWORK POLICY AND CONTROL[7]
Definition[1]	Fundamental organization of a system embodied in its components, their relationships to each other and to the environment, and the principles guiding its design and evolution	Formation, change and evolution of the network over time. It included the understanding of the drivers for formation and evolution and the nature of change.	From the standpoint of the focal firm, it is the art of devising, adapting and executing a plan of action to meet desired firm objectives.
Organizational Network[2]	Defined by the complexity of the network[7]: - Number of business units - Degree of differentiation - Employee interrelation (closedness) Established by the organizational structure	Agent: Business Unit Interest: Have an efficient supply base Behavior: Constraint by organizational rules and procedures, but with room for strategic behavior	Governance: Rules, guidelines and procedures imposed by the focal firm itself.
Supply Base[3]	Defined by the complexity of the network[7]: - Number of suppliers - Degree of differentiation - Supplier Interrelation Focal company can modify the structure of the supply base	Agents: Supplier within the supply base Interest: Maximize gains, remain part of the supply base Behavior: Constraint by contracts, informal agreements and expectations. However, there is room for strategic behavior.	Intent of suppliers and focal firm: Gain competitive advantage Governance: Mutual agreements, contracts, partnerships
Supply Network[4]	- Self-organized and emergent New structural patterns are created through simultaneous actions of multiple agents. No central entity imposes new structures[8].	Agent: Supplier within supply network but outside the supply base Interest: Maximize its gains, become part of the supply base Behavior: Unpredictable[8]	Intent of suppliers: Gain competitive advantage Governance: Not applicable, as it is self-emergent and lacks of any type of central control[8].
S.B.O[5] Process[6]	Overarching process that aims to reduce the complexity of the supply base of the focal company and set the right control mechanism to coordinate and control (when possible) the three different network subsets. It deals with three elements of each network: Structure, Dynamics and Policy and Control		

Notes
[1] Definitions are based on Bellamy and Basole (2013).
[2] This network defined as part of the supply base optimization landscape in Chapter 5.
[3] This network defined as part of the supply base optimization landscape in Chapter 3.
[4] This network defined as part of the supply base optimization landscape in Chapter 4.
[5] S.B.O.: Supply Base Optimization
[6] Follows a process-based approach described in Chapter 5.
[7] Based on Choi and Krause (2006)
[8] Based on (Choi et al., 2001; Pathak et al., 2007; Surana et al., 2005)

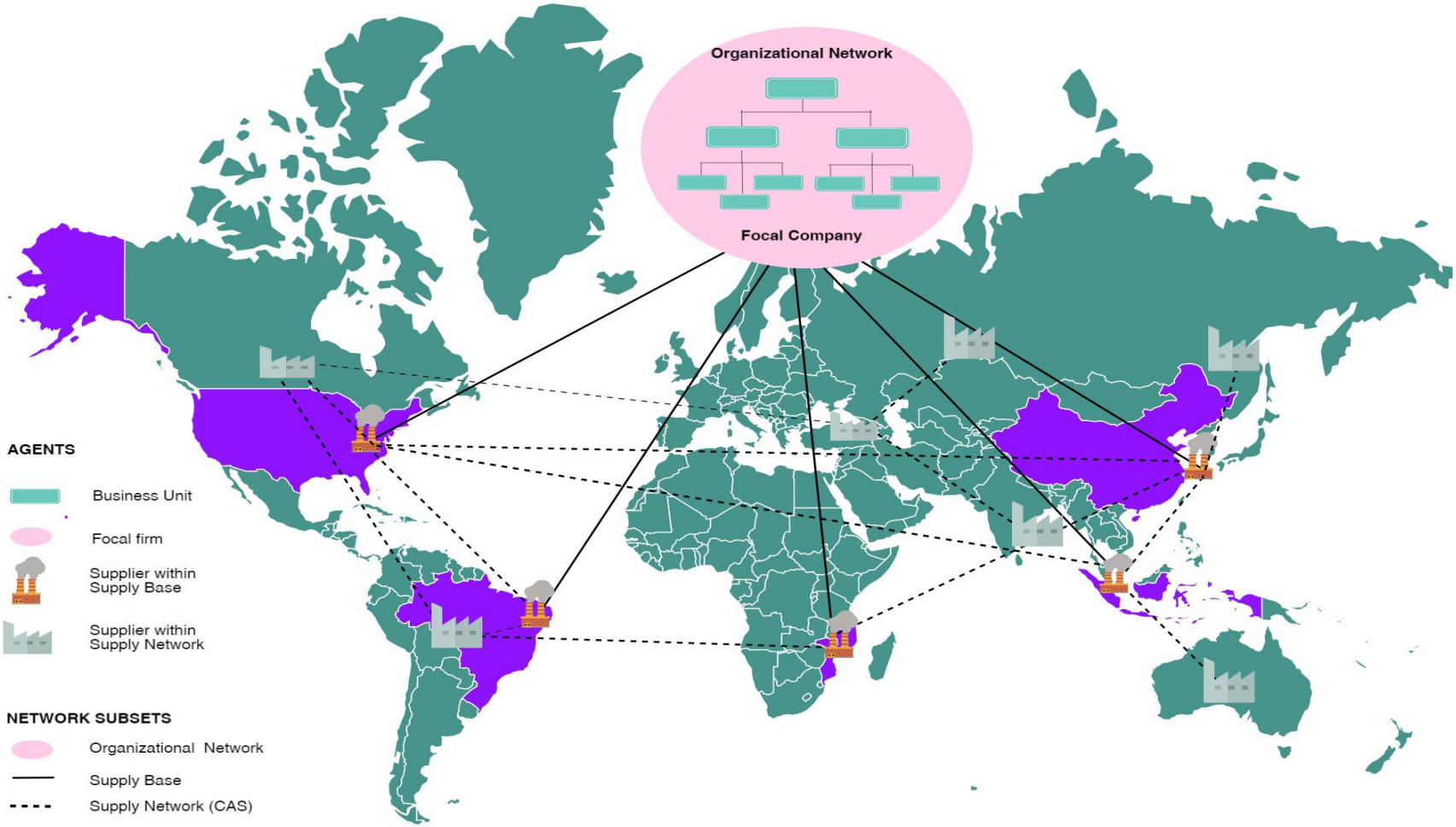


Figure 10. Supply base optimization landscape. Source: This project

PART III: ANALYSIS & CONCLUSIONS

CHAPTER 7: Company Description

The previous part, Part II: Theoretical Foundation presented the literature review and analysis that generated the framework presented in Chapter 6, which is the baseline for the analysis of case studies that will be presented in this part, Part III: Analysis & Conclusions. This chapter deals with Stage C, presented in Figure 1, in Chapter 2, where the overall planning of the research was presented. Three chapters composed the final part of this thesis that are Company Description (Chapter 7), Analysis of Case Studies (Chapter 8) and Conclusion and Recommendations (Chapter 9). Chapter 7 presents a general description of Philips, which is the company where the case studies were developed. Chapter 8 presents the process to select the case studies and the analysis of the evidence collected in the field. Lastly, Chapter 9 presents the conclusions derived from the development of this research and the recommendation for Philips and the academia. In summary, Part III presents the development and outcomes achieved during stages C, D and E of the planning presented in Figure 1.

7.1 Company Background

As mentioned in Chapter 2, the development of the case studies was done in Royal Philips, which represents the context of this research. Specifically, Royal Philips is a Dutch technology company founded in Eindhoven in 1891. It has a long history of product development and innovation, having revolutionized the production of very diverse products. Table 14 shows a summary of the technological heritage that characterizes Royal Philips. However, currently, the company focuses on three main areas: consumer electronics, healthcare and lighting. The company is organized into two main clusters: Personal Health and Health Systems. Figure 1 displays a graphical representation of how the company is organized (Koninklijke Philips N.V., 2014).

Table 14. *Philips' technological heritage. Source: Adapted from (Koninklijke Philips N.V., 2014)*

Period	Main technology
1891 - 1915	Carbon filament lamps
1915 - 1925	X-Rays machines and radios
1925 - 1940	Radios, televisions and electric shavers
1940 - 1970	Introduction of the Compact audiocassette and ground breaking contributions in transistors and integrated circuits.
1970 - 1980	Product innovation for images, sound and data
1980 - 1990	Technological landmark: Compact Disc
1990 - 2000	Successful commercialization of Compact Disc technology
2000 – Present	3D scanner and health solutions

The cluster of Personal Health has a highly diverse portfolio of products. It has five main business groups (BG), which are very different among each other: Domestic appliances, Personal care, Coffee, Health & Wellness and Sleep and respiratory care. It is interesting to note how commoditized and innovative products are managed within the same cluster. The first three BGs has highly commoditized portfolios that contains products like blenders, hairdryers, trimmers, vacuum cleaners, etc. In the other hand, Health and Wellness has innovative products as the Sonic Care and Vita-light. Thus, business leader of Personal Health must manage a highly diverse portfolio of products with a wide range of technological characteristics.

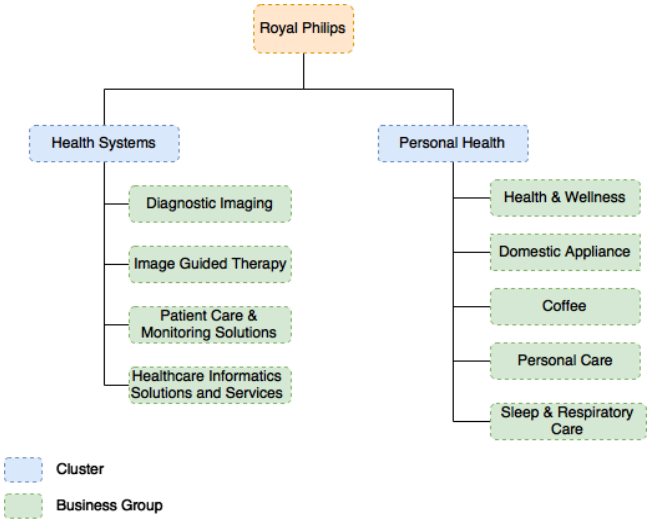


Figure 11. Organization Royal Philips. Source: This project

The cluster of Health Systems has a stronger focus on innovations and connected healthcare. This cluster has four business groups: Diagnostic Imaging, Image Guided Therapy, Patient Care & Monitoring Solutions and Healthcare informatics solutions and Services. Each business group is divided in subsequent business units, making fifteen business units in total. Some representative products provided by this cluster are MRI machines, X-Ray systems, monitoring systems and ultrasound equipment.

In general, it can be concluded that the degree of innovation of the products offered by Personal Health is incremental, whereas the cluster of Health Systems offers highly innovative products.

7.2 Procurement Department

Philips is a divisional organization that was lacking an overarching procurement department until 2012. The procurement function was part of the operations department of each business group, which was an autonomous business itself. Several internal tools were developed and used to carry out the procurement activities, however, such autonomy made that each procurement department used the common tools available in different ways, creating diverse outcomes. As each group was performing their supply chain management in relative isolation, hence the overall supply based evolved into a large and inefficient network of suppliers that were difficult to manage and control. In total, Philips has a supply base of more than 5500 suppliers globally. Nevertheless, in 2012, an overarching procurement department was stablished in 2012, bringing to the procurement function a new and integrated vision and mission. Thus, the new department agree on three commitments to the company: 1) Accelerate growth and improve performance 2) though increased customer focus, greater speed and higher quality of execution 3) and making any further progress with the strategic values. Moreover, as part of the third commitment, optimization of the supply chain became an important part of the activities the procurement department is responsible for (Philips, n.d.).

The main KPIs measure within the procurement organization are shown in the table below.

Table 15. Summary of main procurement KPIs. Source: Adapted from (Philips, n.d.)

TOPIC	KPI	TARGET	DEFINITION
Financials	BoM Savings	5.6%	Total actual "hard-procurement" savings divided by the total spend in the current year.
Quality	Cost of non-quality	1.99%	Maximum value of cost of non-quality per category
	DPPM	-10%	Reduction in DPPM caused by supplier compared to previous year
Risk & Sustainability	Single & Sole Sourcing	94	# of non-accepted single/sole source SKUs in % of the total single source parts as of January 2017
Operational performance	Supplier consolidation	-10%	Reduction of the supply base (Baseline 2016: 5388 Suppliers)
	DfX on NPI	95%	NPI covered by DfX Methodology

7.3 DfX Team

In order to maintain a competitive advantage, firms like Philips, are continuously embracing initiatives that aim to create more value to the customer. One of the most successful initiatives is called Design for Excellence (DfX), which is a team of internal consultants that aims to generate significant impact in term of revenue increase, cost reduction and competitive advantage by optimizing manufacturing footprint. In summary, DfX initiative is looking for ways to reduce the complexity of the supply base that resulted from the relative isolated operations of each business group. The optimization of the supply base is achieve through the development of the so-called *DfX Conventions*.

7.3.1 DfX Conventions

The DfX Convention is the standardize methodology used by the DfX team. Initially, conventions aim to optimize the value chain of a product. Due to its success, it was scaled up to analysis supply base inefficiencies for commodities across multiple business. Therefore, the complexity at stake increased considerably. The ultimate aim of the DfX convention is the creation of ideas that could increase the value for Philips. This is a very important aspect, because it focuses on the idea generation, not on the implementation of such ideas. The standard work plan for each convention is described below.

Table 16. Phase description of the DfX methodology. Source: company documentation

PHASE	PURPOSE
Preparation	Obtain clear alignment and confirmation on timing, scope and dedicated resources and time. Identification of required data, logistics, expertise, and required products' availability for the kick-off
Kick-off	Share current list of potential improvement *ideas* Share any first analyses to underpin selected levers
Idea generation	Define cost drivers
Mid-Term review	Evaluate, quantify the prioritized ideas (CSR). Discuss savings ideas identified in the convention Obtain decision status on all presented ideas (go/no-go) Agree on next steps following convention, including resourcing and responsibilities
Creation of business cases	Create business cases for ideas that obtained a "go" status in the Mid-Term Review
Closure Meeting	Define next steps for implementation

The DfX conventions are temporarily, thus some temporarily roles are assigned to the different members of the team, whom have a fixed role within the organization. The description of the different roles in the DfX conventions is presented below:

Table 17. DfX convention's roles and responsibilities. Source: Company documentation

ROLE	RESPONSABILITIES
DfX Owner	Support convention leader by managing stakeholders Prioritize & commit on the resources for implementation of improvement ideas Typically, the commodity manager takes this role.
DfX Leader	Manage scope, time and resources throughout the DfX as a project manager Manage stakeholders together with team and owner, assuring that DFX convention will be executed and that Ideations are prioritized and resources will execute the implementation. Secure implementation of improvement ideas via agreed resources and ensure progress monitoring & structural report into the Standing system/organization after convention
DfX Coach	Provide knowledge and experience in the DfX methodology to the convention leader and the DfX team
DfX Team Members	Gather existing data, conduct analyses and generate improvement ideas Carry out data analysis and provide in-depth knowledge on solution ideas and risks

7.4 Summary

This chapter provided a description of the Philips, which was defined as the context where the research evolved in. In detailed, this chapter provided a description of the company and procurement department background. Additionally, it provided an explanation about the DfX team and the conventions they develop as their standard methodology.

CHAPTER 8: Analysis of case studies

The previous chapter presents an overview of the context of this research, which is Royal Philips. Thus, after obtaining an understanding of the company environment, this chapter presents the process followed to select the case studies, and a comprehensive description of the case studies. Comprehensive means that the description of the case studies goes beyond the selection criteria presented in Chapter 2, which focused in data availability, diversity and problem formulation only. This section provides information regarding the commodity within the scope of the case study, the products associated with such commodity, year of development of the convention and the general structure of the supply base. This information will enrich the knowledge base about the context of this research, thus it is expected to contribute with a better understanding of the results.

8.1 Selection of the case studies

As mentioned before, Chapter 2 provides a description of the process to select the case, but not the content of it. Thus, this section explains how the list was reduced from 888 conventions available in the database of the DfX Team to three conventions only. First, based on the selection criteria *diversity* only *commodity* conventions were selected. The other type of convention executed by the DfX Team is called *product* convention, which typically focus on the improvement of the product *per se*, like technology improvement, supply chain efficiency or quality improvement of the components; hence, the diversity of the stakeholders in the product convention is not as high as in the commodity convention. From Chapter 2, you might recall that *diversity* was chosen as selection criteria to follow a theoretical sampling based on the recommendation of Eisenhardt (1989). The diversity of the stakeholders is an element that characterize decision making in networks, thus it is important to make sure that the case studies are being analyzed, represent such theory. Therefore, based on this logic and the feedback of the company supervisor, the *commodity* conventions were selected, which reduced the list from 888 to 10 conventions.

The second criteria to evaluate was *data availability*. Chapter 2 mentions that the evaluation of multiple sources of evidence is considered by Yin (2014) as a tactic to increase construct validity when doing case studies. Therefore, the availability of data documented in a standard format is considered a selection criteria for the cases that will be analyze. Section 7.3.1 explains the main phases of a convention, where it was highlighted that the most important meeting as the kick-off and the closure meeting. Ideally, the DfX coach, will document the presentation review during these meeting, which

provide information about the scope of the convention, the aim, targets, ideas and implementation proposals. Therefore, based on Yin (2014) and the fact that not all DfX coaches document their conventions, the researcher decided to select only the conventions with access to the kick-off and closure meeting presentation. As a result, this criterion reduced the list from 10 to six conventions.

Third, the last criteria that was evaluated is *broad problem formulation*, which also follows a theoretical sampling approach as for the criterion *diversity*. As explained in Chapter 2, De Bruijn and Ten Heuvelhof (2008) make a distinction between structure and unstructured problems. A structured problem represents a problem for which there are few solutions; therefore, the solution is quite straightforward, whereas an unstructured problem never has one right solution. In decision making in network, problems are defined as unstructured problems, giving the actors freedom to act. Thus, a broad problem formulation with no clear right solution proposed at the beginning of the convention was the third requirement to fulfil. Based on this reasoning, the list was reduced from six to three final conventions that are presented below.

Case Study 1: Adaptors

Data Availability: Kick-off, Mid-Term and Closure Meeting

Diversity: Five business groups from PH and two from HS

Broad problem formulation: Supply base optimization by looking into supplier consolidation, design, value chain and cost/spend.



Case Study 2: Batteries

Data Availability: Kick-off and Closure Meeting

Diversity: Three business groups from PH and Three from HS

Broad problem formulation: Supply base optimization by commodity standardizing and leveraging demand across PH and HS to improve competitive landscape

HS  

PH  

Case Study 3: Computers

Data Availability: Kick-off, Mid-Term and Closure Meeting

Diversity: Four business groups from HS

Broad problem formulation: Supply base optimization by commodity standardizing and leveraging demand across PH and HS to improve competitive landscape.

HS

8.2 Within case analysis

Section 8.1 explains the selection process followed to reduce the list from 888 to three conventions that were selected for further analysis. Subsequently, this section presents a within case analysis. The analysis consists of two parts: The first one provides a description of the commodity, the business units involved and the products related to the commodity within the scope of the convention. The second of the analysis consist of an interpretation of the findings based on the theoretical framework presented in Chapter 6. In summary, the framework identified three networks namely *Supply Base, Supply Network* and *Organizational Network.* Additionally, it identified three main elements to analyze for each network that are *Structure*, *Dynamics* and *Policy & Control*. In this sense, the elements corresponding to the Organizational Network are complexity (Structure); Behavior and Interest (Dynamics); and procedures and corporate guidelines (Policy and Control). The elements characterizing the supply base are complexity (Structure); behavior and interest (Dynamics), and Contract and agreements with the focal company (Policy and Control). Finally, the elements that characterize the supply network are self-emergence (Structure), unpredictable behavior (Dynamics) and lack of central control (Policy & Control). In consequence, this section describes how each convention related to the networks identified and dealt with the structure, dynamics and policy & control of each of them.

8.2.1 Adaptors

First, this sub section presents a broader description of the commodity and the products that use the adaptors within the scope of this convention. The scope of this convention was limited to the wall mount adaptors, which are used in different products across Personal Health and Health Systems, however the adaptors are not standard. Hence, there are different versions of adaptors, depending on the product, region of sales and power required. Furthermore, the products that use the adaptors within the scope of the convention represent a mix of incremental and high innovative technologies. For example, the shavers that belong to the business group called Male Grooming are incremental technologies, whereas the technologies present in the products for the ultrasound systems are considered highly innovative. Moreover, each business group or even each product will have a different version of the preferred adaptors that will depend on the power required and the region of sales. Table 17 provide a comprehensive description of this commodity and the products that are related to it.

Table 18. Main commodity characteristics. Source: This project

Commodity	Adaptors
Commodity description	Wall mount adaptor for a wide range of consumer devices
Degree of innovation	The adaptors is classified as an incremental, as the technology used is widely available in the market.
Business Units	*Personal Health*: Male grooming, Beauty, Oral Health Care, Mother & Child Care and Floor Care *Health Systems*: Sleep & Respiratory Care and Ultrasound
Products	Some examples of products that use the adaptors in the scope of the convention are: Male Grooming Oral Health Care Mother & Child Care Ultrasound 

Supply Base

First, Table 12 uses the definition supply base structure given by Choi and Krause (2006), which says that the structure of the supply base is the number of suppliers, the degree of differentiation among them and the interrelationship between them. Therefore, they argued that if a manager aims to change the structure of the supply base, it should target one of these three elements. However, they also acknowledge that the number of suppliers is most accessible element for managers. During the evaluation of the documentation of the convention for adaptor, this statement was confirmed as this convention just focused on the consolidation of suppliers, aiming to reduce the number of suppliers of the supply base.

As the CAS theory confirmed suppliers behave strategically in order to maximize their gains (Bellamy & Basole, 2013; Choi et al., 2001; Surana et al., 2017), therefore any process that ignores

this behavior limits is realism. In this regard, both interviewees for this commodity agreed that contracts and agreements are useful tools to constraint the opportunistic behavior of the suppliers; however, they are not always effective. They mentioned that they had *exploitable relationships*, which means that the suppliers were charging higher prices than the benchmark and not delivering the required quality. However, they were lock-in as they were single source suppliers; therefore, they could not easily switch to a new supplier, as the process to qualify a new supplier was time and resource consuming. Therefore, they suggested that an additional option to control the opportunistic behavior of suppliers is by preparing for the negotiation and setting strong negotiation rules at early stages of the product life cycle. Preparation means collect data that would increase the bargaining power as cost, labor cost trend, concentration of the market and so on. On the other hand, strong negotiation rules are analogous to rules of the game, like asymmetric share distribution to ensure competition within the suppliers. For example, if there is an attractive project, the negotiation design should enforce that the best supplier gets the 70% of the business and the second one get 30%. In this way, the suppliers interested will pursue the biggest share and competition is ensured.

Supply Network

As mentioned on Section 4.3, the supply network co-evolves with new customer markets, new technological developments, economic trends or even natural disasters (Choi et al., 2001), therefore their exploration provide valuable information of such trends. In this regard, all interviewees confirmed that any effort to improve the supply base should include an analysis of the major trends in the market. As one of the interviewees said "Scouting and supply network exploration is our daily bread". On the other hand, they also confirmed that the introduction of a new supplier faces a lot of resistance, as there is no history performance record; therefore, the organizational network usually perceives the introduction of *challengers* as a risky activity. Therefore, the introduction of a challenger is a slow and challenging process that requires a lot of time to show the benefits that a new supplier might bring to the business. Based on the interviews, it was captured that some of the commodity manager used strategies describe in the theory of decision making in networks. For this commodity, *priming* based on cost was the only strategy mentioned by the interviewees.

Organizational Network

Based on the theory of networks and decision making in networks, Chapter 6, defines the structure of the organizational network as the number of business units, the degree of differentiation and how

closed they are to any intervention. Therefore, during the analysis of the documentation of the adaptor convention, the research noticed that the business units involved have high level of differentiation. For example, the scope of this convention included business that offered incremental technologies like shaver and baby monitors, and in the other hand ultrasound systems that require FDA approval. Therefore, the interviewees reported the management of the stakeholders was one of the most challenging tasks during the convention, as each business has different priorities and interests. However, previously, PH and HS worked in completed isolation, therefore the interviews pointed it was a contributing factor that lead to the creation of two different supply bases for adaptor, one for HS and the other for PH, which hampers the creation of economies of scale.

Table 19. Within case analysis for adaptors based on proposed theoretical framework. Source: This project

Supply Base	***Structure*** The structure of the supply base based on the number of suppliers versus spend is as follows: *Personal Health*: 4 suppliers classified in strategic, preferred and commercial *Health Systems*: The 85% of the total spend is concentrated in 15 suppliers, therefore the remainder 15% of the total spend is allocated to 60 suppliers. ***Behavior*** Presence of exploitable relationships with six suppliers, that were charging between 15% - 50% higher prices than the benchmark Non performing suppliers: On shelf availability incidents ***Policy and Control*** In health systems, only 25% of the supply base is certified with ISO 13485
Supply Network	Market is consolidated: Top 10 suppliers represent 53% of business, however there is competition. Supply market for low power adaptors concentrated in China. Suppliers investigating satellite operations in India and Brazil because of existing or upcoming import duty regulations. Suppliers are increasing the level of automation to offset labor cost increase. Wireless charging penetration remains low.
Organizational Network	***Structure*** *Personal Health*: Male grooming, Beauty, Oral Health Care, Mother & Child Care and Floor Care *Health Systems*: Sleep & Respiratory Care and Ultrasound ***Interest*** Same time zone support, which suggest regionalization of the supply base. Product differentiation through charging accessories (e.g. wireless, charging travel case, charging glass cup, etc.). Supply base able to cope with (semi) medical low power applications: 50% of supply base having ISO13485 available in 2016, 100% in 2017 Reduce availability incidents (OSA) by 50%

8.2.2 Batteries

Similarly, the batteries within the scope of this convention are used in a wide range of products across Philips. For this convention, battery packs are the targeted commodity. A battery pack consists two cells, the primary cell is rechargeable and the secondary cell is non-rechargeable. It is important to mention that the main cost driver of this battery pack is the primary cell, representing 90% of the total cost of the battery pack. In order to meet the different requirements in power and performance requirements of the diverse products across Philips, different business groups are purchasing a wide variety of primary and secondary cells. Therefore, the supply base of this commodity has evolved

into a large and redundant supply base, with a long tail of suppliers with low spend. See table below for more details.

Table 20. Commodity characteristics for batteries. Source: This project

Commodity	Batteries pack
Commodity description	Battery packs are composed by 2 cells: Primary/Non rechargeable battery and secondary/rechargeable battery. The main cost driver is the primary cell.
Business Units	Personal Health : Male grooming, Beauty and Oral Health Care Health Systems: Sleep & Respiratory Care, Patient Care & Monitoring Systems and Healthcare Informatics Solutions and Services
Products	Some examples of products that use the battery packs in the scope of the convention are: Beauty  Oral Health Care  SRC  PCMS 

Supply Base

As mentioned before, in the framework proposed in Chapter 6, the working definition of the structure of the supply base given Choi and Krause (2006), which has there elements: Number of suppliers, degree of differentiation and interrelation among them. In the previous case, the team of the convention focused on the reduction of the number of suppliers. The ideas proposed at the end of the convention focused also on the number of suppliers, but did not limited options to reduce the number of suppliers only, as some of the ideas proposed could potentially increase the number of suppliers. The ideas considered a broader range of business needs that were expressed by the internal stakeholders, like regional services (also known as regionalization) and risk reduction via dual sourcing. Hence,

regionalization and dual sourcing could potentially increase the number of suppliers and are approaches used by the interviewees to improve the supply base. This finding aligns with Choi and Krause (2006), which argues that managers should focus on the reduction of the complexity as a whole, not only in the number of suppliers. Therefore, managers should consider the different approaches that aim to change the supply base (not only to reduce it).

As stated before, CAS theory confirmed suppliers behave strategically in order to maximize their gains (Bellamy & Basole, 2013; Choi et al., 2001; Surana et al., 2017), therefore any process that ignores this behavior limits is realism. Similar to the Adaptors convention, both interviewees for this commodity agreed that contracts and agreements are useful tools to constraint the opportunistic behavior of the suppliers; however, they are not always effective. They also mentioned that they had *exploitable relationship*, which means that the suppliers were charging higher prices than the benchmark and not delivering the required quality. Additionally, for this commodity, quality is a key factor, as one interviewee affirmed: "This is a very critical component, as there is a risk of explosion, so we do not want suppliers with poor quality". In this case, a long term contract locked-in Philips with a supplier that was charging up to 63% higher prices in products where the supplier new it was single or sole source. Moreover, the supplier had the worst DPPM of the supply base. The interviewee explained that the root cause of this issue is that a long-term contract is in place; however, both parties negotiate the price every year. Therefore, this is an example on how a control mechanism have failed to constraint the opportunistic behavior of the supplier. In this sense, the interviewees also recommended to focus on the preparation phase of the negotiation as a way to increase the bargaining power of the focal firm. Some of the important aspects to mentioned are: Prepare on market trends, labor cost, should costs, savings expected from supplier, negotiation strategy, price road map (if long-term contract will is possible).

Supply Network

The position of the focal firm in the network also affects the bargaining power of the focal firm. The analysis of the market trends will provide information regarding the degree of demand for a specific commodity and the industries that are part of the demand. For example, as interviewee 3 highlighted, Philips represents 1% of the total market of batteries where the raising demand for batteries in the Electric Car industry is increasing the price of this commodity, therefore it has low barging power during negotiations. As consequence, interviewee 2 stressed that strict negotiation rules could help increase the bargain power in order to get better terms and prices out of the negotiation.

Organizational Network

As previously mentioned, based on the theory of networks and decision making in networks, in Chapter 6, I defined the structure of the organizational network as the number of business units, the degree of differentiation and how closed they are to any intervention. Similar to the previous case, the degree of differentiation between the different business units is high, in the sense that the products offered had different degrees of innovation and belong to different industries. For example, PH is a player in the consumer electronics industry where products are based on incremental technologies, whereas HS competes in the Healthtech sector, where products are based on technologies with a high level of innovation. As interview 6 confirmed, the differentiation in technologies will influence the approach in the negotiation with the supplier, as "In PH the negotiation will focus in price and quality, whereas in HS the discussion is about price too, but innovation is also considered". The intrinsic characteristics of the products offered by each business units was acknowledge by 28% of the interviews as a contributing factor to have two different supply bases for commodities that a used in PH and HS.

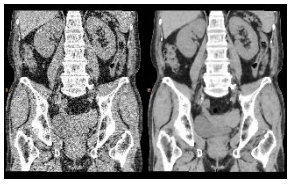
Table 21. Within case analysis for adaptors based on proposed theoretical framework. Source: This project

Supply base characteristics	***Structure*** The structure of the supply base based on the number of suppliers versus total spend is as follows: *Personal Health:* Main cell and secondary cell: The 75% of the total spend is capture by two suppliers out of nine suppliers. Battery packs assembly: The 76% of the total spend on the assembly of the battery packs is allocated to four out of 16 suppliers. *Health Systems:* Battery pack assembly: The 81% of the total spend on the assembly of the battery packs is allocated to three out of 21 suppliers. Three suppliers have capabilities to supply entire Health Tech adapter portfolio ***Behavior***: Exploitable relationship with three suppliers, charging up to 63% higher prices than the benchmark ***Policy and control :*** Long term contract induced supplier lock-in
Market Trends	Philips represents less than 1% of global market The cost of the Li Cells are dropping down YoY (~3 -5%) and the storage capacity is increasing YoY by ~5 -7%. High demand for 18650 cells due to electric cars, therefore prices are rising
Organizational Network	***Structure*** Personal Health : Male grooming, Beauty and Oral Health Care Health Systems: Sleep & Respiratory Care, Patient Care & Monitoring Systems and Healthcare Informatics Solutions and Services ***Interest*** Cost reduction by 30%

8.2.3 Computers

For the computer convention, the scope includes hardware, software and service provided to the customer by Philips. In most of the cases, Philips buys the three components from suppliers and combine them with the products that Philips offer to the customer. This commodity serve highly innovative products mainly, in the cluster of Health Systems, some examples of this product are MRI machines, ultrasound systems and patient monitoring. In the hardware side, Tier 2 suppliers were also considered during the analysis. The diversity of the commodity has resulted in a supply base with a long tail of supplier with low spend. See table below for more details.

Table 22: Main characteristic of Case 3: Computers. Source: This project

Commodity	Computers
Commodity description	This commodity is composed by two main categories: Computing solutions: Desktops, workstation, laptops, tablets and mobile devices Tier 2 Components: microprocessors, HDD and SSDs, memory modules, motherboards and video cards. Besides hardware, computing solutions also includes customer services and software provided by Philips to the customer
Business Units	Health Systems: Patient Care & Monitoring Systems, Healthcare Informatics Solutions & Services (HISS), Image Guided Therapy and Ultrasound.
Products	Some examples of products offered by Philips that use the computers in the scope of the convention are: IMR  CT Scanner  Cardiology 

Supply Base

Based on Choi and Krause (2006), the structure of the supply base is defined by the number of suppliers, the degree of differentiation and the interrelation among them. On the other hand, Ogden and Carter (2008) stated that there are three approaches to reduce the supply base namely standardization,

systematic elimination and tiering. However, during the evaluation of the computer convention documentation, the researcher found that some of the ideas proposed at the end of the convention suggested using Tiering in the opposite direction. Instead of delegating control to Tier 1suppliers, which will theoretically reduce the transaction costs, the members of the team suggested to recover the control over the Tier 2 suppliers that were providing Video Cards and other electronic components, in order to benefit from economic of scales, which eventually will increase the transaction cost. Similar to previous case, the computer convention team also proposed to eliminate the suppliers in the tail, using systemic elimination.

Besides changing the structure of the supply base, 10 out of 18 ideas proposed at the end of this convention aimed to change the control mechanisms in the supply base. For example, one idea suggested formalizing the internal procedure to claim warranties, ensuring they are tracked and claimed. Another example is an idea that aimed to improve the supplier qualification process. In the documentation of the convention, the team argued that the process was not standard nor efficient; therefore, the time to market of a product was up to 2 years. The convention team proposed to standardize the process across all business units and decouple the hardware qualification from the software qualification. In this sense, the process is could be faster, but standard at the same time. In this regard, interviewee X confirmed that warranties, business processes, EOLS and so on are more relevant in this commodity, as it also includes services and it is a commodity with short PLC, therefore improving the Control Mechanisms and Policies of the supply base improves the performance of the suppliers in the supply base.

Both interviewees related to this convention, confirmed that suppliers always protect their own interests, however they acknowledge that competition and cooperation exists. Which aligns with Chapter 4, Section 4.3, where it was stated that CAS explains the co-existence of competition and cooperation among suppliers and focal firm (Choi et al., 2001; Surana et al., 2005). In this regard, managers are confronted with the dilemma of control versus emergence, where control enforces competition and emergence cooperation (Choi et al., 2001). The interviewee for this convention preferred to let things to emerge, arguing that in this commodity the focus is on cooperation and innovation. Therefore, they disagree that strict negotiation rules will deliver good results; however, both interviewees argued that a good preparation before the negotiation is a key element to achieve a win-win situation.

Supply Network

As mentioned on Section 4.3, the supply network co-evolves with new customer markets, new technological developments, economic trends or even natural disasters (Choi et al., 2001), therefore their exploration provide valuable information of such trends. In this regard, interviewee 3 highlighted that due to the short life cycle of this commodity, the constant analysis of the market trends and supplier scouting is a best practice that should be done on daily basis, not only for negotiation preparation.

Organizational Network

The scope of this convention involved business from HS only, creating a more homogeneous group of stakeholders. However, interviewee 3 pointed out that the scope of the convention was broad in terms of hardware. The suggestion from the interviewee is to break down the convention into manageable pieces to achieve better results, as collaboration in unnecessary large groups is challenging.

Table 23. Within case analysis for computers based on proposed theoretical framework. Source: This project

Supply base	***Structure*** The structure of the supply base based on the number of suppliers versus total spend is as follows: A 90% of the total spend is allocated to 16 suppliers, whereas the rest is divided among 126 suppliers. From the 126 suppliers, 14 are classified as niche suppliers, 110 as "long tail" suppliers and the remainder 10 are in the process to be phase out. ***Behavior*** Strong relationship between supplier and buyer (e.g. Philips has preference over other buyers when there's a shortage) ***Policy and Control*** Warranties and EOLS are source of waste.
Supply Network	Intel's *tic-toc* dominates the technological development pace Intel, HP and Dell are the three main players for Philips
Organizational Network	***Structure*** Health Systems: Patient Care & Monitoring Systems, Healthcare Informatics Solutions & Services (HISS), Image Guided Therapy and Ultrasound. ***Interest*** Reduced cost by aligning internal technology life cycles and create leveraging best-in-class technology and pricing Innovative products

8.3 Cross-case analysis

The previous section presents a within case analysis based on the framework presented in Chapter 6, where three main networks that are involved in the process to optimize the supply base were defined, namely Organizational Network, Supply Base and Supply Network. Additionally, each network is characterized by its structure, dynamics and control & policies. Therefore, the within case analysis compares the cases based on the contracts described in Appendix A, which were derived from the theoretical framework presented in Chapter 6. This section shows the main finding that stemmed from the analysis described above. The interpretation of this analysis is presented in the next section, which is the process that aims to guide managers through the optimization of the supply base.

8.3.1 Supply base optimization

Section 3.2 points out the lack of consensus regarding the meaning of supply base optimization, therefore the first question of the interview guide aimed to clarify the definition of this term among the interviewees. The researcher decided to use this term during the interviews, as it is one of the three strategic targets of the procurement organization in Philips explained in Section 7.2, therefore it is the terminology used in the company. From seven interviews four key terms emerged, 71% of the respondents mentioned *meet business requirements* and *suppliers with right capabilities*; whereas 57 % of the participants mentioned *right number of suppliers* and *consolidated supply base* (See Appendix B for more details about the key terms found during the interviews). Therefore, the resulting working definition based on the key terms elicited from the analysis of the interviews is:

"*Supply base optimization is an ongoing process that aims to have the right number of suppliers with the right capabilities to meet current and future business needs*"

Note that this definition positions the supply base as a tool that serve the business needs expressed by the Organizational Network, which at the same time are shaped by the market trends and future expectations in the supply network. Section 3.2 presents the different definitions found in the literature related to supply base optimization. For example Choi and Krause (2006) refer to supply base optimization as the reduction of the complexity of the supply base. On the other hand, supply base consolidation and reduction explicitly refer to the reduction of the number of supplier (Chen & Paulraj, 2017; Cousins, 1999). It is important to highlight that this definition have a egocentric per-

spective that focuses on the structure of the supply base only, neglecting the interactions and interdependencies between the supply base, the organizational network and the supply network. Therefore, it is argued that the proposed definition has a network-level approach that reflects the dynamisms and complexity of the landscape of the supply base optimization.

Additionally, this definition support the ongoing transformation of the procurement function from a back office to a strategic activity, which is widely mentioned in different academic publications (e.g Burt et al., 2003; Hong & Kwon, 2012; Quintens, Pauwels, & Matthyssens, 2006; Stock, 2001). In this regard Wiggins and Seal (2017) reported that leaders in procurement agreed that the leading benefit of transformational programmes was the improved alignment with internal stakeholder's needs. Therefore, the author argue the procurement function should shift from relying purely on commercial advantage towards a total cost of ownership perspective, ultimately contributing *directly* to the business goals. Wiggins and Seal (2017) also report that cost savings and cost avoidance comes at the top of the list of procurement goals and the stakeholder needs, however they warned that conflicts arise when cost reduction are pursued at expense of other needs. Therefore, in depth understanding of the stakeholder's needs is a pre-condition to initiate any effort to optimize the supply base.

8.3.2 Supply base

As just mentioned, the aim of the process to optimize the supply base is to make sure that the supply base has the right number of suppliers with the right capabilities. On the other hand, Choi and Krause (2006) defined the structure of the supply base as the number of suppliers, the degree of differentiation among them (including supplier capabilities) and the interrelation among. Therefore, if the process to optimize the supply base aims to have the right number of suppliers with the right capabilities, it means that it explicitly aims to change the structure of the supply base. For this purpose, Ogden and Carter (2008) defined three main approaches: Standardization, Systematic Elimination and Tiering, which I defined as Reductive approaches as they ultimate goal is to reduce the transaction cost the focal firm incurs in managing the supply base. However, the analysis of the 36 ideas proposed by the three conventions analyzed, showed three alternative ways to modify the structure of the supply base. From 36 ideas, 26 proposed to change the structure of the supply base, therefore the analysis is presented below.

In general, the modification of the supply base was not constraint to reduce the supply base. For example, *Dual sourcing* was proposed to reduce the risk of the supply base. Dual sourcing could potentially increase the number of suppliers in the supply base; however, it certainly means an increment in the transaction costs the focal company incurs when managing the supply base. In any case, this approach was just a mean to satisfy an explicit business need, as the internal stakeholder articulated that they wanted to de-risk four specific suppliers. The second example is *Regionalization,* where suppliers with specific footprint were preferred. Among the 26 ideas that seek to change the structure of the supply base, just one idea suggested to regionalize the assembly of batteries to a regional location for the European market. The third and last example is *Tiering*. Ogden and Carter (2008) defined Tiering as the delegation of control of components, sub-assemblies or commodities to Tier 1 suppliers. However, four ideas seek to recover this control once delegated to Tier 1 suppliers, aiming to reap the benefits of economies of scale. In summary, these examples support the argument that is not about incrementing or reducing the number of suppliers, but satisfy the business needs of the internal stakeholders. The following table presents a summary of the different approaches to modify the structure of the supply base. Please keep in mind that I defined expansive or reduction based on the potential on increase the transaction costs that focal firm could incur in managing the supply base.

Table 24. Different approaches to modify the structure of the supply base. Source: This project

EXPANSIVE APPROACHES	REDUCTIVE APPORACHES
Regionalization	Systematic Elimination
Dual Sourcing	Standardization
Tiering	Tiering

Contrary to what (Choi & Krause, 2006) stated, optimization of the supply base is not exclusively about reduction of the complexity by changing the structure of the supply base. Clark (2016) argued, appropriate contract management provides the necessary transparency to ensure not only that savings are achieved but that promised performance levels are delivered. Therefore, an analysis of the of the contract landscape during the process to optimize the supply base could identify potential areas of improvement. In this regard, 10 out 36 ideas proposed to change the some contractual terms or implement standardized internal process that allow better contract management. For example, one idea proposed to develop a database of the *should-cost* of the commodity, thus each commodity manager checks it before going into a negotiation. Another idea is to have a standardized procedure to negotiate, track and claim warranties, as the team found that three business units had warranty terms above

the standard; however, they did not transfer those benefits to the customer. In summary, the analysis of the ideas proposed by the computer convention support the statement that supply base optimization could be achieve by ensuring the right structure of the supply base and appropriate contract management to secure that the desired savings are achieved and the promised levels of performance of the suppliers are met.

Table 25. Summary of the ideas proposed jointly by the three conventions and their aim. Source: This project

CASE	STRUCTURE	POLICY & CONTROL	TOTAL
Adaptors	1	0	1
Batteries	17	0	17
Computers	8	10	18

8.3.3 Supply Network:

As mentioned on Section 4.3, the supply network co-evolves with new customer markets, new technological developments, economic trends or even natural disasters (Choi et al., 2001), therefore their exploration provide valuable information of such trends. In this sense, the outcome of the interviews support the previous statement, as 29% of the respondents mentioned that the exploration of the supply network is an ongoing practice that provide insides about the technological and economic trends, which is useful information to plan the commodity strategy and mold the business needs. Furthermore, 57% of the respondents mentioned that the scouting of new potential suppliers is also an ongoing process that should anticipate the business needs, as the qualification of a new supplier involves a due diligence process that is time and resource consuming. As Surana et al. (2017) stated, the supply network is a self-organized system that emerges with no central control. Therefore, the focal firm cannot attempt to control it, but to understand it, in order to anticipate the behavior of the suppliers that is driven by co-evolutionary forces between the agents and the environment (Pathak et al., 2007).

8.3.4 Organizational network

Based on the results presented in Section 8.2, the organizational network is the network that states the business needs. Choi and Krause (2006) argued that there are four areas of managerial focus when it comes to managing the supply base: Cost, Risk, Responsiveness and Innovation. From the documentation of the conventions, the researcher analyzed the underlying business need behind each idea proposed at the end of the convention. Not surprisingly, 72% of the ideas aim to improve costs, 15%

seek to solve risk concerns of the business and 13% to improve the responsiveness of the supply base. Interestingly none of the ideas pursues an improvement in innovation. However, none of the ideas aimed to improve the innovation of the supply base, even though Philips brand itself as a high innovative firm.

As Wiggins and Seal (2017) recommends, the procurement department must develop a sourcing strategy that proactively considers the business needs and the creation of the understanding and appreciation of each function's contribution to the business. This might sound trivial; however, based on the results showed in the report by Wiggings and Seal, the tendency to have centralized procurement department makes it more challenging to implement and execute activities that forges such understanding between the procurement function and the business units. In this regard, Philips is an example of such trend, as the company established the centralized Procurement department in 2012, however the results from the interviews demonstrates that commodity managers are aware of the importance to understand the business requirements of each business unit, as 71% mentioned that supply base optimization is about *meeting the business needs*.

In conclusion, the previous paragraphs explained how the process of supply base optimization related with the three different networks identified in Chapter 6. The following subsection deals with the process to optimize the supply base.

8.3.5 The process

The previous paragraphs describe the findings regarding the dynamics between the organizational network, the supply base and the supply network. However, until now, the process to optimize the supply base has not been addressed as such. Therefore, this subsection presents the rationale that led to the process presented in Figure 12. The input data for this analysis is the convention documentation, the DfX training booklet and the Negotiation Design training booklet. The analysis started with the study of the DfX methodology described in section 7.3.1, which consists of six stages, although the main goal of the convention is to generate ideas to improve the supply base only. This methodology does not follow up the ideas up to the implementation stage, leading to a lack of commitment to implement the ideas generated. Therefore, six out of seven interviewees agreed that one of the major issues of this approach is that there is a lack of commitment to allocate resources to implement the ideas. One reason appointed by Interviewee 3 and 7, is that there is no close follow up to the implementation stage; therefore, other priorities compete for resources within the business units. For this

reason, the conclusion is that the proposed process should have a better follow up, to make sure that the ideas generated are implemented.

Therefore, the proposal is two tackle this issue in two ways: First, by creating ownership in the team to implement the ideas and evaluate their impact in the structure, performance and capabilities of the supply base (Round 5 and Round 6). Second, by defining a threshold that indicates the benefits that a business unit must obtained for it to commit their resources to implement the ideas (Round 2).

Additionally, it is important to highlight that the process starts with the interaction of the three networks already mentioned, and the generation of ideas that would increase the fitness among them. Different from previous frameworks, this approach recognizes the interaction between three different networks and place as the driving force to generate ideas. As Choi et al. (2001) posed, the actors in the supply network behave strategically in order to maximize their in an environment where cooperation and competition exists.

After the implementation of ideas, the second point of attention is the negotiation design. From the analysis of the documentation of the conventions, it was evident that all of them included the so-called *Nego Factory*, as an Ad Hoc team. In this regard, Interviewee 3 expressed the importance of designing a robust negotiation approach in order to increase the bargaining power of Philips. He pointed that a mechanistic and airtight negotiation design increase the chances to obtain the best outcome possible out of a negotiation. In the other hand, Interviewee 1 disagree with this approach, as she expressed her preference to have an approach that reassembles a dialog, rather than imposing a strict set of rules that do not allow a fluid conversation with the supplier. Even though interviewees showed preferences for different negotiation approaches, all of them agreed that, the preparation prior a negotiation is the key element to obtain the best result. As Mo (2016) reported, negotiation is more than a discussion around the table, as an effective negotiator will spend more of the time planning how to strengthen their position. Moreover, Interviewee 3 highlighted the evaluation and selection of the suppliers is not about selecting factors and weight them against each other (e.g. Chan & Chan, 2004; Chan & Kumar, 2007; Chen et al., 2006; Hokey, 1994; Luo et al., 2009) but part of a comprehensive negotiation process. For this reason, Round 3 and Round 4 were included in the process of Figure 12.

The third point of attention regarding the process to optimize the supply base is the evaluation of the effectiveness of the process. Section 4.3 frames the supply network as a CAS, one of the distinctive

characteristics of such systems is that changes are non-linear Pathak at al. (2007). It means that there may be small changes that lead to a dramatic reorganization within the system; conversely, there may be large changes with relative small influence over it. For this reason, any change induced in the supply base, which is a subset of the supply network should be monitor and evaluated, as the non-linear behavior is intrinsic of the system. The constant evaluation will ensure that the desired targets meet the business requirements. Therefore, if the aim of supply base optimization is to meet the business requirements, the evaluation of the effectiveness of the process must be according to such requirements.

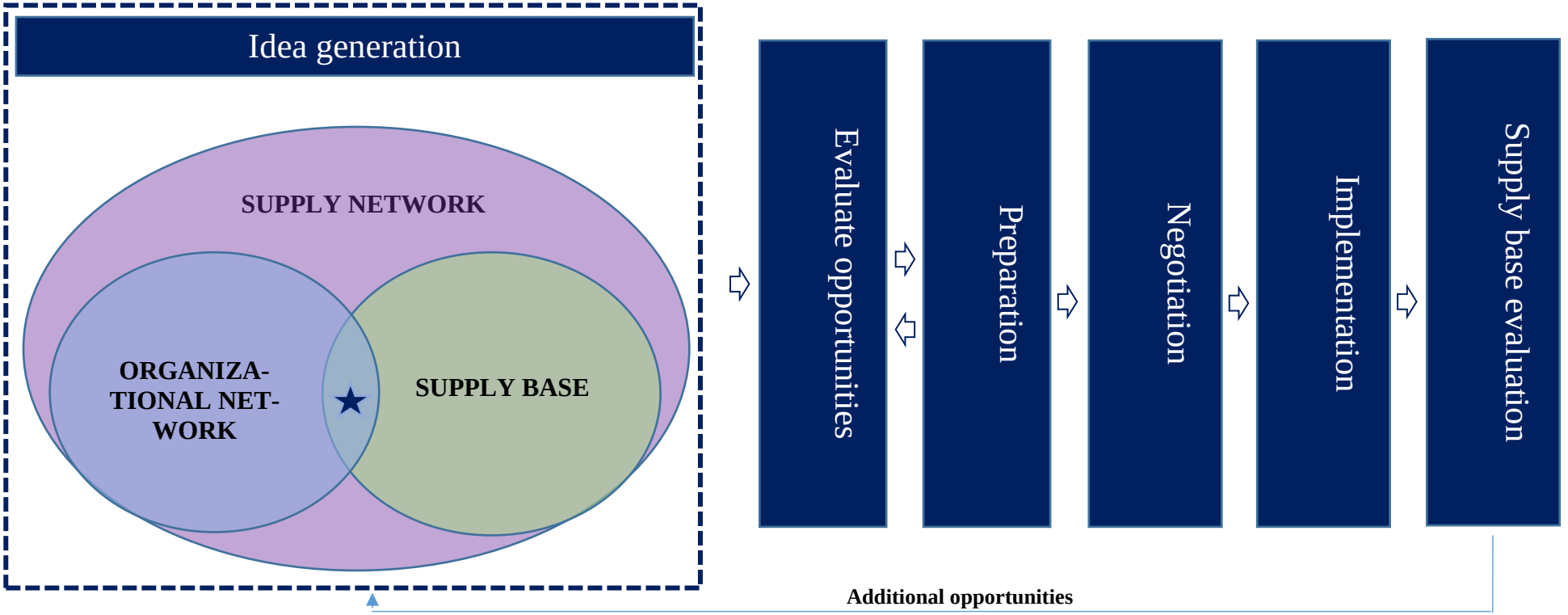
Table 26. Summary of the metrics proposed to evaluated the effectiveness of the process based on the case studies' analysis presents a summary of the proposed KPIs to track the effectiveness of the ideas implemented to improve the supply base. First, the categories follow the proposal of Choi and Krause (2006). The metrics used in the second column were derived from the interviews and the Procurement targets presented in Section 7.2.

Table 26. Summary of the metrics proposed to evaluated the effectiveness of the process based on the case studies' analysis. Source: This project

CATEGORY	METRIC	TARGET	DESCRIPTION
Cost	Savings	5.6%	Total actual "hard-procurement" savings divided by the total spend in the current year.
	Cost of Non-Quality	1.99%	Maximum value of cost of non-quality per category
	DPPM	-10%	Reduction in DPPM caused by supplier compared to previous year
	Supply base consolidation	-10%	Reduction of the supply base (Baseline 2016: 5388 Suppliers)
Risk	Single & Soles Sourcing	-10%	Reduction of non-accepted single/sole source SKUs
Responsiveness	Time to market	-10%	Reduction of time to market of new product releases
	On Shelf availability	100%	Availability of the product on the shelf of the retailer
Innovation	Innovative ideas proposed by supplier	+10%	Ideas proposed by the supplier to innovate a product.
Performance	Contract compliance	100%	Compliance by the supplier on term like EOLS, warranty, sustainability and quality.

A feedback session with Rahul Gundala (Company Supervisor) served as the verification of the validity of the process presented in Figure 12, where he gave his inputs to improve the process that were incorporated to the design on the spot. Therefore, the process presented is the final version of the design after the verification session with the company supervisor.

8.4 Process to optimize the supply base



Supply base optimization: ongoing process that aims to have the right number of suppliers with the right capabilities and right performance in order to meet current and future business needs

ORGANIZATIONAL NETWORK
It provides the current and future business needs based on:

1. **Cost [Savings – Quality]**
2. Risk
3. Responsiveness
4. Innovation

SUPPLY NETWORK
The supply provides insights about:

1. Economic trends
2. Technological trends
3. Potential supplier [Challenger]

SUPPLY BASE
Provides the current and future supply base in terms of

1. **Structure [number – capabilities -** footprint**]**
2. **Behavior [Performance]**
3. Contracts terms and compliance

COMMODITY STRATEGY
Formulation of the supply base strategy [internally known as commodity strategy] by the commodity manager base on the input from the organizational network, the supply network and the reflection on the current and desired supply base characteristics.

Figure 12. Process to optimize the supply base. Source: This project

Round 1: Idea generation

Description
The co-evolution between supply network, supply base and organizational networks generate ideas to increase the competitive advantage of the focal firm in the market. Thus, the essence of the generation of new ideas to improve the supply base lies on the constant exploration of the market trends, the current and emerging business requirements and reflecting if the supply base could meet such requirements.

Activities
- Form a focus group consisting of at least: Commodity Manager, Procurement Engineer, Business Lead and DfX Coach.
- Scout the supply network in search of potential suppliers, new technologies and economic trends.
- Understand current and future business needs.
- Reflect if the supply base is capable to meet the current and future business requirements based on internal needs and external opportunities.
- Use the DfX toolbox to support your analysis.

Expected outcome
Ideas to improve the supply base

Theoretical Background
In this step, the main theories contributing with a deeper understanding of the existing *relationships* and *co evolution* between the organization, the supply base and the supply network are:
- *Complex Adaptive Systems*: The agents co-evolve with the environment.
- *Decision making in networks*: Broad formulation of problems by taking in consideration the different perspectives of the problem at stake.
- *Supplier enabled innovation*: One of the "trends' in procurement, as a way to contributing more directly to the business's goals. This theory was not explored in the literature reviewed, however refer to Section 9.4: Recommendations for future research.

Networks involved: Supply base, organizational network and Supply Network

Round 2: Evaluation of opportunities

Description
The ideas generated from the constant interaction between the focal firm, the supply base and the supply network are evaluated to ensure that their implementation would deliver value to the focal firm.

Activities
- Stakeholder analysis: Identify and involve relevant stakeholders.
- Define thresholds: Involve stakeholders and define the measurements and benefits that will ensure the commitment of resources to implement ideas.
- Prepare business case: Besides savings, prepare a business case that improves the competitive position of the focal firm in the market (e.g. new tech, better service, better warranties and so on)
- Define the future supply base: Structure and Contractual Terms.

Expected outcome:
Positive business case
Decision of go / no go for ideas that exceed the threshold of benefits defined with the stakeholders
Commitment on resources to implement idea if benefits exceed defined threshold
Long list of suppliers (preferably including a challenger)

Strategies: Check Table 10 for strategies that could help to obtain the commitment of the relevant stakeholders, based on the theory of decision making in networks.

Theoretical Background
In this step, the main theories contributing with a deeper understanding of how to evaluate the ideas and get the "Go" from the different stakeholders.
- *Decision making in networks*: Stakeholder analysis, strategies to get commitment from the relevant stakeholders (e.g. create a burning platform; wait for the window of opportunity, clear story line or Framing)
- *Supply management:* Business case and broad understanding of the landscape of the commodity under discussion

Networks involved: Supply base, organizational network and Supply Network

Round 3: Preparation

Description:
Once the relevant stakeholders agreed to proceed with implementation of the proposed idea, the next step is to design the strategy to allocate the business to the most competitive supplier and the implementation plan.

Activities
- Prepare for negotiation: Gather relevant data regarding market pricing, technology trends, volume expectations, labor trends and should-cost price.
- Design negotiation rules: Determine the rules of the negotiation in which the suppliers are going to be evaluated, the main elements are:

  Define the supplier selection criteria: Quantitative (TCO, price, value added, cost of materials, etc.), non-quantitative (responsiveness, capabilities, etc.) and knock out criteria.

  Negotiation strategy: Tactics to use during negotiation, RFQ rounds, timing, allocation distribution.
- Create communication roadmap: Create internal and external communications timeline.

Expected outcome:
Negotiation plan and short list of suppliers (based on knock out criteria).
Decision of go/ no go for negotiation rules from main stakeholders.

Theoretical Background
The main theories contributing with an understanding of how to prepare for the negotiation are:
- *Complex Adaptive Systems*: Theory that create awareness about the agency of the suppliers, as they seek the own benefit. However, also considering that cooperation and competition co-exist in the supply network.
- *Negotiation Theories*: Based on the information provided by Interviewee 3, the main theories that support the negotiation preparation are Game Theory, Auction Theory and Bargaining Theory. Section 9.2 provides more insights about future research about this topic.
- *Supplier selection*: Literature broadly explores the different criteria to evaluate suppliers.

Networks involved: Supply base, organizational network and Supply Network

Round 4: Negotiation

Description
The execution of the negotiation plan takes place at this stage. In summary, the suppliers are evaluated, the negotiation with the supplier(s) takes place, and the business is allocated to the most competitive party.
Activities
- RFQ round: Usually, an initial RFQ round will provide information about the cost and cost structure of the supplier. The RFQ will provide the quantitative elements of the evaluation criteria defined in the negotiation plan.
- Evaluation: Based on the RFQ data and the evaluation of the non-quantitative criteria, the suppliers are ranked.
- Negotiation: The execution of the negotiation will depend on the tactics prepared in Round 3.
- Allocation: The opportunity will be allocated to the winner(s) if benefits exceed the threshold agreed during the evaluation of the opportunities.
Expected outcome
Decision on business allocation to winner(s)

Theoretical Background
In this step, the main theories contributing with a deeper understanding about how to execute the overall negotiation plan are:
- *Complex Adaptive Systems*: Theory that create awareness about the agency of the suppliers, as they seek the own benefit. However, also considering that cooperation and competition co-exist in the supply network.
- *Negotiation Theories*: Based on the information provided by Interviewee 3, the main theories that support the negotiation preparation are Game Theory, Auction Theory and Bargaining Theory. Section 9.2 provides more insights about future research about this topic.
- *Supplier selection*: Literature broadly explores the different criteria to evaluate suppliers.

Networks involved: Supply base, organizational network and Supply Network

Round 5: Implementation

Description
Once the allocation decision is made, ideally the implementation plan is executed with the resources committed in step 2. In this section, I will present a summary of possible ideas to implements.
Activities
- Implements ideas: Some example of ideas that could improve the supply base are:
  - Change the structure of the supply base by:
    Reducing it: - Consolidation, standardization or Tiering.
    Expanding it: Dual Source, tiering or regionalization.
  - Change the control mechanism in the:
    Supply base: Re negotiate contract terms (e.g. warranties, EOLS, customer services, etc.)
    Organization: Modification, implementation of standardization of internal procedures that aim to improve the supply base.
Expected outcome
Implementation of idea generated in Round 1.

Theoretical background:
In this step, the main theories contributing with a deeper understanding about which modification can be implemented in order to improve the supply base:
- *Supply management:* Approaches to reduce the supply base, dual sourcing and regionalization.
- *Decision making in networks*: Strategies to maintain the commitment of resources to implement ideas.

Networks involved: Supply base and organizational network.

Round 6: Supply base evaluation

Description
After the ideas are implemented, the results are evaluated in terms of the overall improvement of the supply base.
Activities
- Check on monthly basis the main KPIs to track the improvement of the supply base. Below you can find a set of recommended KPIs collected from the analysis of the case studies and the literature review:
  - Cost: Savings, reduction of the supply base, reduction of DPPM and cost of non-quality.
  - Risk: Reduction of single and sole sourcing.
  - Responsiveness: Time to market and on shelf availability.
  - Innovation: Ideas proposed by the supplier to innovate a product
  - Performance: Contract compliance
Expected outcome
Additional opportunities that will contribute with the idea generation in Round 1. The feedback loop created enhance continuous improvement of the supply base.

Theoretical background:
In this step, the main theories contributing with a deeper understanding about how to measure the improvement of the supply base:
- *Supply management*: Main elements to consider when improving the supply base (Cost, Risk, Responsiveness and Innovation)
- *KPIs and metrics*: This literature offers tangible measurements to track the performance of the supply base based on Cost, Risk, Responsiveness and Innovation.
- *Innovation Theory:* Provide suggestions on how to measure the level of innovation.

Networks involved: Supply base and organizational network.

8.5 Summary

This chapter describes the analysis of the data collected from the interviews and the documentation reviewed in the company. The process that lead to the final framework to optimize the supply base (Figure 12) can be described in three steps: 1) Framework, 2) Process and 3) Content. The first step taken is the creation of the Theoretical Framework based on the literature review presented in Chapter 3, Chapter 4 and Chapter 5. The outcome of such literature review, called the Theoretical Framework, is presented in Chapter 6. As previously mentioned, this theoretical framework is the baseline of the case study research, as the data is analyzed based on the constructs defined in this step. The second step is the analysis of the process followed during the development of the conventions selected as Case Studies. From the analysis of the documentation of each convention, two main building blocks were identified: DfX Methodology and Negotiation Design. Two different department are specialized in each of the main building blocks identified. During this step, the training manual of both departments were studied and analyzed. This analysis is considered as part of the data reviewed for the development of this thesis. In more detail, the DfX Methodology dictates a set of minimum steps to complete a convention (Section 7.2). The Nego Design guides how the negotiation with the suppliers will be executed. The third step was to create and apply the interviews to the participants of the DfX conventions. The interviews were developed based on the theoretical framework created in Step 1. Additionally, the results were analyzed based on the theoretical framework presented in Chapter 6. Finally, the analysis of the building blocks of the process followed during the DfX Commodity Conventions and the feedback obtained during the interviews generated the six steps represented in Figure 12.

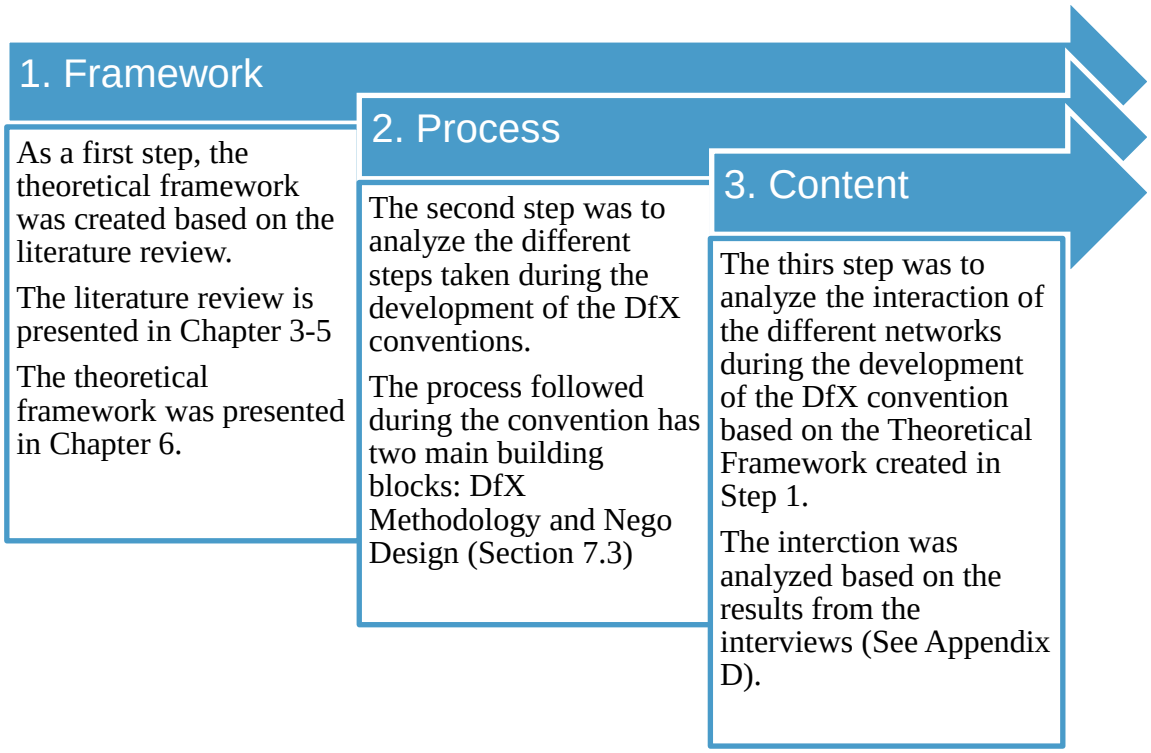


Figure 13. Steps followed during the data analysis. Source: This project

CHAPTER 9: Conclusions and Recommendations

The final chapter of this report presents the conclusions and recommendations that stemmed from the reflection about the development of the present research. This chapter consists of four sections that are Section 9.1: The first section presents a synopsis of the three main contributions of this research. Section 9.2 presents a recapitulation of the research sub question and the answers provided along the development of this research. Section 9.3: Reflects on the academic and managerial relevance of the main contributions presented in Section 9.1. Section 9.4: reflects on the scope and limitations of the present research and expose possible paths for future research. Additionally, this section also describes recommendations for the company under study.

9.1 Conclusions

As I mentioned it in the first chapter of this thesis, SCM and supply management research have focused on linear relationships between buyer and suppliers (e.g. Chan & Chan, 2004; Hokey, 1994; Rezaei & Ortt, 2012; Sheth & Sharma, 1997) and the technical issues related the flow of materials, finances and products (Fisher, 1997), overlooking the complexities and dynamics of supply networks. Therefore, it is argued that the academia have failed to provide managers a realistic mental map that reflect such complexities and dynamism. In reaction to it, the academia proposes to utilize a system-level perspective in supply management research to provide such realism. In this regard, it is concluded that this thesis contributed to expand the application of network-level analysis in the supply management research. In this sense, this thesis has three main contributions: First, it proposes a **new definition of supply base optimization** based on the feedback of the interviewees. Secondly, it provides a **theoretical framework** that reflects the dynamism and complexity involved in the process of supply base optimization by incorporating a network – level perspective. Third, it **provides a process that guides** managers through the never-ending process of supply base optimization. In the following paragraphs, I would explain in detail each contribution. The next section explains the contribution to utilization of the network-level perspective into the supply management research.

The **first contribution** of this research is to provide a **new definition of supply base optimization from a network perspective**. Based on the input from the experts and the analysis of documentation of the conventions, the definition of supply base optimization is as follows:

"*Supply base optimization is an ongoing process that aims to have the right number of suppliers with the right capabilities and right performance in order to meet current and future business needs*"

This new definition expands the definition given by Choi and Krause (2006), as they argue that supply base optimization refers to reduce the complexity of the supply base, which is limited to the modification of its structure and neglects the three important aspect of an optimize supply base: 1) The behavior of the suppliers, reflected in their performance. 2) The interaction with the organizational, as the ultimate goal is to meet the business needs. 3) The interaction with the supply network, as this is the window that allows forecasting the future business needs by the analysis of the technological and economic trends. Therefore, it can be concluded that the proposed definition takes a network-level perspective and provides a better insight of the different aspects involved in the supply base optimization.

The **second contribution** of this thesis is a **theoretical framework** that serves one main purpose: To **provide guidance to analyze the process to optimize the supply base from a network-level perspective**, providing researchers a more realistic mental map of the supply network to analyze its processes. This framework aims to close the gap highlighted in Section 1.1, as this framework contributes to expand the utilization of a network-level perspective in the domain of supply base optimization.

On the other hand, the analysis of the data collected in the firm, namely the interviews and the documentation of each convention, lead us to the third contribution of this research. The analysis of the evidence is based on the theoretical framework explained above. Hence, **the third contribution of this research is the creation of a process to optimize the supply base**, which takes a network level perspective and acknowledges the interactions of the different actors at each network. It also takes a processed based approach; therefore, it does not assume that all stakeholders perceive the problem of supply base optimization in the same way, reflecting how efforts to consolidate the supply base are executed in the practice.

9.2 Recap of the Research Questions

The previous section provided a synopsis of the main contribution of this research, presenting an overview of the main outcomes. On the other hand, this section provides a recapitulation of each research sub question posed in Chapter 2 and its respective answer.

RSQ1: What is supply management and how the supply networks are related to it?

After the analysis of the literature, the conclusion is that supply management is the action to manage the supply base, which is the subset of the supply network. Therefore, the supply base is the portion of the supply network that is in direct control of the focal firm. On the other hand, researchers claim that the optimization of the supply base is a key activity of supply management that creates competitive advantage for the focal firm, therefore is should be in the managerial agenda (e.g Choi & Krause, 2006; Talluri & Narasimhan, 2005). In this regard, Choi and Krause (2006) defines supply base optimization as the action to reduce the complexity of the supply base. Furthermore, they define complexity in terms of the elements that characterize its structure, that is to say number of suppliers, degree of differentiation and the interrelationship among them.

However, there are two important remarks about supply base optimization. First, Chapter 3 presented the main frameworks and approaches to optimize the supply base by tackling its complexity. However, the most recent academic publications in SCM and supply management research take a network perspective, highlighting the importance to deploy coordination strategies that ensures coherent collective behavior in the supply base which increases the adaptability of the focal firms (Pathak et al., 2007; Surana et al., 2017). Therefore, the next research sub-question explores why it is important to consider the dynamics of the supply networks when optimizing the supply base.

Secondly, the frameworks to optimize the supply base reviewed in Chapter 4 failed to illustrate the real world complexities faced by managers, as they are based on simplistic assumptions. For example, Sarkar and Mohapatra (2006) assumed that a large supply base exists, all decision makers perceive the supply base as large and additionally, that there is an consensus among decision makers that a reduction of such supply base is needed. Scholars in strategic decision-making and decision making in networks would actually challenge such assumptions, arguing that at strategic level, such agreements are never reach through trivial means (De Bruijn & Ten Heuvelhof, 2008; Rouse, 2005). For this reason, the third research sub question address the decision making process that it is involved in the optimization of the supply base.

RSQ2: Why is it important to analyze the dynamics of the supply network when optimizing the supply base?

The previous research sub question defined the supply base is the portion of the supply network that the focal company actively manages; it also suggests that the optimization of the supply base should

aim to reduce its complexity. However, it neglects the agency of the suppliers, which means that suppliers behave strategically in order to maximize their gains, evidencing competition among them. Nevertheless, competition among supplier co-exists in the supply network along with cooperation as when it comes to price reduction, development of new technologies or performance improvement, they become highly dependent of each other. Therefore, I argue that it is important to consider the dynamics of the supply network as the optimization of the supply base should also evaluate and modify (if needed) the control mechanisms to mold the behavior of the suppliers according with the interests of the focal firm. Therefore, focusing on complexity reduction when optimizing the supply base is a simplistic approach, as it neglects the behavior of the suppliers and diminishes the adaptability of the focal firm to the changing environment.

Additionally, framing SN as CAS highlights the fact that the actors involved in the process to optimize the supply base have the power to make their own decision; however, the theories reviewed in this domain does not provide any insights on how this decision making process evolves, which lead us to the next research sub question.

RSQ3: How does the process of decisions making develops in supply networks and organizations when optimizing the supply base?

First, the literature about decision-making in networks states that firms have a network-like organization, as they consists of different business units or departments, which may have conflicting interests, both between and within themselves (De Bruijn & Ten Heuvelhof, 2008). Therefore, the achievement of an agreement between different business units follows an unstructured and complex process where multiple interests are discussed. For this reason I concluded that the assumptions made by Ogden and Carter (Ogden & Carter, 2008) Talluri and Narasimham (2005)in the frameworks they proposed are unrealistic. As mentioned before, they assumed that the stakeholders involved in the optimization of the supply base agree that a large supply base exists, all decision makers perceive the supply base as complex and that there is a consensus among decision makers that a reduction of its complexity is needed. Therefore, the organizational network is the third network identified as part of the process to optimize the supply base (Besides the supply base and the supply network previously explained).

Based on De Bruijn and Ten Heuvelhof (2008), the conclusion is that the process of decision making in networks follows a process-based approach. Different from the project-based approach, the process-based approach has no clear initial goal, as the solution of the problem at stake is an outcome of the process itself. This approach differs from what the frameworks explained in Chapter 3 proposed, as they emphasizes that clear goal setting is a key element to optimize the supply base (Ogden, 2006) and that a reduction of the supply base is the ultimate desirable goal (Ogden & Carter, 2008; Sarkar & Mohapatra, 2006). Therefore, this research sub question establishes that the process-based approach is suitable to address the problem posed by the optimization of the supply base and to manage the three interconnected networks involved in the process.

RSQ4: What are the main elements to deal with when optimizing the supply base?

The main elements to consider when optimizing the supply base are the *structure*, *behavior* and *policy & control* of each of the networks involved in the process to optimize the supply base. The previous research sub questions presented the different networks that are involved in the process, that are organizational network, supply base and supply network. On the other hand, Bellamy & Basole (2013) identified the three fundamental themes to analyze a network: Structure, Dynamics and Policy & Control. They use this framework to analyze the SN as a whole, however I propose to use the same framework to analyze each network identified in previous research sub questions. In this sense, the elements corresponding to the Organizational Network are complexity (Structure); Behavior and Interest (Dynamics); and procedures and corporate guidelines (Policy and Control). The elements characterizing the supply base are complexity (Structure); behavior and interest (Dynamics), and Contract and agreements with the focal company (Policy and Control). Finally, the elements that characterize the supply network are self-emergence (Structure), unpredictable behavior (Dynamics) and lack of central control (Policy & Control). The full explanation on how defined the elements cited above is described in Chapter 6. The outcome of this research sub question is the theoretical framework proposed in Chapter 6, which is the baseline of the analysis of the case studies. The result of the analysis of the cases studies presented in Chapter 7 is the answer for the next research sub question.

RSQ5: How is the process of supply base optimization executed in the practice?

Based on the analysis of the data elicited from the case studies, in the practice the optimization of the supply base is a never-ending process that constantly evaluates the business needs and the market trends in order to adjust the structure, capabilities and performance of the supply base according to

such needs and trends. During the analysis of the data, each network was studied based on the three themes identified in the fourth research sub question. For this reason, this research question was divided into three other questions that will answer how the process to optimize the supply base relates to each of the networks previously identified.

RSQ5a: How does the supply base optimization process relates with the firm?

From the analysis of the interviews conducted during the case study, the conclusion is that the Dynamics and the Policy & Control, are the elements of the organizational network that co-evolve along the process to optimize the supply base. The interests of the business units are known in Philips as business requirements, which dictates the behavior of the business units involved in the process to optimize the supply base. These business requirements co-evolve along the process because of the constant interaction between the different business units, internal functional departments and the influence of the economic, technological and market trends. The business requirements are expressed in terms of cost, risk, responsiveness and innovation, where not surprisingly, cost was the most mentioned factor during the interviews (72% of the interviewees mentioned it).

On the other hand, the internal process and guidelines are the control mechanisms that facilitate or hamper the management of the supply base. Therefore, if the goal is to optimize the supply base, such process and guidelines should also be part of the analysis as they can facilitate a more efficient performance of the supply base. Finally, based on the interviews the structure of the organizational network is an element that influences the process to optimize the supply base, but cannot be influenced by it. As Interviewee 3 mentioned “that the way it is, and you have to learn how to live with it”.

RSQ5b: How does the supply base optimization process relates with the supply base?

From the analysis of the interviews, the conclusion is that the three elements (Structure, Behavior and Policy& Control) of the supply base co-evolve along the process to optimize the supply base. Choi and Krause (2006) argued that the reduction of the complexity was the ultimate goal when optimizing the supply base, focusing only in the modification of the structure of the supply base. However, based on the analysis of the data collected during the case studies, the scope of this activity is broader. It also includes managing the behavior of the suppliers and the control mechanisms in place, to make sure that the suppliers of the supplier base could meet the future business requirements and that their current performance meets the current needs.

RSQ5c: How does the supply base optimization process relates with the supply network?

From the analysis of the interviews conducted during the case study, the conclusion is that the Structure and Dynamics of the supply network are the elements that indirectly affect the process to optimize the supply base. First, the supply network is consider a pool of challengers to the incumbent suppliers, therefore suppliers scouting is a key activity along the process to optimize the supply base. Secondly, the analysis and observation od the supply network provides information regarding the economic, technological and market trends that shape the business requirements of the organizational networks. Additionally, this information is used during negotiation with suppliers also, as it strengthen the bargaining power of the focal firm. Therefore, even though the focal firm does not have any control over the supply network, its dynamics and structure influences the process to optimize the supply base.

How to optimize the supply base of a firm with a global footprint considering a network-level perspective?

Finally, it is concluded that a firm with a global footprint can optimize the supply base by generating ideas from the analysis of the constant analysis of the business needs and market trends and pose them against the structure and performance of the supply base. If the supply base is not able to meet the current or future business needs, then the team should analyze the options to close such gap and follow the six rounds proposed in Figure 12.

9.2 Relevance of this research

This section highlights the academic and managerial relevance of this research of the main three contributions presented in Section 9.1.

9.2.1 Academic relevance

From the academic point of view, thesis provides an ***innovative framework to analyze the process involved in supply base optimization from a network-level perspective,*** incorporating the learnings and developments achieved in different domains into the analysis of the process to optimize the supply base. It combines elements of diverse theories like Complex Adaptive Systems, Complexity Theory, Decision Making in Networks and Network analysis. Researchers claim that this theories present

concepts that are less idealized and more close to reality, therefore it provides models that represents the reality of supply management more accurately.

Firstly, it captures the complexity and dynamism of the supply networks, by framing the Supply Network as a Complex Adaptive System, which claims that actors interact with each other and with the environment following shared and simple behavioral rules in order to increase their *fitness*. In the context of supply networks, it means that that every actor behaves strategically in order to maximize their gains and proposes that they should be manage as such. The acknowledgement of the agency as an important element to factor in the analysis of the supply networks adds realism to the framework and provides a more accurate vision of the dynamics of the supply network.

Secondly, it captures the complexity of the interactions within organizations by linking the supply base optimization process with the theory of decision making in networks. Organizations are usually organized in hierarchies, however, based on the theory of decision making in networks, they behave like networks. In the context of supply base optimization, it means that there is not right solution about how to optimize the supply base. In the other hand, the solution is a partial outcome of the process that is achieved by the interaction of the different stakeholders. This linkage allow us to prescribe strategies used in decision making in networks to optimize the supply base in order to obtain the required commitment from the different parties involved, like actors analysis.

Third, it illustrates the landscape that the process of supply base optimization evolves in provides a description of the main characteristics of each network identified. The landscape is composed by an overarching supply network that self emerges. The supply network has a subset, which is controlled by the focal company, called supply base. Furthermore, embedded in this supply base, is the organizational network, which is the organization and its different business units. There characteristics for each network previously identified are grouped in three main themes: Structure, Dynamics and Policy & Control.

Finally, it differs from previous supplier selection frameworks. It acknowledges that constant negotiation between the three different networks should be managed, in order to optimize the supply base and prescribe actions on how to obtain such agreements. Therefore, it focus on the process to optimize the supply base rather than just focus on the supplier selection criteria and its raking (e.g Chan & Kumar, 2007; Chen et al., 2006). Additionally, it corroborates the validity of the conceptual guide provided by Bellamy & Basole (2013) and it represents the first attempt to develop constructs to

measure the three elements identified by the authors that are Structure, Behavior and Policy & Control, closing the gap identified in Section 1.1.1. The general constructs are presented in Appendix A.

9.2.2 Managerial relevance

From the managerial point of view, the ***process proposed in Chapter 8 is based on realistic assumptions***; considering a network-level perspective therefore, providing managers guidance on how to optimize the supply base. First, it provides a new approach to address the supply base optimization. The frameworks for supply base optimization available in the literature take a project-based approach. However, this thesis takes a process-based approach that could be relevant for situation when multiple a diverse stakeholders are involved. For example, this approach is applicable for commodities that are used by different business units within an organization or for company-wide initiatives to optimize the supply base. In this case, the presentation of facts and data do not represent a sufficient incentive to obtain the commitment and collaboration of the main stakeholders. In this sense, it suggest that managers should manage the front and backstage of the process in order to achieve good enough results. In this sense, manager should provide more than coherent numbers and facts reflected in positive and realistic business cases, as this is just the backstage of the process,. Managers should also manage the expectations and perception of the main stakeholder in order to obtain their commitment and support. This point is especially relevant for manager with a strong engineering background, as the management of expectations and perceptions might not part of their skill set.

Secondly, it acknowledges the agency of the actors, presenting a more realistic design, which provides guidance to managers who want to optimize their supply base, based on assumptions that are closer to reality. For example, it recognizes the importance to neutralize the opportunistic behavior of the suppliers by including a step to design the negotiation strategy, which aims to increase the bargain power of the focal firm. Moreover, it tackles the lack of commitment of the internal stakeholders when implementing the ideas generated at the first stage of the process by proposing a process that follows up the implementation of its ideas and the measurement of its results aiming to create accountability in the team.

Third, it acknowledges the interaction between three networks, illustrating the network-level perspective taken during the analysis. Therefore, it acknowledges that the process develops in a landscape where three different subsets of a network are in constant and inevitable interaction. For example, it states that the generation of ideas to improve the supply base come from the iterative interaction and

adaptation of the business needs expressed by the Organizational Network, the Supply Base structure and behaviors and the technological and economic trends foreseen in the Supply Network. Hence, the result is the commodity strategy, which summarizes the main ideas to implement in order to optimize the supply base.

The main relevance for Philips is that this research contributes with the efforts to map the main procedures involved in the optimization of the global supply base for Philips Health Tech. As previously mentioned, Philips is a collection of different business in different industry sectors that are consumer electronics and health systems. However, in the last years Philips is transitioning from a consumer electronics to a Health Tech firm by merging and acquiring different businesses and companies. In the previous way of working, each business unit enjoyed relative autonomy to adequate the different processes to manage the supply base to each particular business needs. Nevertheless, during this transition, it has become evident that there is a lack of standardize processes, as different business and even different commodity managers optimize their supply base in very different ways. Therefore, there is an ongoing effort to document and standardize process among the different business, as a first step towards an optimized supply base that could support the future business needs of the envisioned Health Tech Company. Therefore, the present thesis is the first attempt to standardize the process to optimize the supply base for Philips Health Tech.

9.3 Recommendations

9.3.1 Recommendation for further research

The first recommendation for further research is the consideration of a more extensive list of firms in the case study design. As described in Section 2.2, Royal Philips was the only firm included in the analysis, despite the fact that this research followed a multiple case design, limiting the generalizability of this research to companies with similar characteristics. In this sense, this research applies to companies with a global footprint, in the industries of consumer electronics and health systems that have a divisional organization and have a centralized procurement department. Therefore, in order to increase the external validity of this research, it is advisable to use the theoretical framework proposed in Chapter 6 to analyze the process followed by companies with distinct characteristics.

The second recommendation is to include the perspective of the suppliers of the supply base and the supply network. As explained in Section 2.3, this thesis takes a view centered in the buying firm;

therefore, it does not include the perspective of any supplier. For this reason, the advice is to analyze the process of supply base optimization including the perspective of the suppliers that are part of the supply base and the supply network in order to increase the internal validity of the research by addressing rival explanations elicited from the supplier perspective.

The third recommendation is to use the framework proposed in Chapter 6 to analyze the process to optimize the supply base of different products. As explained in Section 8.1, the selection criterion *diversity* reduced the list of conventions from 888 to 10, as only the *commodity conventions* met the requirements in terms of number of business units. Remember that the commodity is a product that is used as a sub component of a finished good or service, so it is inherently shared among different business units. Thus, the suggestion is to change this criterion and select the case studies based on the number of functional departments included in the process to optimize the supply base, as they might represent different interests of the focal firm.

The fourth recommendation is to evaluate different negotiation approaches and their impact on the outcome of the process. Chapter 5 posed the optimization of the supply base as a decision making process in networks and provided strategies that could be used by the focal company to achieve the desired results. However, based on the analysis of the interviews, such strategies does not apply to the negotiation that is usually part of the activity to select a supplier, which is involved in the process to optimize the supply base. The interviewees expressed different preferences of negotiation strategies, for example, Interviewee 1 expressed a strong preference to approach the negotiation with a supplier as a dialog, whereas Interviewee 3 expressed a strong preference to use a mechanistic and strict approach when negotiating with suppliers. Due to time constraints, the effect on the outcome of the process was not included; however, I urge the academia to explore the different negotiation approaches when optimizing the supply base.

The fifth and final recommendation for further research is to apply methodology used in this research to evaluate other activities related it to supply management. A report elaborated by Procurement Leaders (2017), presented a list of activities that are in the agenda renowned CPOs, some of these activities are procurement process enhancement, supplier-enabled innovation, and E-procurement and among others. Therefore, the recommendation is to take a network perspective to understand such activities and design process that could handle the complexities inherent in the interaction and coordination of different networks, providing more realism to their planning, as it could provide procurement managers a better conceptualization of the world around them.

9.3.2 Recommendations for Philips

The first recommendation for Philips is to take the process proposed in Chapter 8 to the next level and m document the process in Aris, which is the platform for Business Process Management used in Philips. Despite the ongoing efforts of the Procurement Excellence Team to create harmonized and standardized business processes in the Procurement Department, there is room from improvement in managing the processes related to supply base optimization. The analysis of the interviews and documentation highlighted the fact that the key processes related to the optimization of the supply base as not standard, such as supplier qualification, supplier selection and business awarding. The lack of standard procedures and transparency make difficult to share best practices among different business units and hamper operational excellence within the organization.

The second recommendation is to create an integrated IT landscape that could support harmonized and standardized process across business units. Philips has grown through merges and acquisitions; therefore, the IT landscape is fragmented, hampering the data and process transparency between the different businesses. Moreover, the lack of data transparency makes the creation of negotiated knowledge an almost impossible task, as different systems through different data that is needed for the business case evaluation. Stakeholders with different interests use the lack of data transparency as a strategy to block or delay the ideas that do not serve their specific interests. Therefore, a lot of time is wasted in the verification of the right source of the data and the data itself.

The third recommendation is implement a stronger top down governance to commit to the resources to implement the ideas generated from the process to optimize the supply base. Three out of seven interviewees confirmed that the majority of the ideas are not implemented due to lack of resources of shift in the priorities. Therefore, it is suggested to set a clear threshold in terms of benefits for Philips (Cost, Risk, Responsiveness and Innovations) that indicates when the internal stakeholders are willing to commit resources to implement the ideas generated. Otherwise, there is a lot of waste generating and evaluating ideas that will never be implemented, which hampers the credibility of the team as well.

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Appendix A: List of constructs based on the Theoretical Framework

ID	CONTRUCT	OPERATIONALIZATION
1	***NETWORK STRUCTURE***	
1.1	***Organizational Network***	
1.1.1	**Number of business units**	Business units involved in the initiative
1.1.2	**Differentiation**	Degree of innovation
1.1.3	**Interrelation among business units (Closedness)**	Closedness to any intervention
1.2	***Supply Base***	
1.2.1	**Number of suppliers**	Quantity of supplier within a supply base for the specific commodity
1.2.2	**Differentiation**	Technological and manufacturing capabilities
		Manufacturing footprint
1.2.3	**Interrelation among suppliers**	Perceived interrelation among suppliers by commodity manager
2	***NETWORK BEHAVIOUR***[1]	
2.1	**Supplier Agency (Supply base)**	Behavior and commitment of the suppliers (e.g. Strategies used by suppliers to safeguard their interests)
2.2	**Buyer Agency**	Interests of the business units and their behavior
2.3	**Supplier Agency (Supply Network)**	Behavior and commitment of the suppliers (e.g. Strategies used by suppliers to safeguard their interests)
3	***NETWORK CONTROL***	
3.1	***Organizational Network***	
3.1.1	**Roles and responsibilities**	Roles involved in the convention.
3.2	***Supply base***	
3.2.1	**Active Management of suppliers**	Types of contracts, agreements or partnerships with the suppliers
4	***SBO PROCESS***	
4.1	**Agenda**	Number of topics in the agenda (e.g. Supply base optimization, quality, technical redesign)
4.2	**Irregularity**	No clear sequence of activities. No clear starting point
4.3	**Arenas**	Business units

Appendix B: Interview guide

General Questions:

1. How many years of experience do you have in the procurement sector?
2. What does supply base optimization mean to you?

Part I. Structure

Internal Organization

1. Does your organization clearly define the roles and their responsibilities?
2. Are there conflicts between the responsibilities assigned by the organizational roles and the convention roles? What was the impact?
3. In case of any conflict found, how would you suggest to solve it?

Supply Base

4. Did you consider the option to include a new supplier (challenger) to the existing supply base? Why?
5. Did you have a reduction target for the number of supplier that were part of the supply base? How did you calculate this target?
6. Did you consider the level of differentiation among the suppliers as part of your convention levers? (Did you consider the region of manufacturing, the different technical capabilities of the suppliers?).
7. From the suppliers within the supply base, did you know about any special relation among them? How did you get to know about it? In what ways can the suppliers be interrelated?
8. Did you consider the interrelation among suppliers as part of the convention scope?
9. How do you evaluate the suppliers? Which elements do you consider relevant to evaluate in a suppliers?
10. Which tools and methodologies did you use to evaluate the suppliers?
11. Is there any difference between evaluating an existing and a new supplier? What is the difference? Why is the case? How do you solve it?

Supply Network

12. How do you keep up to date with you knowledge about the possible suppliers for the commodity under discussion during the convention?
13. How do you decide to include a supplier as a challenger? Which factors do you consider important?
14. How do you evaluate new suppliers?

Part II: Dynamics

Individual Behavior

1. Did the convention faced internal resistance? What kind of resistance? Why?

2. Was the collaboration and commitment of the members of the team constant during the development of the convention? Why?
3. How did the convention get the internal approvals and the collaboration needed? Did you use any specific strategy?

Supplier Behavior

4. During the convention, did you evaluate the behavior of the suppliers?
5. Is there any tool that help you to analyze the strategic behavior of the supplier? If not, do you think it is necessary?
6. Do you think the supply base of the supplier affects the performance of the supplier?
7. Can you give me examples of strategic behavior shown by suppliers during the convention? In general? Which strategies do they use?
8. How did you control the strategic behavior of suppliers?
9. Was the behavior between the incumbent suppliers and the challengers different? For example different levels of engagement, collaboration and communication?

Buyer Behavior

10. Regarding the team in representation of Philips, did you have any initial strategy to maximize the gains during the convention?

<u>Part III: Control & Policy</u>

Organization

1. How is performance ensured and measured within your organization?
2. What kind of tools do you use for people management?
3. Do you think there is a rigorous people management policy in Philips?

Supply Base

4. What type of contracts or agreements do you have with the suppliers in the supply base?
5. What type of contracts or agreements would you like to have in the envisioned supply base?
6. How to you enforce the contract?

Supply Network

7. How do you influence the suppliers that are not part of your supply base?
8. Do you think you can control the behavior of the suppliers that do not belong to your supply base? How?

This is the end of the interview; however, I would like to know if there are any other aspects that you consider important regarding this topic and that were not discussed during the interview? Do you have any reports or material that you consider useful for my research and that you can share?

Appendix C: List of Interviewees

INTER-VIEWEE NUMBER	EXPERI-ENCE (YEARS)	LOCATION	CURRENT ROLE
1	30+	Massachusetts, USA	Procurement Director
2	10	Eindhoven, The Netherlands	Business Improvement Leader / DfX Coach
3	15	Eindhoven, The Netherlands	Director at Procurement Strategy and Transformation Department
4	10	Drachten, The Netherlands	Global Commodity Manager
5	15	Eindhoven, The Netherlands	Global Commodity Manager
6	20+	Bothel, USA	Commodity Manager
7	17	Best, The Netherlands	Global Commodity Manager

Appendix D: Key Terms

The following key terms were extracted from the answers the interviewees gave to the question: What does Supply Base Optimization mean?

CONCEPT	KEY TERMS	FREQUENCY
SUPPLY BASE OPTIMIZATION	Meet business requirements	71%
	Have right number of suppliers (+ / -)	57%
	Have the suppliers with right capabilities	71%
	Consolidated supply base	57%
	Increase bargaining power	14%
	Right supplier relationships	14%
	Continuous process	14%
	Supplier development	14%

The following key terms were extracted from ideas to optimize the supply base presented by each team at the closure meeting of the convention and the interviews. The frequency is counted per case.

SUPPLY BASE	KEY TERMS	FREQUENCY
Number of suppliers	Right number of suppliers	100%
Differentiation among supplier	Technological capabilities	100%
	Manufacturing capabilities	100%
	Logistics capabilities	100%
	Supplier footprint	67%
Interrelation among supplier	N/A	
Behavior	Collusion	33%
	Exploitable relationships	67%
	Performance record (Logistics, quality, sustainability)	100%
Contracts	Services (EOLS, warranty)	33%

The following key terms were extracted from ideas to optimize the supply base presented by each team at the closure meeting of the convention. Specifically, the key terms correspond to the drivers that motivated the ideas proposed.

BUSINESS REQUIRE-MENTS	KEY TERMS	FRE-QUENCY
COST	Better prices in the market	13%
	Quality [Cost of non-quality]	3%
	Economies of scale	26%
	Costs due to opportunistic behavior	21%
	Service cost	5%
	Inventory	5%
		Total Cost = 72%
RISK	Supplier risk	3%
	Sole source supplier	3%
	Single source supplier	10%
		Total Risk = 15%
RESPONSIVENESS	Efficient customer service	3%
	Efficient service to buyer	5%
	Time to market	5%
		Total Responsiveness = 13%
INNOVATION	N/A	0%
		Total innovation = 0%

The following key terms were extracted from the answers the interviewees gave to the sections related to the supply network.

SUPPLY NETWORK	KEY TERMS	FREQUENCY
Benefits	Potential suppliers	57%
	Technological trends	29%
	Economic trends (labor market, material cost, demand)	29%
Cons	Supplier need to go through due diligence process	29%
	Suppliers without historic track on performance	29%
	Supplier not incentivized (awareness benchmark)	14%
Others	Basic expectation of commodity manager	29%