Tampere University

DANIAL PARSA

SHOULD-COST ANALYSIS AS AN ALTERNATIVE TO OPEN BOOK ACCOUNTING

Faculty of Business and Built Environment
Master of Science Thesis
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ABSTRACT

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Master of Science Thesis
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A key question that decision makers from start-ups to SMEs and corporates face is "to outsource, or not to outsource?". In today's business world which is fast-paced, the pressure on companies to provide products and services is higher than ever. To respond to this pressure but holding costs down, all types of companies need to outsource their non-core processes and more concentrate on their key core competencies. Nevertheless, the gained advantages of outsourcing can be beyond only cutting costs. Hence, it is critical to understand the different benefits for both company and its partners. Sharing information and supply chain collaboration have become the main elements of their success. Suppliers' pricing decisions historically may have been in mystery and the details of a price are confidential. It is logical for a buyer to want to probe the main cost drivers. A recommended approach is to persuade the supplier to open its books. Some believe open book accounting (OBA) as a solution to that and it can deliver, but not guarantees, considerable results or cost savings.

The objective of this study is to find an alternative to OBA when the business partners are not ready or willing to open their books. The study shows OBA may not succeed even in mature and rather partnership-oriented relationships. Therefore, should-cost analysis supports the purchaser to achieve its aims to control the profits and costs made within upstream of supply chain. The study shows such alternative to OBA enables the purchaser to enhance the supply network's efficiency by bringing the cost transparency into the customer-supplier relationships. This study illustrates should-cost analysis is an effective tool in determining fair and reasonable pricing and today it has to be embedded in procurement processes. Should-cost analysis determines what a product should cost on the basis of labor, materials, overhead, and profit margin.

Keywords: Customer–Supplier Relationship, Network, Supply Chain Management, Inter-Organizational Cost Management, Should-Cost Analysis, Open Book Accounting, Profit-Whiplash Effect, Profit-on-Profit

PREFACE

While studying Master of Industrial Engineering and Management, I have realized my interest and passionate towards researches in the area of cost management. Discovering an opportunity to conduct a comprehensive study based on a case study in this context and elaborating and documenting the untouched and overlooked areas in inter-organizational cost management were strong motivators to me. Besides that, a three-year-experience in the industry of hose assembly was a driver to conduct this study. This study tries to broaden the companies' understanding about their suppliers' cost structure.

By performing this study, I learned a lot about different types of partnerships and their corresponding inter-organizational cost management practices. Therefore, I had the chance to apply and examine this background knowledge in the procurement process of a case study and successfully finish this cost management development study. This study offers a solution to OEMs and makes the procurement process more transparent.

In particular, I would like to thank Dr. Jouni Lyly-Yrjänäinen for providing inspiration, guidance, encouragement and clarifying the study orientation during performing whole of this thesis writing. I would like to also thank Professor Teemu Laine for his important inputs and helpful comments and motives during the thesis writing. I also express my appreciation to the representatives of companies who by sharing their insights supported this study. Lastly, I would also like to thank my family and my friends helped me a lot and were always inspiring me.

Tampere, 16 January 2019

Danial Parsa

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS AND ABBREVIATIONS

SC	Supply Chain
SCM	Supply Chain Management
CSF	Critical Success Factors
IOCM	Inter-Organizational Cost Management
OBA	Open Book Accounting
SCA	Should-Cost Analysis
OEM	Original Equipment Manufacturer
RE	Reverse Engineering
CAD	Computer Aided Design

1. INTRODUCTION

1.1 Background

Nowadays, the supply chain competition is global, the customers are more demanding and less loyal, and the economic pressures are increasingly forcing the companies to find alternative ways to do their businesses beyond their individual enterprises (Ireland and Crum, 2005). As companies increasingly consider their key core competencies, they outsource more "non-core" aspects of their businesses to take advantages of market opportunities (Handfield and Bechtel, 2002), hence, value added is increasingly created in complex supply networks rather than inside companies. The companies have increasingly collaborated with other supply chain members (Simchi-Levi et al., 1999; cited in Ramanathan and Gunasekaran, 2014), thus, information sharing and supply chain collaboration have become the main elements of their success (Ireland and Crum, 2005) in activities such as forecasting, planning, replenishment, resource sharing and incentive sharing (reviewed by Ramanathan and Gunasekaran, 2014).

According to Ellram (2002), more than 50 percent of the cost of sales of most manufacturers is made up of costs related to purchased products and services. Presenting as a percentage of industry's revenue (Ellram, 1996), on average, 63 percent of manufacturers, 86 percent of wholesalers, 78 percent of retailors, 86 percent of utility businesses and 25 percent of service sectors is made up of purchasing costs. Therefore, in many supply networks purchased products costs are the most important differentiators between competing companies and supply chains. To improve the profit by lowering the costs, looking at the cost of purchased goods is considered as a starting point. Therefore, having a control over earned profits by companies in upstream of supply network is a potential concern for sourcing managements. "Profit-on-profit" introduced by Suomala et al. (2010) is a phenomenon which occurs in supply networks due to lack of cost transparency and information sharing among organizations. This phenomenon, however, in this study is called "profit-whiplash effect" which is a better description of this incremental effect. Profit-whiplash effect shows a minor "unfair" profit in upstream results in an amplified profit in downstream bore by the final customers, and negatively influences the competitiveness of supply networks and their units.

Open book accounting (OBA) has been introduced for this purpose and examined in the accounting literature. Open book accounting is defined as openly disclosing the cost and other data which are generated in accounting system of supply chain members (Agndal and Nilsson, 2010) and sharing the cost information is a core of OBA (Kajüter and

Kulmala, 2005). However, a minimal or adequate level of supplier-purchaser trust to expect openness is needed (Kulmala, 2004). Windolph and Moeller (2012) review the literatures have widely addressed problems and prerequisites of OBA implementation. Thus, despite the OBA literature that often takes deep access to supplier's products cost data for granted, OBA implementation is a challenging practice. In addition, in some cases OBA is not necessarily the best way for cost transparency among business partners.

Therefore, cost management as the most powerful supply management concept for proficiency and success of supply network (Anklesaria, 2008) is needed to be studied and elaborated in the circumstances which the business partners are not interested in a collaborative relationship. Extending the enterprises' insight towards their suppliers' cost structure is critical but it is still in its infancy. Hence, finding alternative ways to figure out the purchased product's cost structure to increase awareness is a critical but overlooked issue in current literature.

1.2 Objective

Open-book accounting (OBA) and other inter-firm accounting techniques are explained as essential means to control costs inside customer–supplier relationships which brings improvements in the quality of that relationship (Windolph and Möller, 2012). However, disclosing cost data can jeopardize the supplier's position when the purchaser employs the data through price negotiations to squeeze the profit of the supplier. This study aims to step beyond the restrictions and limitations of the concepts of exiting cost management, because of not being capable of covering this problem. This thesis addresses this gap by investigating the should-cost analysis as an alternative to open book accounting and its impact on buyer–supplier relationships.

By embedding reverse engineering into cost management practices, the should-cost analysis aims to provide the purchasers with the essential information for a judicious price negotiation (Mealer and Park, 2013). Should-cost analysis is an analysis, conducted by a customer, to break down the expenses of a supplier that are involved in fulfilling a contract or delivering a product or service. Should-cost analysis supports the purchaser to build a big-picture upon the overall cost break down in terms of costs such as material, labor, production process, product's rejects, overheads, packaging and transportation costs to guide negotiations that occur between the supplier and the buyer. Hence, the should-cost analysis enables the purchaser to discover the cost reduction opportunities independently.

This concept can provide the needed inputs into the procurement process which has important implications for the design of cost management within inter-organizational relationships. Thus, the objective of this paper is…

... to examine the concept of should-cost analysis and discuss its role as an alternative to OBA to enhance the supply network's efficiency by bringing the cost transparency into customer-supplier relationships.

To address this objective, the literature of inter-organizational relationship, inter-organizational cost management, OBA, reverse engineering and should-cost analysis are reviewed. Then, a generic process of should-cost analysis is proposed to demonstrate its potentials to meet the expectations of OEMs in the absence of open book accounting. Lastly, this proposed process is applied and tested in an of inter-organizational cost management context in an industry related to the case study.

1.3 Data Gathering Method and Research Process

Research is the essential step for starting a project, since research provides knowledge, formulates strategy, provides confidence, and helps practitioners to achieve desired results (Kelly, 1998). Amaratunga et al. (2002) defines it as a systematic process that intends to create and touch new knowledge areas. Research methods include procedures and rules and is seen as tools to solve problems. Moreover, choice of methods and the ability to adequately select among (or combine) methods are important issues (Ghauri et al. 2005). While there are various specifications of the term research, their bottom line can be concluded as systematic studies done for a topic in order to gain useful knowledge related to a specific subject. Different topics require their own specific research methods. Therefore, different factors are effective on the research methodology; however, some of these methods are applicable to most of the different topics.

Empirical researches use empirical evidences. Empirical research is seen as a tool to achieve knowledge by experience or observation and report of explorations and conclusions (Minor et al. 1994). After this part, the researcher starts to build a hypothesis. Theories, on the other hand, are to explain and understand the phenomena and extend existing knowledge within the limits and then test within the real-life. The theoretical framework refers to the structure for supporting a theoretical part of a research study (Trinajstić, 1996).

According to Moody (2002), the empirical studies are categorized in two groups of quantitate and qualitative methodologies. The nature of management research induces the use of qualitative research methods rather than quantitative ones. Qualitative approaches concern understanding and interpretation, on the other hand, the quantitative approaches rely on explanations, testing of hypothesis and statistical analysis (Eriksson and Kovalainen, 2008). In early stages of empirical methods, qualitative methods are often applied; however, qualitative methods are more applied to test the theory. Most research methods, however, are a combination of both methods. In addition, Wohlin et al. (2006) explain the empirical sturdies include four groups: case study, experiment, survey and postmodern analysis.

Business related area has a strong social science background which is reasonable because it is related to human decision making. This characteristic makes a profound effect on the research methods typically used in the field. Firstly, management research supports more qualitative than quantitative methods. Secondly, most typical way of conducting a business-related research is a case study. It is characterized by its pragmatic approach, often implemented as case studies. They are used when the research question is "how" or "why" a phenomenon is happening (Yin, 2009). With the case research, it is possible to a comprehensive understanding on a subject, while using it has several challenges: it is time consuming and generalizability of the conclusions might be hard for small number of cases (Voss et al., 2002).

A case study examines an academically interesting issue in its practical context (Saunders et al., 2012). A benefit of employing a case study is which it often answers the "why?" question as well (Saunders et al., 2012). Case study research gives a clearer understanding over complex phenomena and reveals the hidden aspects. The case study provides the possibility to use multiple beneficial data gathering methods. Both qualitative and quantitative data generation methods can be applied in case studies, while qualitative data gathering method is more common.

According to Miles et al. (1994), qualitative research has three major components: data, interpretative or analytical procedure and finally report. First, data is often collected through ways which are explained later. Second, interpretative or analytical procedure means the techniques to analyze and conceptualize the data to reach the findings or theories related with a specific subject, finally, report includes written or verbal part of the research.

Following the same order of ideas, Yanow et al. (2014) stated that there are three qualitative data gathering methods: reading, talking and observing. Reading is since previous written material can be used as a data gathering method; nonetheless, reading material depends heavily on the context in which they were developed. Talking resembles to the qualitative interviews proposed by Gummesson (1993), and thus its main advantage is that it can provide deeper information since it resembles to a normal conversation. Lastly, observing means that the researcher is able to evidence how the phenomenon takes place and, in some cases, affect it. Each research method is meant to be used depending on researcher's purposes and the specific case study needs

An important decision towards a case study research involves choose of suitable data gathering methods. Gummesson (1993) explain five different methods which could be employed in context of management topics. These are using existing materials, questionnaires, interviews, observations and action science. Using existing materials includes usage of books, published papers and other sources of information which are easily accessible. Second, questionnaires are a set of questions which are conducted with a target audience. Third, interviews are often formal discussions with relevant people that provide

a deeper insight into the research topic. Fourth, observations can be done either on a process or a person to gain knowledge non-verbally. Finally, action science enables the researcher to have a close involvement within a research process. Depending on the course of study, researcher can shape and change the process to his convenience. (Gummesson, 1993)

Suomala and Lyly-Yrjänäinen (2012) provide further insight into action research that involves a direct manipulation of the phenomenon investigated: interventionist research. Some of the strengths that separate interventionist research from other methods include the possibility of building access to different organization levels and organizational phenomena that are perceived as invisible or non-discussable; the practical utility of the collaboration between academia and industry; and the heightened potential of making practically valuable findings directly within the target organization. On the other hand, interventionist research pits researchers with managers, which sets abilities in order to conduct successful research.

The research methods relevant to the case study of this paper were mostly qualitative interview and using of existing material. Existing material basically consisted of the web page content of the companies within the hose assembly industry where information about the product mix and technical specifications were found. Qualitative interviews were used to gather more information from involved-representatives in the same projects in this industry.

This study pursues the goal of creating a framework to assist OEMs to get a clearer understanding over the purchased suppliers' products. This theoretical framework was tested in a real case study. Several data gathering methods were employed like interviews, existing materials, observations and lastly action science. Firstly, several online resources like the companies' websites and their products were checked out and observed. This gave a big picture over the company and its operations. Then, several interviews with the involved-people in the similar project were conducted. Therefore, the ultimate goal of this research was clarified. This information always has been complemented by the concrete experience of the author within the industry of hose assembly.

The data needed in this case study was collected through observation and action science. While conducting this study and in the development progress, the author paid a visit to companies in hose assembly industry and their suppliers and also had presence in a lab for some measurements for the cost management study of the case. Therefore, observation and interviews had a key role in the data gathering process. Author involvement made it possible to demonstrate the main idea of this study.

The start of the research process backs to 2016, when the author worked on a project related to the course of "business development in sales and sourcing". The main goal of that project was to analyze and elaborate the concept of profit on profit (that later is called

profit-whiplash effect). That project was conducted for a company operating in mining and construction equipment industry in Tampere, Finland. That project was accomplished after presenting the results to the company's management and few visits to the hose assembly supplier and the mining and construction equipment company both operating in Tampere, Finland. Visits of that project to the highly automated production lines of companies besides the author's three-year-experience in the industry of hose assembly in car industry in Tehran, Iran were the main motivators for the author to select this topic to conduct in-depth studies in this area. The milestones of the research process are roughly demonstrated in Figure 1.

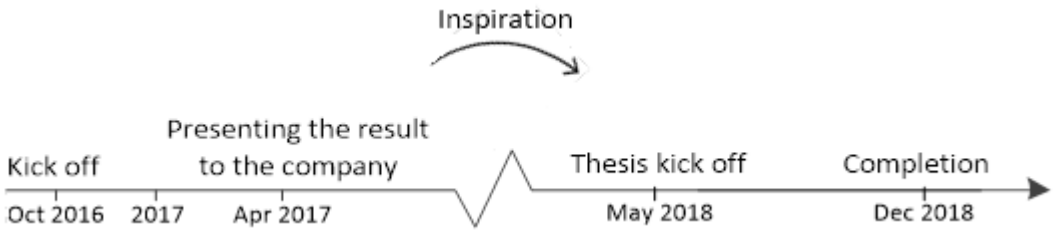


Figure 1. Research process overview.

In the middle of May 2018, the research process was commenced as the author started to conduct a research on a project related to a case study. This project aimed to find alternative ways to concurrent cost management practices like open book accounting and was performed in the industry of hose assembly with a focus on car and mining and construction equipment industries. Figure 2 illustrates the working process of the thesis.

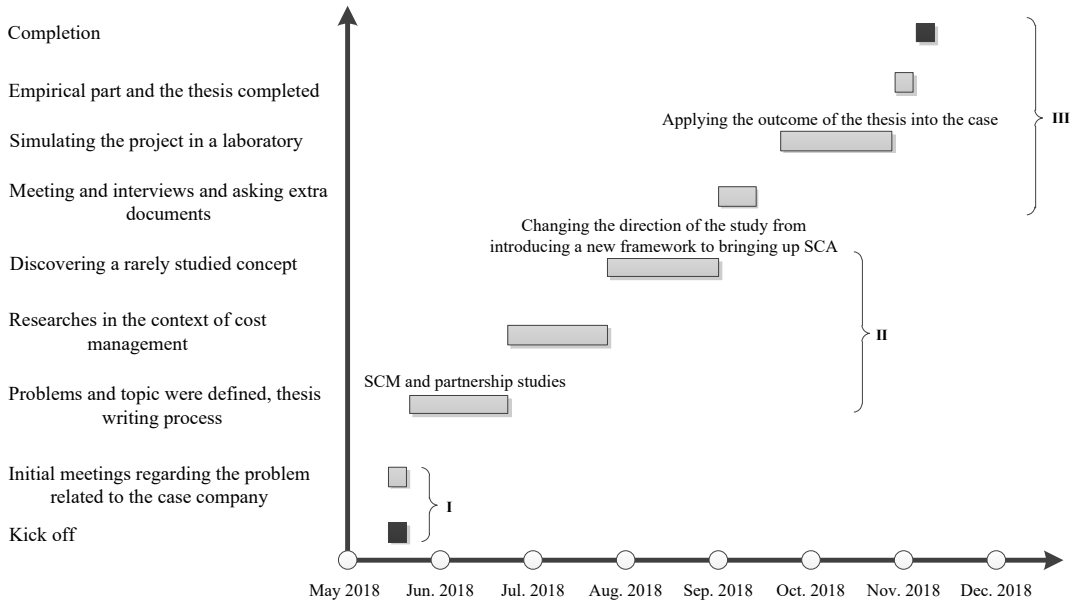


Figure 2. A general overview of the research process.

The research process is divided into three main stages. The first one involves receiving the option to conduct this study on a case. Then, this stage was continued with identifying

and elaborating the problems related to the case through few meetings with companies' representatives. Identifying the main problem could rather impact the whole research process.

The second stage refers to studying and analyzing the identified problem from an academic perspective. Therefore, an exhaustive and intensive literature study over several managerial concepts was conducted. The outcome of these studies is creating several frameworks to tackle different problems throughout the case industry.

Lastly, this stage involves applying the frameworks within the case to solve the problems and validate the research's proposed solutions. Therefore, the researcher presented in some laboratory sessions, meetings with the experts and finally wrapping up the thesis work.

1.4 Structure of the Thesis

This thesis is broken down into nine chapters. Each chapter conveys main contents and certain objectives as following:

Chapter 1 focuses on the introduction, the background and also the objective that this study pursues. Moreover, this chapter contains the data gathering methodologies and the research process. Hence, Chapter 1 can be seen as the concrete part of the thesis.

Chapter 2 elaborates the characterization of supply chain management and new trends inside it in different researches. This chapter discusses different strategic partnerships in the supply chains and looks at information sharing as either a building block or bottleneck of a successful supply chain.

Chapter 3 is seeking to the new and overlooked areas the inter-organizational cost management. In that sense, the concept of cost structure is discussed from a new insight and the profit-whiplash effect as an implication and contribution to cost management area is introduced.

Chapter 4 is aiming to have a rather comprehensive study over the open book accounting concept and its characteristics to find out its strengths and downside as an eye-opening to select the most efficient alternative in OBA's absence.

Chapter 5 is the core of this study. This chapter by digging in older practical projects in Department of Defense of the US sheds a light over the concept of should-cost analysis. Therefore, a more cost management- oriented look at the concept of reverse engineering is also conducted.

Chapter 6 briefly explains the case, product components and its general industry supply network. This chapter also discussed the reason of conducting a project in the inter-organizational cost management context.

Chapter 7 demonstrates the application of should-cost analysis in the case to tackle the challenge of price fluctuation within the hose assembly industry.

Chapter 8 reviews the research process of the thesis, the challenge and the framework which is proposed in this thesis. So, it analyses the application of the proposed concepts and framework in the case. Lastly, it shows the findings, the challenges, the implications and the limitations of the project.

Chapter 9 is the conclusion of the report. It brings up the discussed background, the selected objective of the thesis and the findings and discoveries after the thesis completion.

2. INTEGRATING THE SUPPLY CHAIN

2.1 New Trend in Supply Chain

Characterizations of supply chain (SC) have been the focus of different researches. A group of organizations or individuals which pass forward the materials refers to a supply chain (londe and Masters, 1994). The definition of SC is not unique, as Chopra and Meindl (2007) explain that it includes the business parties that are directly or indirectly meeting and fulfilling the customers' needs. In that definition, meeting the customer's need is considered as the focal aspect of the supply chain. Felea and Albăstroiu (2013) note which supply chain implies all functions that are needed to fulfill the customer's needs like new product development, operation, marketing, customer service, finance and distribution which are necessary to meet the customer's needs. From a system dynamics standpoint, Otto and Kotzab (2003) and Hall and Saygin (2012) see supply chain as "a chain of consecutive, sequentially interdependent local transaction systems". Consequently, supply chain management (SCM) deals with handling trade-offs among different supply chain actors. To avoid conflicts due to interdependencies, coordination and cooperation are means for trade-off management which by interpreting various actors can improve supply chain's performance.

Supply chain structure refers to a model including miscellaneous nodes of economic entities, like manufacturers, suppliers, customers, retailers, and distributors. Supply chain's functions and cooperation such as production, retail and distribution, in this model, are the drivers of businesses of the nodes. Logistics, information flow and capital flow are the components for continuous value-addition through whole supply chain.

The nature of SCM needs an ongoing analysis and optimization of the nodes' functioning and making sure cooperative relationships are established amongst nodes. Therefore, the value-creation throughout the supply chain, and businesses at each node will be maximized. Hence, the supply chain structure management is regarded as the core of SCM (Li and Lai, 2009). Waller (2003) and Mentzer et al. (2001) describe supply chain as involved members within flows of information, services, products, finances from one business actor to another in both upstream and downstream directions. Based on this conceptualization, five types of supply chain through the degree of complexity, as shown in Figure 3, can be identified (Montoya-Torres and Ortiz-Vargas, 2014).

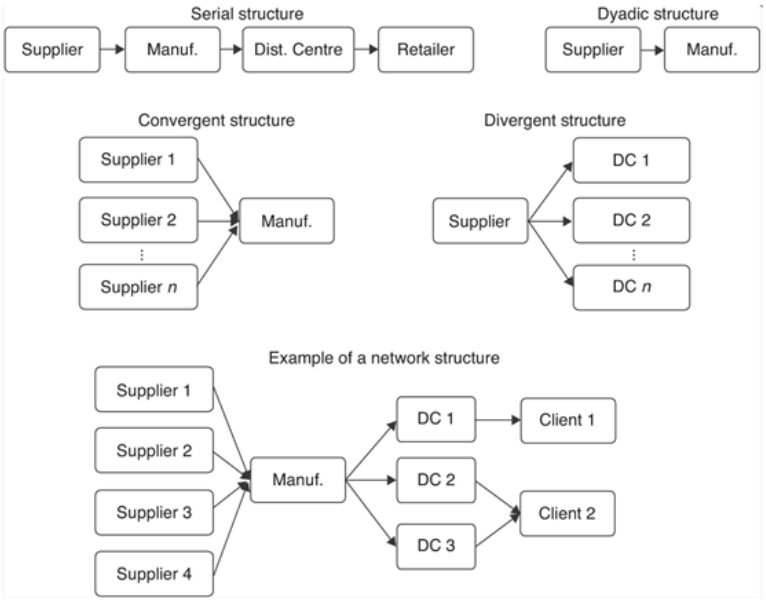


Figure 3. Supply chain structure (Adapted from Montoya-Torres and Ortiz-Vargas, 2014).

The figure above shows a supply chain can have various levels of complexity. The dyadic structure implies two business entities including a focal company and its supplier which is the most studied structure in literatures due to its simplicity in analysis and modeling (Montoya-Torres and Ortiz-Vargas, 2014). This type of supplier-customer relationship includes different ties like economic, social, juridical, or other ties (Kulmala, 2003). Serial structure is also a typical structure which considers entities like supplier, manufacturer, distributor and retailer. A convergent structure involves a situation which several suppliers deliver components to a distribution center. Conversely, divergent structure is more practical and shows a supplier supporting different entities. Finally, the network structure as the most complex and comprehensive one occurs when both divergent and convergent structures occur simultaneously (Montoya-Torres and Ortiz-Vargas, 2014).

The introduced classifying approach to supply chain is beneficial to examine the practices initially within a supply chain with the lowest complexity and then develop them to more complex supply chains with more business actors. In this study, the frameworks are created on the basis of dyadic and serial structures and can be scaled up and promoted to more complex supply chain structures and supply networks. Kempainen and Vepsalainen (2003) summarize the changes within supply chain from 1990s to 2003 as a situation which the operation analysis and problem identification were only done from material flow efficiency point of view. Therefore, cost competitiveness and inventory management were the main SCM concerns. The collaboration within supply chain was often with the close business partners like first -tier supplier and customer, and other supply chain members were not identified. However, the collaboration among entities of an extended supply chain is beyond first-tier customers and suppliers.

Braziotis et al. (2013) argue that recent approaches towards supply chain are mostly viewing supply chain as one system (supply chain-centric against organization-centric view)

as Ritter (2000) stresses no business is isolated and operating independently in business world. All firms are dependent on other firms' collected resources. The dyadic relationship is the fundamental relationship which helps in analyzing the relationship development. However, the relationships have become broader, and companies are members of a network of relationships. Fletcher and Barrett (2001) explain network as a system which comprises many dyadic-relationships between suppliers and customers. Håkansson and Ford (2002) define network as several nodes that are connected through relationship which form a complex business market. The nodes are business units like producers, suppliers and customers. Therefore, supply network is characterized as a network of connected firms that cooperate to improve the information and material flows to provide the end customer with value (Lysons and Farrington, 2006). Kajuter and Kulmala (2005) explain that blurring of firms' boundaries leads to emergence of networks which are defined and distinguished by the end product. In addition, they explain individual members of networks even can be a member of other competing networks. Figure 4 is an illustration of SC evolution to network.

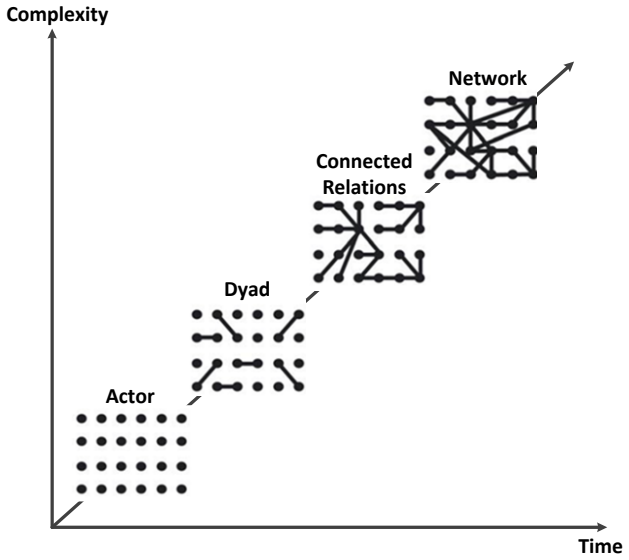


Figure 4. From supply chain to supply network (Modified from Ritter et al., 2004).

The dots are the representatives of SC actors (like supplier and distributor) and a dyadic relationship bridges them together. However, the firms are usually directly or indirectly connected to each other via a complex relationship. Håkansson and Snehota (2000) state that "every relationship is not only a bridge between two actors but also a reflector or a projection of other relationships". Therefore, any firm depending on its role is a member of either upstream network (called supply-side) or downstream network (called demand-side). Figure 5 explicitly illustrates a supply network and its characteristics.

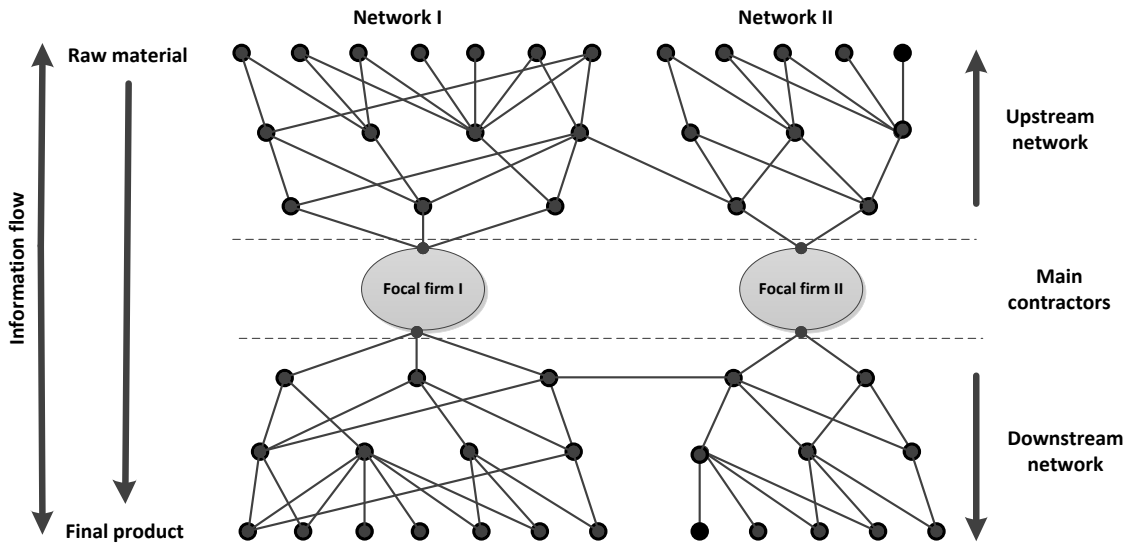


Figure 5. Supply network (Modified from Harrison and Hoek, 2014; Kulmala, 2003).

The figure above illustrates looking at a supply network provides companies with a view of the overall materials and information movement from start to end, enabling them to know the value creation occurs through partnerships to make sure the end-customer is provided with the best possible value. SCM has been specified by several authors in recent decades. Mentzer et al. (2001) specify SCM as

> *"... the systematic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purpose of improving the long-term performance of the individual companies and the supply chain as a whole"*

According to the conceptualization, obtaining long-term performance improvements in individual members and through supply chain by the strategic coordination within a supply chain is highlighted. Similarly, Yap and Tan (2012) see SCM as a competitive advantage of an organization and a successful implementation of SCM strategy supports companies by promoting customers' satisfaction, increasing market share and ensuring the profitability across the supply chain. Ho et al. (2002) and Lambert and Cooper (2000) define SCM as

> *"a philosophy of management that involves the management and integration of a set of selected key business processes from end user through original suppliers, that provides products, services, and information that add value for customers and other stakeholders through the collaborative efforts of supply chain members."*

Based on these conceptualizations, SCM is dealing with providing new ways to manage businesses and relationships with actors in supply chain. Ho and Newton (2002) explain according to the reviewed literature, key elements of SCM are: value creation, key business process integration and finally collaboration. First, value creation for stakeholders

and customers is the main element and overall aim of SCM. Value creation occurs through a network of interdependent and autonomous entities that create value individually or together. Second, the value creation is the outcome of integration and management through key business processes within a supply chain. Business process integration refers to joint actions of business actors with the intent of forming a valuable product flows by smooth information flows. Third, the element of key business processes integration is possible within a collaboration among business actors. Further, Banchuen et al. (2017) argue that an individual company is not able to compete in today's fierce business market for the reason of high customer demand and extreme competition. A comprehensive relationship between supplier and buyer provides additional values for both buyers and improves supply chain's performance. Adam (2008) contends collaboration happens only through information exchange among business actors. Hall and Saygin (2012) conclude the literature of SCM present that better information sharing through supply chain results in shorter lead times, lower inventory levels, lower batch sizes, quick product development and shorter order fulfilment cycles.

A customer–supplier relationship includes different ties like economic, social, juridical, or other ties, and the critical success factors (CSFs) analyze what makes this relationship more partnership–oriented or transaction–oriented (Kulmala, 2003). Studying critical success factors of SCM is a comprehensive way to analyze a partnership-oriented relationship between a buyer and a supplier (Kulmala, 2003). Talib et al. (2015) define the concept of CSF of SCM as crucial factors or set of activities that are needed for the success of an organization. So, managers should have a constant attention to these factors. CSF can be perceived as a bias-free tool which assists organizations for higher performance and monitoring activities and progresses. Talib et al. (2015) by applying Pareto analysis highlight 20 percent of factors (9 out of 25 CFSs) which are the most studied in the literatures as CSF of supply chain management. Figure 6 indicates these nine CSFs which are vital for the success of SCM.

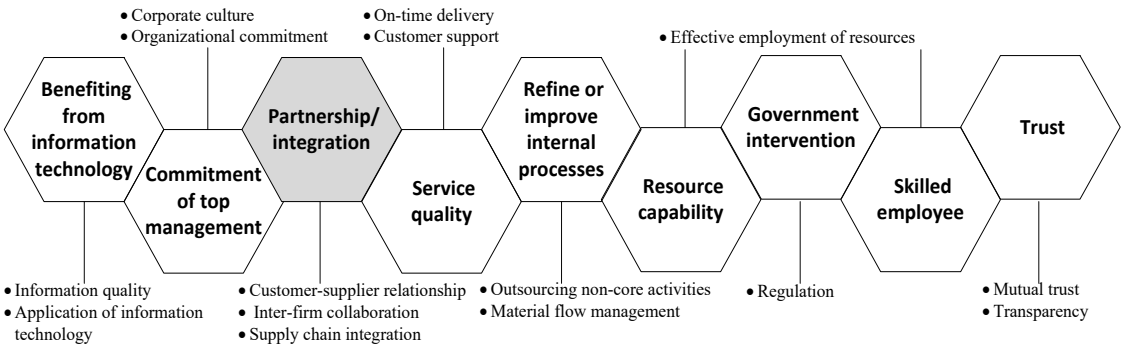


Figure 6. Vital CSF of SCM (Adapted from Talib et al., 2015).

There are some other factors like cost minimization and profit maximization which are not among highlighted factors in the figure above. However, Talib et al. (2015) justify it as the selected mentioned factors are accommodated by the firms, consequently, they can

reach cost reductions. Open communication (cross-organizational communication) and customer-supplier experience are also other items which are not include in the vital CSFs, while, based on industry's' characteristics they can be also taken as CSFs of SCM. Kulmala (2003) concludes that there are similarities between CSFs of a dyadic relationship (as a unit of a supply chain) and a network, hence, factors which are important within dyadic relationships are also important in networks. Exceptionally, open communication is perceived as a network's CSF compared to a typical communication in a dyadic partnership.

Kulmala (2003) reviewed literatures of CSFs which are in connection with the success of "partnerships and networks". Trust, coordination, joint problem solving, shared values, two–way information sharing, mutual integration in strategy formation and operations, top management support, early communications with supplier, mutual commitment, mutual understanding, distinctive value added by suppliers, and sharing risks can be referred as relative factors to this study. All in all, mutual trust, transparency, information sharing, close relationship, constant communication, and shared values are the fundamental factors for stablishing a "good relationship" among business partners with the goal of a successful supply chain and also cost management as is discussed in the next chapter. As shown in the figure above, partnership or customer-supplier relationship is a vital CSF of SCM. The next section focuses on the concept of inter-organizational relationship and its characteristics.

2.2 Inter-Organizational Relationship

The concurrent business environment emphasizes on the competition between supply chains, and organizations are entities of a supply chain which competes with other supply chains (Cigolini et al., 2004; cited in Wu et al., 2014; Lambert and Cooper, 2000). Therefore, instead of solely autonomous entity versus solely autonomous entity, it is nowadays supply chain in front of supply chain. Meeting the requirements of customers as the goal of supply chain occurs by delivering the right product, place, time and quality. However, these principles are achievable by benefiting from both internal and external integration (Harrison et al., 2014). A detailed understanding of the procurement processes and its implementation increases the efficiency and effectiveness of a company in the highly competitive market. Companies are faced with a set of challenges like products delivery to the customers at the right place and proper time, challenges of globalization and its higher risk, and complex supply chain. Therefore, the need of establishing better models than the existing conventional customer-supplier relationship can be addressed to go through the mentioned difficulties.

Inter-organizational relationships are built with the intention of achieving goals which are rarely achievable by individual firms separately (Cheng, 2011). Firms, nowadays, concentrate on their own key parts and core competencies and outsource their non-core activities (Ghodeswar and Vaidyanathan, 2008; Belohlav, and Young, 2007; Belcourt,

2006; Barthelemy, 2001; McIvor. 2000), hence, supply network has a main role on the success of a firm. Inter-organizational relationships can provide higher outcome while "partners combine, exchange, or invest in idiosyncratic assets, knowledge, and resources/capabilities, and/or they employ effective governance mechanisms" (Dyer and Singh, 1998). Sheth and Sharma (1997) stated previously which "organizational buying is dramatically shifting from the transaction oriented to the relational oriented philosophy and will shift from a buying process to a supplier relationship process" meaning a successful procurement is highly dependent on successful inter-organizational relationship. The literature brings up two interrelated types of integration employed by the companies (Figure 7). The first form of integration refers to integrating and coordinating the physical flow of deliveries among supply chain members in a forward direction. Another form of integration refers to the backward coordination meaning multiple firms coordinate their activities to control a supply chain (Frohlich and Westbrook, 2001).

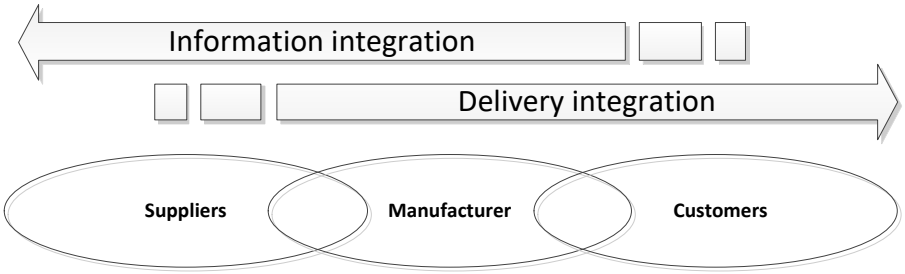


Figure 7. Integration in the supply chain (Harrison et al., 2014).

Arc of integration is a concept reviewed by Frohlich and Westbrook (2001) focuses on the integration from two aspects. First, the direction of integration which can be with suppliers (upstream) or with customers (downstream). Second, the degree of integration which refers to the extent of integration practices. Figure 8 illustrates the idea.

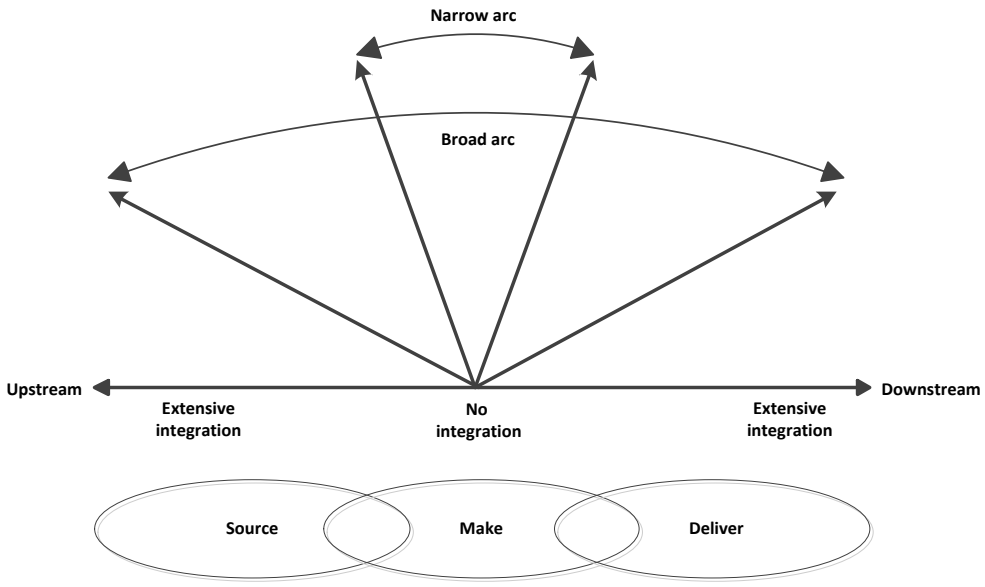


Figure 8. Arcs of integration (Frohlich and Westbrook, 2001).

Business performance is positively proportional to 'the breadth' of the arc and the 'balance' of the arc, hence, the potential benefits are greater if the integration with customers and suppliers is higher. Moreover, the broader integration minimizes material flow uncertainty within the supply network (Harrison et al., 2014). Handfield and Nichols (1999), similarly, explained which nowadays manufacturers not only need to manage and control their firms, but they need to manage the upstream and downstream business actors carefully. Several types of inter-organizational relationships are established with the aim of avoiding market uncertainties and gaining mutual benefits. Several new inter-organizational formations are increasingly generated as organizations seek new competitive advantages while staying away from both market uncertainties and hierarchical rigidities (Knoke, 2001). Figure 9 shows this broad range of relationships.

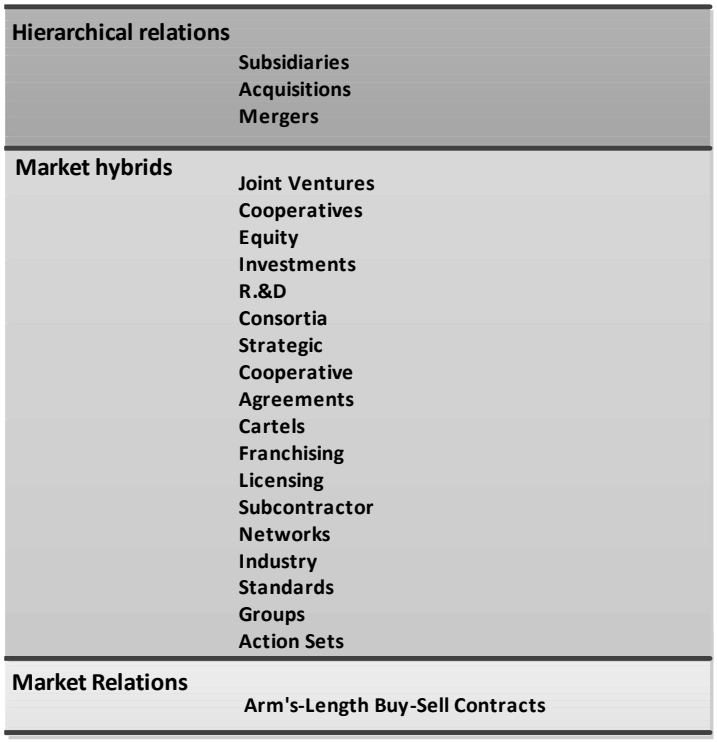


Figure 9. Varieties of Inter-organizational Relations (Knoke, 2001).

Figure above classifies main forms of cooperative agreements discussed in the research and theoretical literature. Looking carefully at this classification shows from market relations to hierarchical relations, collaborating companies have incremental integration within their organizational relationships.

The bottom refers to pure market transactions not needing any force for cooperation, coordination, or collaboration between business actors. Arm's-length contracts may encourage the participants' expectations about repeated future business transactions, but their exchanges are coordinated primarily through the price mechanism. At the top of Figure 9 is hierarchical authority relationships meaning a company takes full control of another company’s personnel and assets.

In the middle of these types of relationships, there are several forms of general alliance called hybrids. Hybrids combines different degrees of bureaucratic integration and market interaction (Knoke, 2001). Such relationship between companies that combine market and hierarchical elements is defined as market hybrids. They refer to both long-term equity-based and short-term project-based collaboration among companies having varying level of interdependence, bureaucratic integration, and market interaction (Olk, 1999).

Few alternative supply chain structures are introduced on the basis of inter-firm collaboration degree. A development of Sako (1992) view- that distinguishes a 'spectrum' of feasible supply relationships, ranging from arm's length to obligational relationship- implies several alternatives like a spectrum. This ranges from arm's length relationship, that the relationship is within the marketplace which prices are its foundation, to vertical integration, as relationships are based on ownership. Vertical integration usually extend to one or more tiers and its direction may be downstream, upstream or both. A continuum of relationship options is shown in Figure 9. The, breadth, duration, closeness and strength of the relationship vary among cases and over time. Figure 10 shows a rather clearer visualization of Figure 9 classifying varieties of inter-organizational relationships in 5 groups including: arm's length, partnership, strategic alliance, joint venture, and vertical integration.

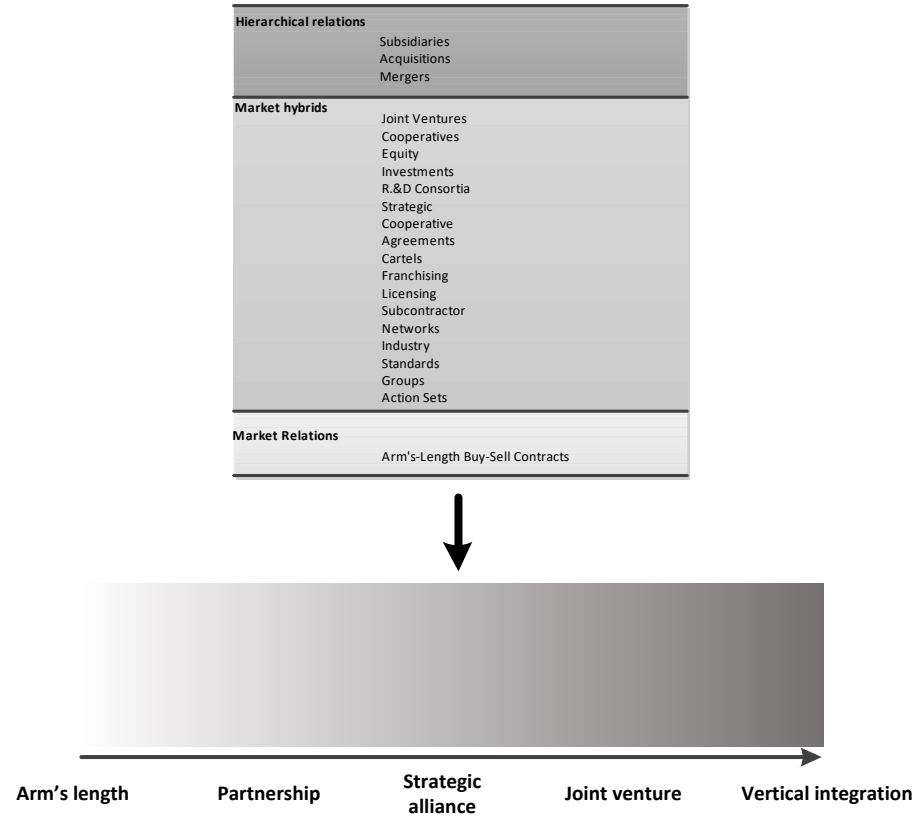


Figure 10. Relationship styles continuum (Modified from Cooper and Gardiner, 1993).

A focal company often has different types of customer-supplier relationships with its partners. This company may adopt an extent of styles meaning selecting the form of relationship to employ in each supply chain is an essential strategic issue.

Harrison et al. (2014) explain optimization of the supply chain process results in an incremental interdependence among business actors. This interdependence provides a realization that increasing levels of adaptation are critical to achieve long-term mutual benefit. Adaptation, here, refers to changes which are made in internal processes of a firm to accommodate the supply partners' needs. However, a view of the relationship may be a norm somewhere, while having quite different implications for the other firms involved.

2.3 Strategic Partnerships in the Supply Chain

Commonly, strategic partnership is a form of cooperative relationships which is characterized based on (Harrison et al., 2014):

- information sharing
- openness and trust
- coordination
- sharing of benefits and risks
- a mutual interdependence recognition
- mutual goals
- compatible corporate philosophies.

Joining a partnership with another company, to any extent, involves a movement from the open marketplace rules toward other alternatives. These various forms of partnership have to demonstrate benefits to business partners. Open market relations have been explained as arm's length relationships, short-term contracts, limited joint development and a large number of suppliers for any part. While, the Japanese prefer to develop their transactions with the non-economic aspects like trust and commitment. These characteristics are important in successful partnerships. Whilst this might bring higher transaction costs and risks, these 'non-economic qualities' assist theme to secure other economic and strategic advantages that are challenging to achieve through the arm's length partnerships. Through partnerships, the benefits are sourced from reduced negotiations and separate contracts, less monitoring costs, and higher productivity. These are complimented by strategic benefits of shorter lead-times and product cycles, and long-term investment. These benefits, however, need to be compared versus the challenges that may be associated with the trust and commitment (Harrison et al., 2014). Some of the potential disadvantages of partnerships are as follows: First, qualitative matters such as design work cannot be accurately designed, second, the need of gathering considerable information regarding potential partners to make decisions, and higher costs of relation formation and maintenance, third, the risk related to the leakage of sensitive information to competitors, fourth, possible opportunism by suppliers, since customers are locked in and the switching costs

of the customers to change suppliers are relatively high. In long-term, there are supply risks as companies join partnerships. By outsourcing the research and development of subsystems and components, customers benefit from the decreased investment they need to make. However, this scenario leads to greater buyer risk of being highly dependent on a smaller number of suppliers for designs. A more detailed view at partnership is illustrated in Figure 11. A strategic partner refers a company that a focal firm is going to develop a collaborative and long-term relationship with that. 'Collaboration' may be the ultimate objective of a partnership may evolve. A transition from open-market negotiation to a collaborative relationship is demonstrated in Figure 11.

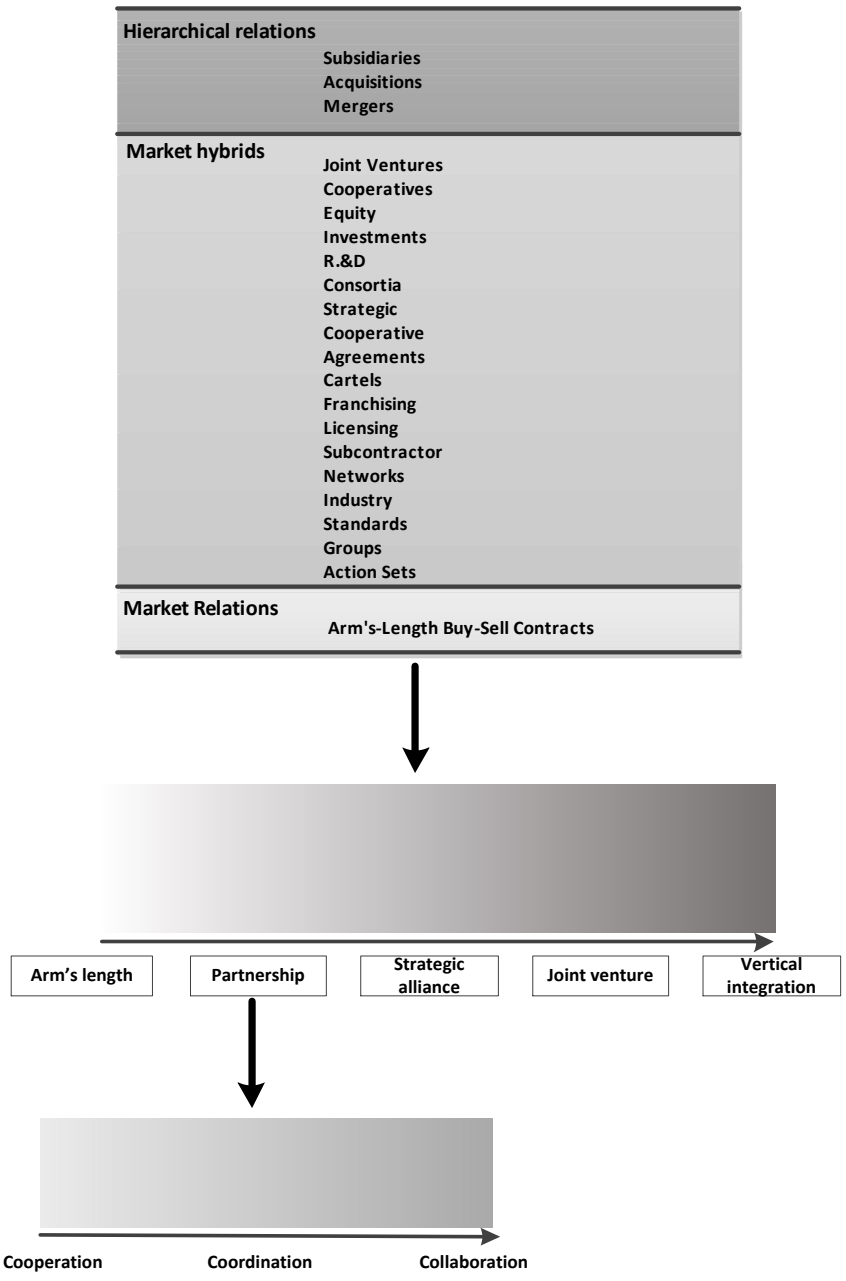
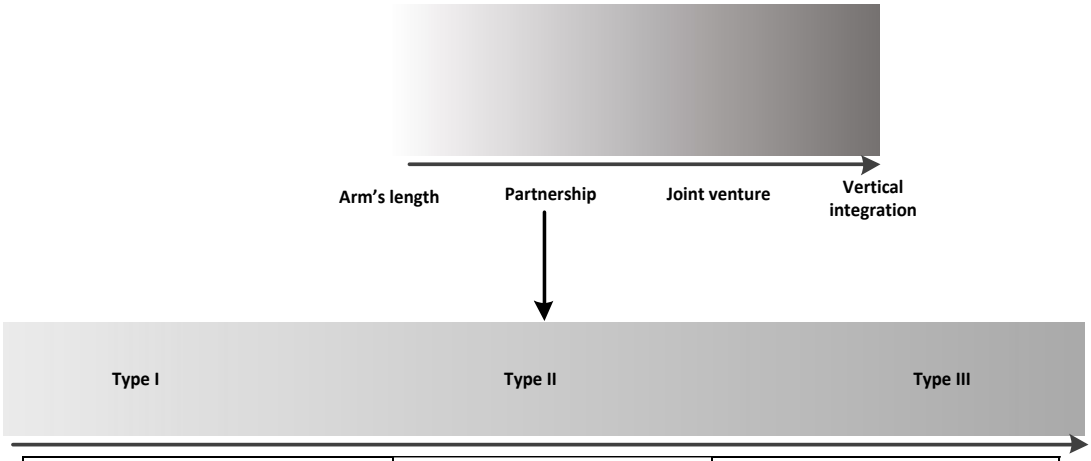


Figure 11. Transition from open market negotiations (arm's length) to vertical integration.

From cooperation to collaboration, obligational aspects of a partnership grow. Cooperation refers to few suppliers and longer-term contracts compared to open market negotiations that are price-based and arm's length relationships. Coordination can be defined as rules where partners can work together. Coordination is a main step in integration of a supply chain. Collaboration, however, is beyond integration involving longer-term commitments by sharing technology and to integrated planning and close control systems. In that sense, two companies which are interdependent develop common processes and adapt to each other. Cao et al. (2010) define the supply chain collaboration as "a long-term partnership process where supply chain partners with common goals work closely together to achieve mutual advantages that are greater than the firms would achieve individually". Moshtari (2016) adds that collaboration involves a partnership process among two or more independent organizations with the purpose of resource sharing to implement or design the operations

Lambert et al. (1996) also has proposed a rather similar model towards partnership, shown in Figure 12. This model describes three forms of partnership, type I, type II and type III, representing incremental levels of collaboration.



Type I	Type II	Type III
Coordinated planning/activities	Integrated activities	Major level of integration
Involves one function/division	Operates across multiple functions/divisions	Each firm sees the others as itself extension
Short-term	Long-term	Long-term without ending time

Figure 12. Classification of partnership (Modified from lambert 1996; Lambert et al., 1996)

Lambert's model is based on the principle that more collaboration is not necessarily better and that what's important is the appropriateness of the relationship. A scenario can be over investing the resources like employees and information system, while the benefits and values are not adequate.

The transition from arm's-length or multiple sourcing relationships (that are mostly short-term and price-based purchase) to a partnership (based on collaboration, cooperation, commitment and trust) needs a supply chain process including designing, developing, optimizing and managing. According to the discussion by Moshtari (2016), attempts by organizations with the intent of handling partnerships and collaborative initiatives usually are associated with notable managerial complexities which result in partnerships failure. Cumbersome bureaucracy, lack of flexibility, difficulties of collaboration results' evaluation, complexity of accountability issues and lack of mutual familiarity among business sides are some of the reasons behind this failure. Harrison et al. (2014) describe the roadblocks against achieving a strategic partnership can be:

- use of power: power asymmetry which involves concerns related an inappropriate use of power
- focused buyers on their own company's benefits
- negative implications: focusing on the negative implications of starting a partnership
- opportunism: sometimes buyers seek benefits in the supplier's expense, while they claim that they value trust, commitment and reliability
- preoccupation with price: price plays a key role in potential supplier selection.

In regard to power, controlling a member by another supply chain member at a various level might be a source of conflict. This conflict which is associated with power, especially when one organization prevents another organization to achieve its goals. With respect to self-interest, companies face difficulties in establishing and maintaining supply chain partnerships. Even the car industry which is usually seen as the supply chain exemplar employs multisource, and for non-critical components and commodities they rarely join collaboration. Regarding focusing on negative amplifications of partnership, buyers consider the benefits obtained through dependence on few suppliers less favorably and they prefer to stress and point out the risks. In addition, buyers continuingly see the cost-saving in SCM as more essential than the revenue (Harrison et al., 2014).

Concerning opportunism, close working relationships might result in higher incentive for opportunistic behavior. Since partners cannot easily gain similar benefits, so customers usually think that suppliers might take advantage if they be taken highly important. Therefore, benefits of the partnership become insignificant in their considerations. The focus on price can be due to buyers are not able to easily value technological capability, know-how, a particular style of production and innovation. Buyers might find it highly hard to measure designing or the amount of productive time spent during design, and so feel the need to guard against high bids from suppliers.

The mentioned list of barriers might not be exhaustive; however, it clearly shows that still the lowest price is a traditional but common approach for the buyers. Therefore, in theory a partnership is a great way in business, however, it is not always the most efficient and

effective way to organize a business. Apart from business partnership has several advantages and disadvantages, business partnerships even might start but fail. In addition, Koulikoff-Souviron and Harrison (2007) explain it is important to notice which strategic partnerships are very resource intensive. So, it is important to identify where is the most important point along the route in Figure 12 for a certain supply relationship. In some cases, as explained earlier, an arm's length relationship based on open-market negotiations will be the most efficient and effective relationship.

2.4 Information Sharing: Building Block or Bottleneck of Successful SC

Information sharing is considered as a key part of SCM. It refers to only by improved information integration in supply chain can minimize the variability due to information asymmetry, increase the coordination among node companies within supply chain, and ultimately improvements in core competitiveness of companies (Hua and Cong, 2011). Talja (2002) states information sharing could be classified according different aspects: type of information, goal of information sharing and sharing level. Accordingly, Kumar and Pugazhendhi (2012) pose three main questions related to information sharing that need to be answered: "1) with whom should information be shared? 2) what information should be shared? 3) what are the challenges in the process of information sharing?".

SCM emphasizes the coordination of products and information flows among all supply chain partners. It is only combination of both flows that lead to the full content of SCM. Information sharing involves the mutual sharing of business and market information among exchange partners and has a significant effect on companies' performance. Therefore, sharing information within SC is an essential factor to develop supply chain performance that can increase the efficiency by decreasing the inventories and facilitating the production processes (Kumar and Pugazhendhi, 2012). Huang et al. (2003) explain that information sharing across a supply chain enables each company to make precise decisions related to orders, better allocated capacity and production planning, hence, dynamics of supply chain become highly optimized. Information sharing and coordination of business partners within a supply chain lessen the whiplash effect and result in lower costs of supply chain and higher supply chain performance. Therefore, sharing correct information in a appropriate format in a timely manner for higher benefits of the supply chain and its entities is the main the focus of debates (Sardjoe, 2017).

The companies within a supply chain by sharing information avoid the whiplash effect (also called whiplash effect). The demand distortion makes the demand that is received by buyers larger than the real sales to the customers, and this phenomenon spreads into upstream in an increasing form (Lee et al., 1997). This phenomenon that is created by distortion of demand can result in extra costs, higher waste, bloated inventory and delayed product deliveries (Simchi-Levi et al., 2000). Many companies try to overcome the whiplash effect by increasing their buffer inventory, hence, extra expenses will be saddled to

the supply chain (Chan and Chan, 2009). Therefore, supply chain members by integrating their processes and developing information sharing as a win-win strategy can improve costs, efficient inventory, delivery and inventory aspects which can result in higher revenue, profit margin, flexibility, improved operational performance, higher productivity and quality (Cachon and Fisher, 2000). Lotfi et al. (2013) report several researches have been performed to analyze the connection between information sharing and supply chain performance and cost reduction.

Four forms of information sharing introduce the degree of it: 1) No information sharing that refers to a situation that companies protect their own information privately and order quantity is the only shared information, 2) partial information sharing pattern is sharing prediction of orders with the first-tier manufacture, 3) one-way full information sharing pattern describes more open pattern which involves sharing demand information and inventory, 4) two-way full information sharing pattern has the highest level of openness that describes sharing of demand information and inventories between both manufacturer and distributor (Hall and Saygin, 2012; Tu et al., 2003). Kembro et al (2017) claim that an effective information sharing among supply members increases the transparency and lessens the uncertainties.

Several studies discuss the benefits in the context of sharing information across supply chains. Nevertheless, many supply chains exist which the information is not shared through them because of several reasons (Ali et al., 2017). Allred et al. (2011) state a high-level of collaboration is uncommon and efforts for information sharing improvement is rarely embraced holistically. Butner (2010) also reports lack of visibility is amongst top five supply chain challenges. Visibility of supply chain implies enabling a collaborative decision-making environment among partners. While available information is greater, but it is not effectively acquired, managed, analyzed, and shared to those who require it. Moreover, increasing the external visibility is a difficult practice which is largely ineffective. Butner (2010) reports many companies have no time for information sharing and they do not see collaborative decision-making as an effective approach. The reasons behind failure of information sharing can be constraints related to information quality issues, incompatible information systems, lack of trust and confidential information (Ali et al., 2017). Yang and Maxwell (2011) adds lack of resources, concerns of losing autonomy and valuable competitive advantages, resistance to change, concerns of information misuse, and concerns of information quality are some other barriers in front of information sharing.

To sum, a successful supply chain requires a careful consideration on different CSFs. A robust information sharing among supply members have an impact on partnerships and is considered as a foundation to achieve significant cost minimization and profit maximization. Nevertheless, it is sometimes a difficult practice to perform. As it was discussed earlier, depending on the benefits that a company gains, it might prefer to avoid staring a partnership and so sharing information. Ireland et al. (2002) explain within the broadness

of inter-firm relationships, the application of management accounting techniques changes considerably. Hence, it is critical to investigate the inter-firm relationship with the goal of elaborating and understanding the accounting information flows of the relationship, and so implementing a proper technique of management accounting. Therefore, more in-depth studies, especially in the context of cost management, are needed to find out in what ways the information sharing can decrease or even increase the costs and what cost analysis practices enable the companies to reveal improvement areas within the supply network.

3. A NEW INSIGHT TO PROFIT BEHAVIOUR WITHIN SUPPLY CHAIN

3.1 Cost Breakdown Structure

Very critical pieces of information of suppliers that support the purchasing companies in procurement and sourcing activities are supplier's productions process, labor costs, material costs and other relevant costs to supplier's production and equipment. Before beginning to understand how pricing strategies work, it is essential to start the argument with the concept of cost structure. In that sense, a drilling down into specific types of costs and understanding their attributes are required.

Cost information is often used to describe different costs occurring within a company. The concept of cost (breakdown) structure is a commonly used tool in cost management and life-cycle costs (Hu, Pu et al. 2004), which involves types and proportions of different costs that contribute in total cost of an object (Lahikainen et al, 2005). A traditional form of cost structure divides costs into three main groups of direct materials, direct labor and overhead (Hundal, 1997, Hendricks, 1989; cited in Lahikainen et al, 2005). In Figure 13, cost structure of a product is illustrated.

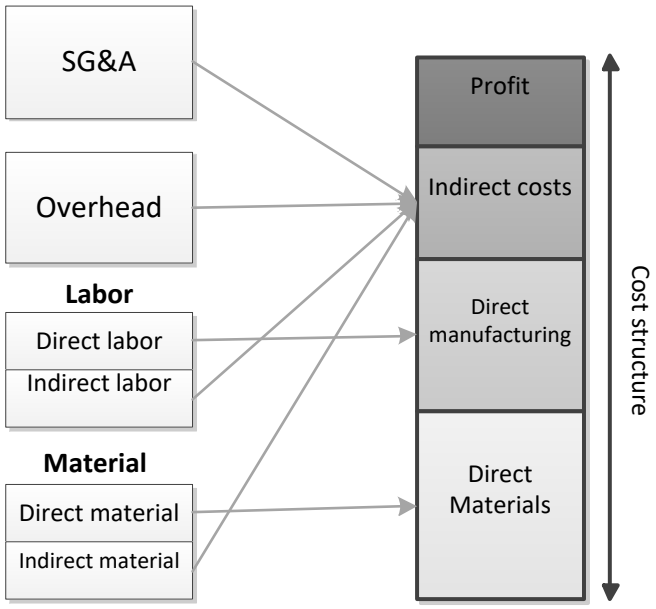


Figure 13. Price structure (Adapted from Anklesaria, 2008; Lahikainen et al, 2005; Milling, 2003).

According to Hansen and Mowen (2005) and Leitner (2012), the relation between costs and cost objects helps to increase the cost structure accuracy of a company. Costs associate to cost objects directly or indirectly. Direct costs (direct material and manufacturing costs) are traceable and assignable easily and precisely to a cost object, whilst, indirect

costs cannot be allocated simply and precisely to a cost object. A cost object involves items like products, departments, customers and activities. There is another form of cost structure which costs are divided according to the bill of material (BOM) of products (Hundal, 1997).

Another classification of costs by (Spaller, 2006) is variable costs, fixed costs and semi-variable costs. Fixed expenses (also called fixed costs) like rent cost remain stable and do not fluctuate when changes occur in the level of activities like sales and production volume. On the other hand, variable expenses change in direct proportion to level of an activity like sales and production volume. Direct material, direct labor, and sales commissions are some types of variable costs. Semi-variable expenses (also called semi-fixed costs) refers to costs which are a mixture of both fixed and variable costs.

To conclude, every business is unique, and businesses need to be very careful to understand their material and products' cost structures. As the companies are outsourcing more, they are technically decreasing their fixed costs like having fixed staff, but their variable costs scale up or down with the fluctuation in the business activity level.

While the cost structure of an object as a crucial activity is identified, applying it to understand the cost and so price behavior in real world is also essential for managers. Hinterhuber (2003) asserts that on average, a 5% price increase improves operating profit around 22% which shows the importance of pricing as an industrial marketing tool. However, studies provide scant evidence regarding the subject of pricing from customer's perspective, and they often are not aware of prices and it is the least important purchase criteria for them.

Pricing decision impacts the revenue directly which is a source of competitiveness and have a critical role in strategic planning (Forman and Hunt, 2005). However, pricing decisions are highly challenging due to uncertainties within dynamic environments resulting in many variables in determination of a price. The main objectives of stablishing prices are maintaining competitiveness within marketplace and making fair and appropriate profit. However, being competitive and at the same time generating fair and adequate profit often come to conflicts (Kortge, Okonkwo, Burley, and Kortge 1994).

When developing a pricing strategy, a broad range of internal and external factors to the firms should be considered. However, the attention to how these factors in combination affect choice of pricing is not enough (Forman and Hunt, 2005). Pricing can be defined as an effort to represent the perceived value of a customer in monetary terms and a customer is interested to pay for. However, firms often employ simple approaches for pricing by just adding a favorable profit margin on top of the products' costs.

$$\text{Price} = \text{Cost} + \text{Desired profit}$$

Cost-plus approach while being simple is not a proper approach. Since the customer's perceived value is often neglected and this approach does not determine if potential customers are willing to purchase the product at that price (Herist et al. 2011; Kortge et al., 1994).

An essential distinction in economics is between price takers (those who have no control over their prices) and price maker (those who control the prices to some extents). The first group involves characteristics of a perfect competition and the second group refers to some degrees of monopoly (Kew and Stredwick, 2016). However, price levels often influence the number of customers buy products and services. As the price increases, fewer people are willing or can afford purchasing and the remainders might lessen their purchasing frequency or quantity. Therefore, it is not only the supplier which defines the price, conversely, the buyer's willingness to pay for a product is an essential factor. Low et al. (2013) explain price sensitivity involves the change of consumer demand which is a result of the rise or fall of price. As it is shown in Figure 14, Nagle and Holden (2002) identify nine factors that influence the willingness of the customer to pay for acquiring a product:

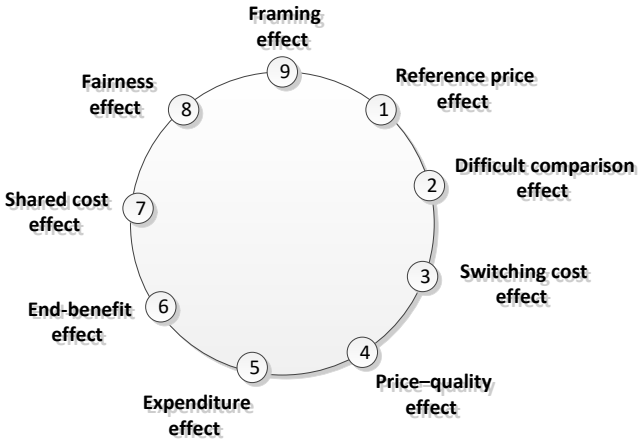


Figure 14. Factors that affect buyer's price sensitivity (Modified from Nagle and Holden, 2002).

According to the figure above, (1) reference price effect represents when the buyers are unaware of substitutes and alternatives, their price sensitivity decreases, (2) difficult comparison effect means when making valid comparisons is challenging, buyers will be less price sensitive toward their purchases, (3) switching cost effect represents as the costs (both monetary and non-monetary (Cram, 2001)) related to changing suppliers increase, the price sensitivity decreases, (4) price–quality effect explains as the higher price is a signal of better quality, buyers become less sensitive toward prices, (5) expenditure effect means how large the involved expenditures are compared to the buyer's income. Therefore, there is a more price sensitivity when a higher percentage of budget is needed to be spent for the purchase, (6) end-benefit effect means the more price sensitive a buyer is toward the whole ensemble, the more price sensitive is toward the sub-components of that

whole ensemble, (7) shared cost effect or the percentage of price which the customer pays affects the buyer's price sensitivity, (8) fairness effect also emphasizes that higher emotional perception of fairness results in lower price sensitivity, (9) framing effect states buyers become higher price sensitive as they feel the price as a 'loss' instead of a 'gain'.

Contribution margin is a concept which is used in measuring profitability and is a tool in daily pricing decision makings. Using it as a profitability measure is helpful in analyzing how cost behavior affects profitability, because contribution margin approaches focuses more on fixed and variable costs behavior. From pricing decision standpoint, it can be used to determine the price which needs to be achieved to cover variable costs, contributing in covering fixed costs and ultimately generating acceptable profit. Contribution margin concept is widely used as a tool for decision making and internal planning. Its application could be in budgeting, make or buy analysis, product line analysis, and pricing (Spaller, 2006).

Contribution margin (CM) is a key concept that is useful for decision making in pricing situations. According to Milgram et al. (1999), contribution margin specifies whether a product is generating profit or loss and allows companies to determine the profitability of individual products. Therefore, it clarifies the need for repricing a product or service, and finally it specifies the possibility for offering sales bonuses. The contribution margin is the percentage of each sales dollar which remains after paying the variable expenses (LeBruto et al., 1997) such as costs of goods sold, sales commissions, freight costs, and maintenance on equipment in production line. Low contribution margin demonstrates that a business segment or a product line might not be profitable. Hence, higher contribution margin is a signal of more profitable product line (Milgram et al., 1999). Generating contribution margin just enough to cover fixed costs points out a break-even point, while, larger contribution margin covers both fixed costs and profit. Finally, having negative contribution margin represents sales and associated production activities are depleting the capital (Groth et al., 2000),

Milling (2003) defines contribution margin as the sales price subtracted by the variable costs (direct costs (Tambrino, 2001)) of a product. Generally, the profit planning of a firm focuses on accumulated contribution margin from total sales volume of that firm. A company experiences a loss as long as the cumulative contribution margin generated by total sales is not enough to cover fixed costs.

Also, according to Rollins and Perri (2013), contribution margin-based pricing is a strategy which the production cost of each unit is determined, then the price will be set at a higher level in order to have a contribution (contribution margin per unit), not a profit. Spaller (2006) explains contribution margin only takes the fixed and variable costs into consideration and it involves the remain after subtracting variable costs from the total sales revenue and that remainder contributes in covering both fixed costs and profit.

Therefore, the company will cover the unpaid indirect costs of production. The price has to be set in a sense to cover the whole cost and the contribution which is calculated by:

Contribution margin = Selling price – Variable costs

Or

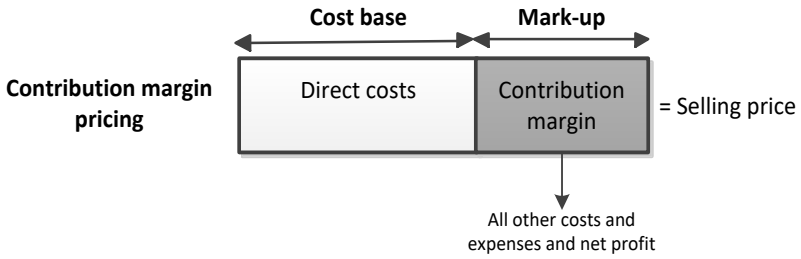


Figure 15. Contribution margin pricing.

Moreover, contribution margin ratio shows CM as a percentage of sales (S):

$$CM\ ratio = \frac{CM}{S} = \frac{(S - VC)}{S} = 1 - \frac{VC}{S}$$

And at a unit level:

$$CM\ ratio = \frac{Unit\ CM}{P} = \frac{(P - VC)}{P} = 1 - \frac{VC}{P} \Rightarrow Selling\ price = \frac{VC}{1 - CM\ ratio}$$

According to Groth et al. (2000), contribution margin (in this study gross profit) at a company level is:

CM = Revenue - Variable Costs

A product's contribution to total firm's profit is maximum, when the chosen price maximizes aggregate contribution margin (Herist et al. 2011; Groth et al., 2000):

contribution margin per unit × number of units sold

Low-contribution margin is more prevalent in labor-intensive businesses, while high-contribution margin often turns up in more capital-intensive businesses with costly machineries and facilities.

3.2 Accumulated Cost within Supply Chain

From a procurement and sourcing management point of view, management is obligated to purchase services and products in the right quantity, with expected quality, from the proper supplier, and at a proper time and price. Moreover, the customers that have will-

ingness to pay define the values of a product. Therefore, firms and their supplier candidates have to work together to realize cost savings and eliminate the non-value-added activities through the supply networks. Additionally, in geographically fragmented production and complex value networks, the intermediaries account a large portion of sales prices of products and services. From a cost perspective, accumulated costs influence the competitiveness of firms and so networks' success and their capabilities to compete in global production networks.

A progressive reduction of accumulated costs on the basis of consistent information sharing and communication among firms to analyze the accumulated costs can contribute to a competitive supply chain. Hence, by using network analysis beyond the walls of the focal company, the accumulated costs cascading from upstream to downstream to final customers of a supply chain are discussed. To see how the accumulation of costs is affecting the prices within a supply chain, Figure 16 is helpful. Any of these members, depending on their activities which incur costs and their expecting profit increase the product prices.

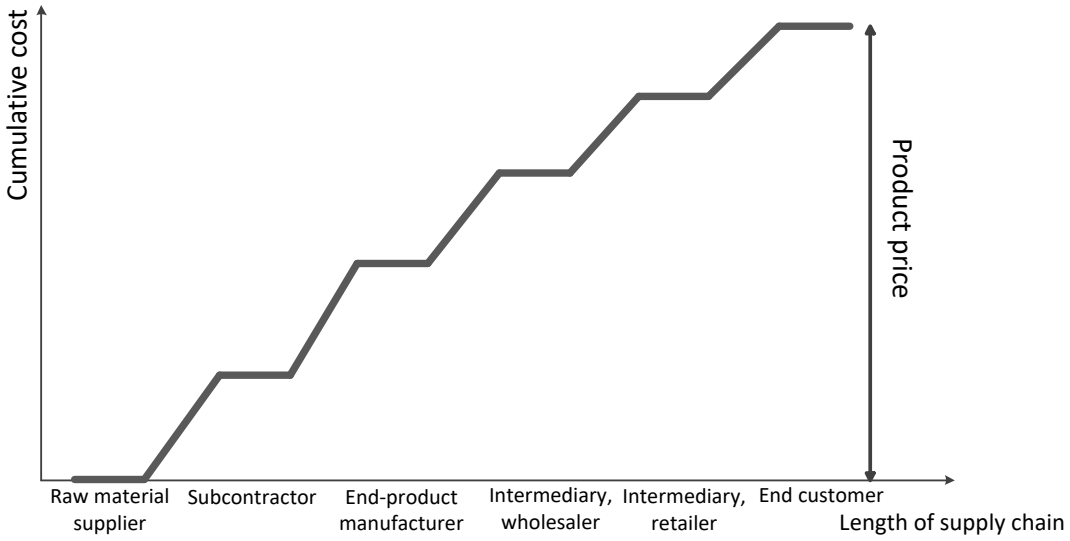


Figure 16. Accumulation of costs in supply chain (Modified from Uusi-Rauva and Paranko 1998, 51.

The figure above clearly shows the occurred costs from beginning to end of a typical retail supply chain which constitute the costs of finished-product. A typical retail supply chain includes multiple manufacturers, warehousing and distributors to have the product delivered to the customer. Here, the chain is a critical concept, since each connected link is in a specific order and direction, and the no link cannot be reached without the previous one. Every link is associated with time and costs, and it includes labor, parts, and transportation. Each carried product by a company can have its own supply chain, though these supply chains may certain suppliers for multiple products are employed, hence, the circumstances become highly complicated, especially when supply chains are international.

The sales price is made up of entire supply chain costs that are charged by different supply chain members. At the beginning, the raw material supplier as a necessary member of a supplier chain is responsible for substances or materials are often used in the primary steps of manufacturing of goods. Subcontractors are another possible supply chain member that contract to provide different components and products for a manufacturer. Manufacturer or the focal company makes and supplies the goods to intermediaries which link the manufacturer to final customers. The figure above illustrates as the products pass through farther downstream and different steps of supply networks, several costs (including variable costs, fixed costs and profits) are cumulated and sometimes amplified. Obviously, this is a simple example compared to cost increase behavior within network approach that is more complicated.

To highly understand the price change effect on a supply chain competitiveness, it is important to start the process with breaking expenses down into two parts, variable costs and fixed costs. Figure 17 shows how the product prices behave across a supply chain. This study adopts a cumulative approach, by providing an assessment of all variable costs and (where possible) fixed costs and focuses on whole supply chain, instead of focusing on a particular company.

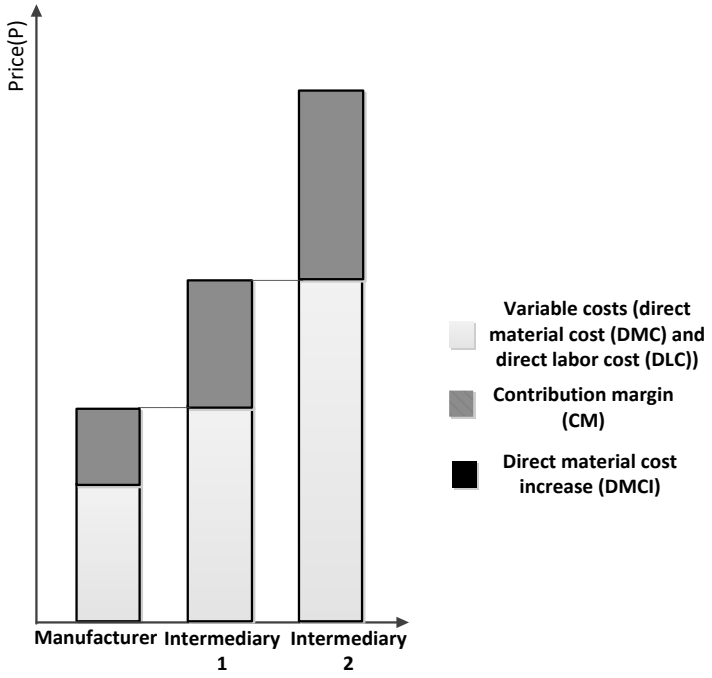


Figure 17. Price behavior across supply chain.

In many sales, a supplier has to pay for materials and/or labour costs that comprise the goods or services provided to the customer's organization. Most suppliers want to recoup those expenses (called "variable costs") plus an additional percentage (called a "contribution margin") to cover indirect costs and profit. As shown in figure above as a simplified

supply chain, the sales price of a supplier becomes the variable cost of the customer adding a contribution margin on top of it. Therefore, as explained earlier each company adds costs on top of the sales price which it repeats across the supply chain.

3.3 Sales Price Increase within Supply Network

Many businesses are under a hustle to bring ever higher returns to their stockholders and they do not put much efforts into the ways they can meet this return. Many of them intend to pick the easy option up which is setting higher prices that their customers pay. Consulting firm McKinsey & Company (2014) reported by holding all other elements equal and assuming no loss of volume, only one percent price increase leads directly to an 8.7 percent more operating profits. No surprise that pricing is seen as a tempting target by suppliers. However, the customers facing with the temptation and the risk of putting up their own prices to cover the increased cost they are incurring. However, price increases can cause volumes to shift to competitors, and so they are not entirely risk-free. As discussed earlier, understanding the level of importance of each supplier relationship is a contemporary way of going about it.

In addition, fixing sales prices during a long- term period is a very difficult practice for companies. Price fluctuations are often driven by fluctuations in different variables. Different intervening variables like cost of production, demand, competitors price, environmental factors, and political factors are effective in price fluctuation of goods and services (Obigbemi, 2010). Considering the SCM definitions, costs are not just generated by information and material flows across the SC; however, they are made by different motives across the SC. Business owners raise sales prices of products or services due to several reasons. Sometimes, price increase relates to a strategic plan to become a higher-quality brand. Price increases might be the result of higher costs which the business passes on to its customers. Customer perceived value is a crucial item for a successful product in supply chain. Higher sales price affects the customer's willingness to pay for a product which directly affects the sales volume of the firm. The behaviour of prices through a supply chain is an overlooked concept and there is not any literature describing this phenomenon.

In a market characterized by perfect competition, the product's price contains all the information concerning the material and its producer. However, the assumptions of perfect markets are not applicable in markets with oligopoly or monopolistic competition (Kulmala, 2002). Because the purchasers have the challenge of getting competitive bids from enough number of suppliers. Therefore, making a choice or trade-off on suppliers with minimal information would be a difficult practice. From a customer's standpoint, in such markets the price hides the actual costs related to the product. Kulmala (2002) represents due to lack of transparency in accumulated costs within such supply chain, the costs of the suppliers are invisible, while the customer is aware of internal costs and purchasing prices. The cost of a product is made up of variable costs, fixed costs, and semi-variable costs (Spaller, 2006). In this study, the focus is on the direct material costs which

are a part of variable costs of products that are bought outside an organization and paid to the material supplier.

Since costs of raw material indicate a large part of the total production costs, a small increase of raw material price leads to a considerable increase in sales prices. Increasing the sales price of a product is not often as the same pace as the increase of direct costs. Therefore, the fluctuations of production costs remain challenging for those in a supply network that do not favor the increase of sales prices. As discussed earlier in this study, contribution margin pricing is a method applied for setting prices in a way that any product provides a target contribution towards fixed costs and profit.

By analyzing networks beyond the walls of individual organizations from a cost perspective, the accumulated costs cascading from upstream to downstream to final customers of supply network is a controversial issue. Generally, the purchasing price increase is the result of higher costs that organizations pass on to the customers. Since costs of purchased goods represent a significant portion of most manufacturers' cost of sales (Ellram, 2002), a small increase of material price leads to a significant increase in the purchasing prices. Surprisingly, sometimes the increase of the purchasing price of a product is not as the same pace as the cost increase of its materials. This concern for purchasers is so-called "profit-on-profit" or "hidden profit" by (Suomala et al., 2010) which is a straight forward concept in accounting, not a speculative concept. Having a control over the profit made through the upstream of supply chain is a starting point for tackling this unfavorable purchasing price increase. Figure 18 demonstrates how an ideal supply chain without a "profit-on-profit" effect looks like.

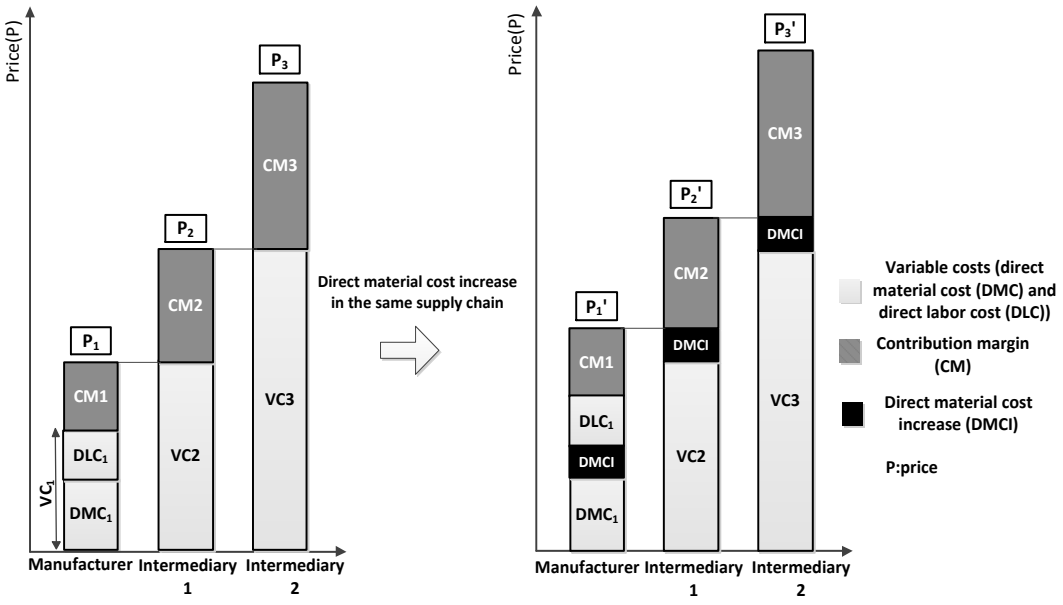


Figure 18. Purchasing price increase due to the direct material cost increase in an "ideal" supply chain.

The figure above provides an illustration to track the "price change" due to the direct material cost increase in upstream of a three-stage supply chain. The figure on left shows

a supply chain without any direct material cost fluctuation; however, the figure on right demonstrates an "ideal" supply chain meaning the product purchasing price is likely to increase the same amount of direct material cost increase in upstream. Alternatively stated, in such a SC, the customer expects to purchase the product with a price made up of the same previous price and material cost increase. The equations below show the purchasing prices are increased as the same pace as the increase of variable costs.

$$P_1' = P_1 + DCI$$

$$P_2' = P_2 + DCI$$

$$P_3' = P_3 + DCI$$

In real business world, companies within a supply network increase sales prices more than the direct cost increase and purchasers are not happy with this phenomenon. Because they prefer to purchase products with the actual increase of direct costs. However as discussed before, when considering the purchase of products, the customer will have a number of key factors in mind to determine the reasonableness of the price. In order to enable the purchasers to distinguish the actual price increase, the concept of profit- whiplash effect is introduced and elaborated in the next section.

3.4 Profit on Profit

Wang and Disney (2016) explain the whiplash effect is a popular concept in operation management. This concept explains large swings of suppliers' production in upstream are the result of slow moving of consumer demands from downstream to upstream. According to Lee et al. (2014), the whiplash effect is a critical factor which magnifies the demands as the customer's order pass upstream.

The consequences of this effect can be setting up and shutting down equipment, hiring or firing human resource, redundant upstream inventory, complicated scheduling and forecasting, and weak business partners relationship (Wang and Disney, 2016). Lee et al. (2014) argue in 2001, nearly 1.3 million Sony PlayStation consoles were banned to enter European countries' markets due to new environmental regulations in Netherlands. Hence, Sony spent significant costs to meet those standards by replacing the parts. This case shows passing a broad range of information such as environmental considerations and criteria across a supply network is a crucial issue which influences the success of supply network members. Such significant changes flow back upstream with unknown consequences. Lee et al. (2014) review "information sharing, integrated supply chain information system, joint planning, vendor-managed inventory, shorter lead times, and synchronized deliveries" are the main remedies to mitigate whiplash effect consequences.

Lee et al. (2014) discuss the whiplash effect is a well-known effect illustrates how important is the demand and information changes across supply networks. This study extends the whiplash effect by synthesizing it with the following discussions in cost management area and profit on profit (POP) as a similar phenomenon. By considering profit (rather than demand) as the variable within a supply network, according to the author's assumptions, the same phenomenon for the profit occurs across the supply network, but from upstream to downstream.

When supply chains become more complex, the same materials or products flow through many organizations. When any actor through the supply chain adds a contribution on top of the direct costs, the results may be surprising as illustrated in Figure 19. In this figure, a supply chain which extra mark-ups are charged over a product's costs and a supply chain that actual prices are transferred within a supply chain are compared. As shown below, a small raw material price increase has substantial influence on the sales price of the third stage of a supply chain.

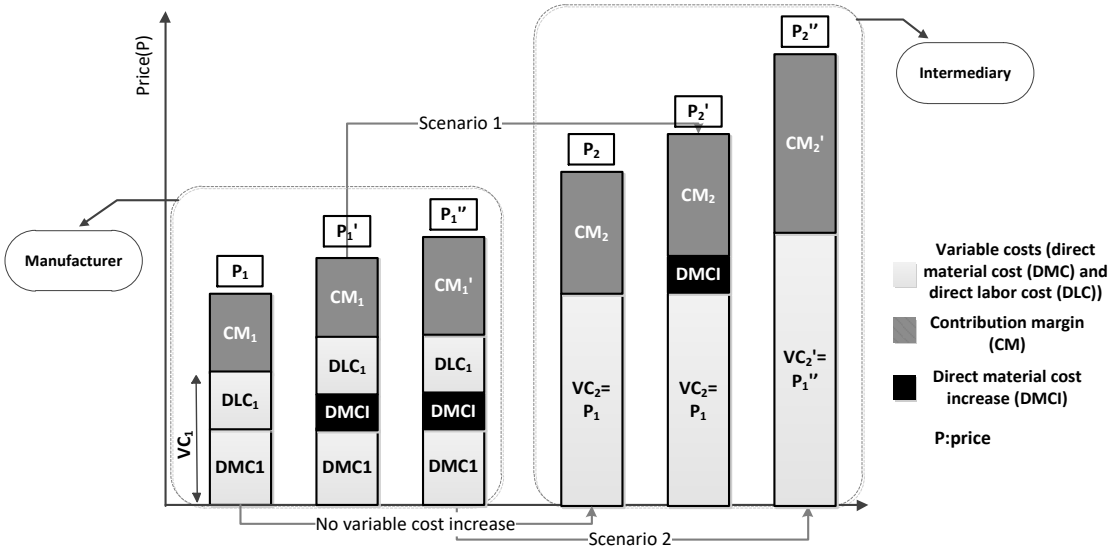


Figure 19. Profit on profit within a supply chain.

Generally, when the direct material cost in upstream of a supply chain increases, two different scenarios concerning the "profit" can be expected. The first scenario refers to a situation which the supply chain actors do not add a contribution on top of direct material cost increase which was also shown in Figure 18. The second scenario involves circumstances that the manufacturer adds a contribution on the direct material cost increase. Then, the contribution of the manufacturer becomes a variable cost for the next business partner who adds contribution on the "unfair" contribution by the manufacturer and this phenomenon continues across the supply chain. This phenomenon occurs more dramatically in supply networks characterized by multiple supply chain crossings that generate overcounting profits, because the products cross several supply chains before reaching the final consumer. As the calculation below shows, the price increase for this model

because of "profit-on-profit" within the supply chain can be several times even larger than the original direct cost.

The profit on profit due to the cost increase is often underestimated, while it can be substantial, to say the least. According to the figure above, there is a possibility for companies or units through the supply chain to add a profit on previous suppliers' profit resulting in multiple layers of profit being included in the final sales price compared to the original price of the manufacturer. The contribution of the manufacturer becomes a direct cost for its first customer who then adds contribution based on the manufacturer's increased contribution. As the calculation below shows, the price increase for this model because of profit on profit within the supply chain can be several times even larger than the original direct cost. This effect occurs more dramatically when the supply chain is characterized by several supply chain crossings that make overcounting the profits, because the products cross several supply chains (supply networks) before reaching the final consumer. Table 1 shows how this unfavorable effect for customers can be formulated.

Table 1. Profit-whiplash effect calculation (contribution margin = M).

First stage	**Second stage**	**…Nth stage**
$P_1 = \frac{VC_1}{1-M_1}$	$P_2 = \frac{P_1}{1-M_2}$	$P_n = \frac{P_{n-1}}{1-M_n} = \frac{VC_1}{(1-M_1)(1-M_2)\dots(1-M_n)}$
$P_1' = P_1 + DMCI$	$P_2' = P_2 + DMCI$	$P_n' = P_{n-1} + DMCI = \frac{VC_1}{(1-M_1)(1-M_2)\dots(1-M_n)} + DMCI$
$P_1'' = P_1 + \frac{DMCI}{1-M_1}$	$P_2'' = \frac{P_1''}{1-M_2}$	$P_n'' = \frac{P_{n-1}''}{1-M_n} = \frac{VC_1 + DMCI}{(1-M_1)(1-M_2)\dots(1-M_n)}$

Surprisingly, the difference between the purchasing prices of a product at the nth stage of an "ideal" and "unfair" supply chain is:

$$P_n'' - P_n' = DMCI\left(\frac{1}{(1-M_1)(1-M_2)\dots(1-M_n)} - 1\right)$$

The coefficient of DMCI is often larger than 1 ($(\frac{1}{(1-M_1)(1-M_2)\dots(1-M_n)} - 1) > 1$) resulting in a large "unfair" profit across long supply networks. This phenomenon in this study inspired from whiplash effect is called profit-whiplash effect which is a better description of this incremental effect. In addition, it does not make any confusion with bank sector interest. Profit- whiplash effect shows a minor "unfair" profit in upstream leads to amplified profits in downstream bore by final customers which influences directly the competitiveness of the supply chain.

To see how the profit-whiplash effect affects the prices across a supply chain an example is useful. If the contribution margin (M) equals 30% and the variable costs increase 10%, profit-whiplash effect in a two-stage supply chain leads to an additional profit of $0.1VC_1$.

With the same assumptions of the latter example:

$$\text{If } \Delta P_n = P_n'' - P_n' = the\ profit - whiplash\ effect\ of\ nth\ stage\ of\ supply\ chain$$

Stage	ΔP
1	0.04 VC_1
2	0.1 VC_1
3	0.2 VC_1
4	0.3 VC_1
5	0.5 VC_1
10	3.4 VC_1

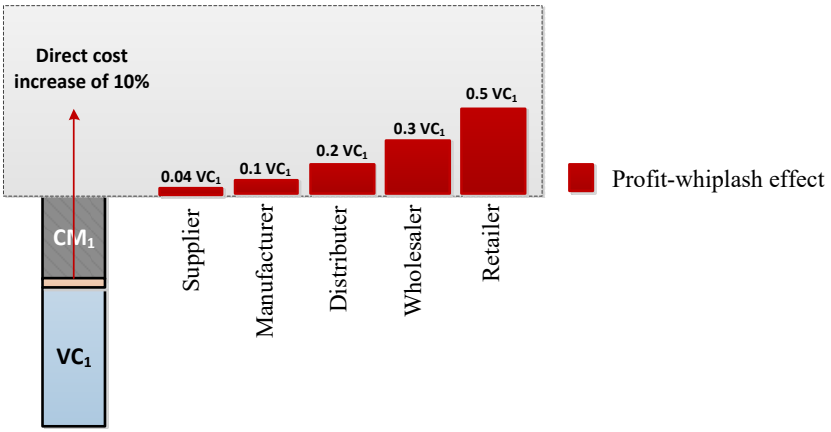


Figure 20. Excessive profit of 5 stages of supply chain after 10% direct cost increase.

If the variable costs were increased by 10% and holding all other factors constant, profit-whiplash effect across a supply chain from first to fifth stage as a percentage of original variable costs respectively is: 0.04%, 0.1%, 0.2%, 0.3%, 0.5%. It is notable the profit-whiplash effect is larger than the original variable cost's value after the sixth stage. This example has simplified away some practical considerations, but it shows the significance of this effect. As a frame of reference, applying contribution margin pricing, assuming a typical cost structure and holding all other factors constant in the example, profit-whiplash effect would increase dramatically as passes through supply chain from upstream to downstream.

To summarize, for a non-commodity product with specific cost structure divided into variable costs and contribution margin, a small material cost increase leads to profit-whiplash effect that is roughly triple or quadruple larger than the original variable costs in early stages of a supply chain. Hence, this concept should be a managerial focus and a strategic priority.

As the figure above illustrates, the excessive and unfair profit increases dramatically after few stages across supply chain and reaches larger than the original direct material costs. As it can be seen, this extra profit negatively affects the profitability and competitiveness of a supply network. Because, this incremental growth of excessive profit is more enormous when different components are coming from different supply chains to build up a product. In other words, in today's business world built of networks crossing each other, the profit-whiplash effect can be considered as a catastrophe for firms and supply chains competitiveness.

As discussed, profit-whiplash effect as a phenomenon which occurs in supply networks due to failure of cost data disclosure practices like OBA, lack of transparency and information sharing. This phenomenon in this study inspired from whiplash effect was called profit-whiplash effect. This effect shows a minor unfair profit in upstream leads to amplified profits in downstream bore by customers, as shown in Figure 21.

Stage	ΔP
1	$0.04\ VC_1$
2	$0.1\ VC_1$
3	$0.2\ VC_1$
4	$0.3\ VC_1$
5	$0.5\ VC_1$
10	$3.4\ VC_1$

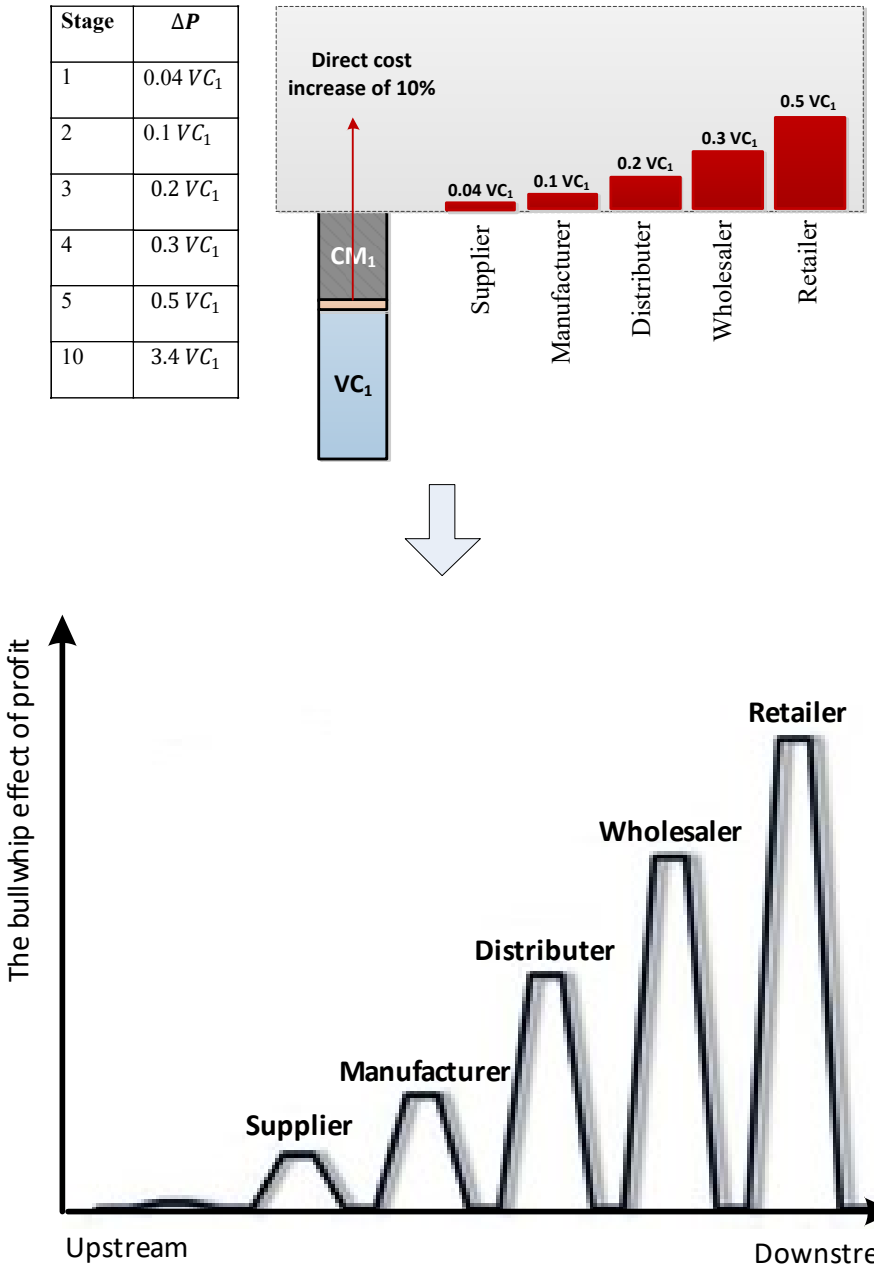


Figure 21. The whiplash effect of profit within supply chain (Modified from Nagaraja and McElroy, 2018).

The figure above shows additional unfair profit increases the sales price which is transmitted to the next supply chain stages. Those additional profits accumulate in the supply chain are ultimately embodied into the higher price that the final consumer pays. The magnification of this type of profit worsens competitiveness of a supply chain, because the real added costs are usually lower than the imposed profits by different members and

mitigating it improves their competitiveness. Because if the charged price by the manufacturer is more than other networks' prices, customers will shift to other supply networks. Similarly, if the product price is lower, the customers would rather to these products.

Profit-whiplash effect is an unfavorable phenomenon which is seen as a concern for managers. However, this effect often happens in the contexts specialized by lack of adequate information sharing and so lack of transparency. Christopher and Gattorna (2005) also stress it by explaining the costs are more than the expected costs due to lack of transparency.

In addition, remaining a proper control over profit is a difficult practice when the profit-whiplash effect is present. This pretense according to the earlier discussion is the consequence of absence of inter-organizational cost management practices like OBA. Therefore, this phenomenon was studied mathematically applicable for a variety of settings, with demonstrations of each case of the impact of the underlying dynamics of the direct cost changes, as well as the effect on the profit.

Picking the vehicles industry as an example, every vehicle is composed by thousands of components, assembled to build a vehicle. These components are made of countless range of materials and come from very diverse sources either local or international (Eugênio et al., 2010). This can be an evidence for how crucial the concept of profit-whiplash effect in some industries like car industry is. Since not only the car industry is a very competitive industry, but also the cumulated unfair profit in such businesses increases steeply.

Thus, while the costs and the profits have decreased over past decades as a consequence of continuous developments in technology and cost reduction policies, the profit-whiplash effect has remained substantial and the magnification effect is still increasing the costs of supply networks undoubtably. Hence, reducing this effect through an agreement among business partners is fully consistent with the interest of the final customers because it decreases the costs of the products.

To shorten the costs across a supply chain, elements of the cost structure of a product need to be determined (Kulmala, 2002). Hence, the collaborative approach of inter-organizational cost management (IOCM) discussed in Chapter 4 as a cost management practice further the boundaries of individual companies and within a supply chain (Kulmala, 2003) is useful. The coordinated and integrated efforts of customers and suppliers for finding solutions with lower costs (Agndal and Nilsson, 2009; Kulmala et al., 2002) and reduction of the information asymmetry of the business partners is an outcome of IOCM (Cooper and Slagmulder, 2004). The existing literatures identify OBA as one highly recognized IOCM technology to disclosure the cost information of product, activ-

ity and process within a customer-buyer relationship (Suomala et al., 2010). Hence, openness and transparency of the information among business partners brings up the relatively new concept of OBA (Windolph and Möller, 2012).

4. COST MANAGEMENT: COST ANALYSIS TECHNIQUES

4.1 Inter-Organizational Cost Management

The costs and expenses related to purchased products and services are increasingly forming substantial part of firms' costs. Hence, managers are tirelessly seeking strategies to control supply chains (Anderson et al., 2009). During the new millennium, customers are more value driven and less brand loyal. Moreover, markets are more price competitive and due to deflationary trends within most markets, an increasing cost reduction pressure to keep the margins can be realized (Christopher and Gattorna, 2005). Christopher and Gattorna (2005) state the reasons behind this phenomenon are: first, global competitors with low manufacturing costs, second, less entrance barriers due to de-regulations within many markets, third, Marn et al. (2003) add internet is applied as a means for easier price comparison.

Based on the foregoing discussions, the competition is between supply chains not the companies (Trent, 2004). In this sense, it is precious to see costs from an end-to-end standpoint. Because all costs through supply chain are reflected in prices of the finished-products. Moreover, if most of a firm's costs happen outside of the firm because of outsourcing, the major cost improvement opportunities also have to be found outside of firm's boundaries. As discussed already, as the rate of outsourcing grows, the supply chain looks like a network rather than a chain which leads to more transactions and interfaces among the companies. Malhotra et al. (2005) contends collaboration happens through information exchange and knowledge creation among supply chain actors for sustainable competitive advantages. However, because of lack of transparency to see one end of the network from another end, the real costs are higher than the expected costs (Christopher and Gattorna, 2005). Pettersson and Segerstedt (2013) represent organizations try to reduce costs within supply chains to increase their income and supply chain cost reduction is seen as a competitive advantage. Starr and Gupta (2017) show that a supply chain by improving the information sharing and forecasting techniques has a potential of up to 9.7 % cost saving.

Cost management (CM) as a key aspect of the management area is a top priority of most companies and supply networks and is seen as a competitive advantage which applies the modern management accounting tools to design and analyze the costs (Kulmala, 2003). Seuring (2002) discusses CM is a proactive management of costs with the aim of influencing cost structure and cost behavior, and it assesses, plans, controls and evaluates the costs along the supply chain. Therefore, CM involves initiating and making decisions

with the aim of cost improvement. Anderson et al. (2009) define strategic cost management as

> *"the deliberate alignment of a firm's resources and associated cost structure with long-term strategy and short-term tactics".*

Therefore, while the managers continuously seek effectiveness and efficiency in firms, value chains' improvements are perused by reconfiguring firms' boundaries, resources relocations, re-engineering process, and finally re-evaluation of offerings according to customers' needs. Anderson et al. also explain in the context of competitive advantage creation, tremendous opportunities related to cost management can be found at the boundaries of firms.

Traditionally, companies mostly focus on their internal cost management which controls the costs within a company (Fayard, 2014). However, as the outsourcing rate of items increases, the problem of information asymmetry between suppliers and buyers as the main reason behind unnecessary cost increases becomes more significant. Therefore, cost management benefits can be achieved only by the cooperation and collaboration of supply chain members, and it is difficult for organizations to benefit from cost management synergies by relying only on the internal focus. Consequently, identification of opportunities for joint cost reductions within supply chain is the main purpose of IOCM (Cooper and Slagmulder, 2004).

In consideration of the foregoing, networks as the result of the blurred boundaries of individual firms provide a platform for IOCM (Kajuter and Kulmala, 2005). To track the costs along a supply chain, the collaborative approach of IOCM as a cost management practice further the borders of an individual firm and within a supply chain is introduced (Kulmala, 2003; Moller et al., 2001; Cooper and Slagmulder, 1999; Cooper and Yoshikawa, 1994). Through a network, IOCM is an approach to coordinate the activities beyond the borders of the organization with the purpose of reducing the total costs (Cooper and Slagmulder, 1999) and creating additional values (Agndal and Nilsson, 2009). In other words, IOCM is defined as cooperative activities of suppliers and customers to achieve value creation and joint cost reductions (Coad and Cullen, 2006). They also state that major part of manufacturing costs (60%-70%) is constituted of purchased products and services (Van Weele and van der Vossen, 1998; cited in Agndal and Nilsson 2009). So, the coordinated and integrated efforts of customers and suppliers for finding solutions with lower costs (Agndal and Nilsson, 2009; Kulmala et al., 2002) and reduction of the information asymmetry of the business partners are outcomes of IOSM (Cooper and Slagmulder, 2004).

Two main components of inter-organizational cost management are: first, the environment that IOCM happens inside it, second, applying the practices and costing approaches of IOCM effectively to reduce costs. IOCM is very effective in contexts with an intense rivalry and large number of outsourcings. IOCM is able to support companies to reduce

the costs in three different ways including: first, assisting the focal firm, its customers and suppliers in finding untouched methods of designing to produce products in more cost-efficient ways, second, finding new ways to reduce the production costs, third, identifying new ways for more efficient interfaces among companies (Cooper and Slagmulder, 1999; cited in Melo and Granja, 2012).

4.2 Cost Analysis Techniques

In the context of sourcing and cost management, Anklesaria (2008) suggests a company before making any serious decision in changing the procurement process requires to take some of the following steps including: leverage volume, price analysis and cost analysis. Leverage volume as a negotiation tool emphasizes on a supply base optimization and allocating more business to fewer suppliers. Price analysis deals with competitiveness studies which enable the company to carefully benchmark its prices and process against selected competitors in the same industry. Finally, cost analysis as the focus of this book refers to understanding the purchased products to make them manageable. It means cost analysis is a critical practice to figure out the cost structure of purchased products and includes three main models: First, should-cost models ranging from industry cost profiles to elaborated process cost models. Second, price discipline techniques that are applied to investigate a request of a price change by a supplier. Third, total Cost of Ownership (TCO) models that are a financial estimate that calls attention to the present value of entire costs while the life of a service or a product. Ellram (1996) states effectively managing the costs of purchased products and service is an important topic in procurement management. Hence, before choosing the best cost analysis technique, the nature of companies' buy should be understood. In that sense, to come up with a standard process for managing costs of purchased products, purchased items need to be classified into different groups that depend on the supply chain relationship and the purchase's importance for the company in terms of costs. The idea is illustrated in Figure 22.

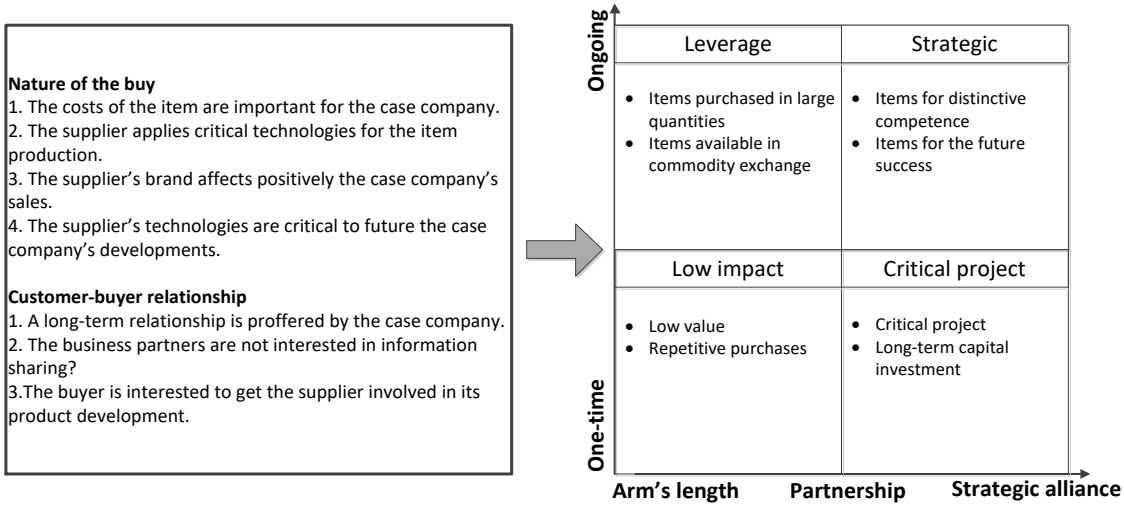


Figure 22. Classification of purchases for cost analysis (Modified from Ellram, 1996).

Each axis in the figure above is a continuum, hence, each group rather than being strictly classified are varying in degree. The corresponding cost analysis techniques for each discussed category in the figure above are illustrated in Figure 23.

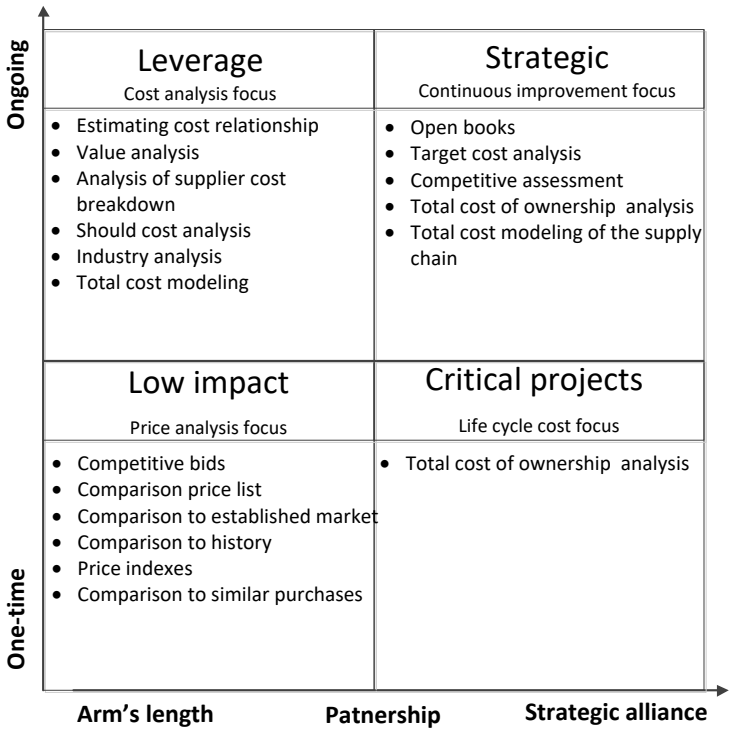


Figure 23. Cost analysis techniques (Adapted from Ellram, 1996).

The figure above shows the cost analysis technique which is selected based on the importance of the item and the relationship level between the buyer and the supplier (Ellram, 1996). Generally, each of the technique has its advantages and disadvantages. The more accurate techniques use the past data; however, they are less effective for products which are at their early stages of their life cycle. In addition, some techniques can be easily implemented, while others need experts to find the needed data.

Low impact purchases include simple cost analysis techniques concentrating on price analysis. Price analysis techniques are usually preferred to cost analysis techniques, because they can be done in a timely and costly manner. Competitive bidding refers to formal solicitation and inquiries through telephone to generate offers from the supplier. This technique is effective only when several qualified bidders exist. Another technique is comparison to price list which is on the basis of retail prices. It needs a careful analysis, because few commercial customers are willing to pay at such prices. Established market prices are useful in established markets of items like commodities. Historical price data and price indexes represents the prices historically paid by the buyer. The common drawback with relying on historical data can be the assumption that the prices will be similar to the future prices. The price movement, price trends, and technological changes need to be considered, otherwise, the estimate will no longer be accurate, and the model is thrown

off. Comparing the current purchase with similar purchases is another approach to adjust the prices accordingly.

Leverage purchase as a cost analysis approach tries to support the buyer company with providing cost data to ensure that prices charged by the supplier are fair and they are not overpaying. This cost data is useful as a negotiation tool for better prices and also in make-or-buy strategy decision making. Leverage purchased refers to purchases that the buyer spends a large amount of money to the supplier. However, due to some reasons the company has not entered into a strategic alliance. Estimating cost relationship is applying the cost data of a similar item for purchased one. Value analysis is a technique which compares an item's function to its cots and replaces the same performances with lower prices. Analysis of supplier cost breakdown is a technique that needs the supplier to open its books with the target of showing reasonableness of the prices. However, this approach requires particular conditions like a trustful supplier-buyer relationship. Should-cost analysis is a time-consuming approach that involve attempts to independently construct purchased products' cost structure. Industry analysis deals with the knowledge of a buyer toward an industry and various advantages which a supplier has like a comparison on the level of automated production line which affects the product's cost structure like overhead and labor cost. Total cost modeling instead of looking at the product's cost structure focuses on the cumulated costs of performing business with a certain company within a period of time.

Strategic purchases refer to a situation which the purchased product is very critical in buyer's company on a continuous basis. This category as a proactive approach differs from leverage category in a desire of the buyer having a collaborative and long-term relationship with the supplier rather than a limited purchase. It focuses on a long-term relationship based on strategic cost management tools with the purpose of continuous improvements in total costs. Open books represent a collaboration and mutual commitment between supplier and buyer to identify high cost areas, improve costs structures and reduce the costs. This approach requires particular situation like a high level of trust between business partners. Target cost analysis is a technique which points out the price which the buyer is willing to pay unlike should-cost analysis that deals with how much a product should cost for the supplier or manufacturer. The aim of competitive assessment is to analyze competition product to see how they are made; this analysis can be a basis for improvements in the supplier's product. This technique can be done alone or in a conjunction with the supplier. TCO concentrates on high costs which are not adding value to the service or product. Total cost modeling applies the same logic of total cost of ownership, however its scope is broader and soared within a supply chain level. For example, any late shipment occurring in upstream imposes high costa to downstream. **Critical projects** involve a one-time or an infrequent expenditure with a high value like major equipment or asset that has a long-term influence of the buyer's company. For such cases, total

cost of ownership is the preferred technique, because critical projects are associated with many costs beyond the purchase price.

The above discussion shows all purchases are not equal and suggests an approach to buyer companies to determine the proper technique depending on a particular purchase and situation. This study will be continued with an especial focus on leverage and strategic purchasing approaches in certain circumstances. It is important to point out, should-cost analysis can be considered as an alternative for open book accounting (OBA) when the success factors of OBA are not met. Before conceptualizing should-cost analysis, the next section is devoted to the concept of OBA and its characteristics as the building block of should-cost analysis.

4.3 Open Book Accounting in Networks

IOCM and its practices like OBA are perceived as a response of accounting management to the changes occurring in SC context (Suomala et al., 2010). Based on the foregoing, sharing information is seen as the center of IOCM. Hence, openness and information transparency among business partners brings up the relatively new concept of OBA which was appeared when the concepts of lean production and supply were spread several years ago (Windolph and Möller, 2012). Cost data is seen as an extreme confidential piece of information within organizations (Kajüter and Kulmala, 2005) which includes product, activity or process cost information within buyer-supplier relationships (Suomala et al., 2010) that can expose company's financial constraints and objectives (Seal et al 1999). Hence, OBA has a key role in IOCM studies (Romano and Formentini, 2012; Kajuter and Kulmala, 2005). The information sharing direction is either unilateral or bidirectional. The first one refers to when the supplier exposes its accounting information like the component cost information to the purchaser. The second one represents a situation that both business sides reveal their books (Hoffjan and Kruse, 2006). However, according to Agndal and Nilsson (2010), OBA is defined as openly disclosing the cost data which are generated in accounting system of supply chain members and the data sharing is usually from the supplier to the buyer which is unidirectional. Accordingly, OBA often tends to be used by buyers (Agndal and Nilsson, 2010).

A supplier can become motivated to benefit from OBA supported by the buyer in order to reveal its cost reduction opportunities (Agndal and Nilsson, 2008b). Therefore, adopting OBA practices can be regarded as a sign of readiness and commitment of the supplier to mutual development through the supply chain (Suomala et al., 2010). In addition, OBA is considered as a strategy that results in trust, cooperation and commitment to a long-time relationship among firms involved in a SC (Agndal and Nilsson, 2008a). Therefore, OBA can be extended beyond the first-tier business partners.

In Chapter 2, the importance of better information sharing through a collaborative relationship within a supply chain was discussed. Better information sharing results is shorter

lead times, lower inventory level, lower batch size, quick product development, shorter order fulfilment cycles, better decisions on ordering and mitigating the whiplash effect. All these consequences can be concluded as supply network's lower costs and higher performance. Therefore, the mutual trust obtained by OBA implementation can provide significant improvements within supply networks. Suomala et al. (2010) define OBA as a flexible accounting template which have different motives form short-term benefits like increasing the pressure over supplier for lower prices to long-term partnerships which shares values among business partners (Figure 24). Håkansson et al. (2010) also support this argument by explaining the benefits of OBA implementation is linked to its purposes, it can be intended for monetary aspects like better financial performance or intangible benefits like strengthened inter-firm relationship.

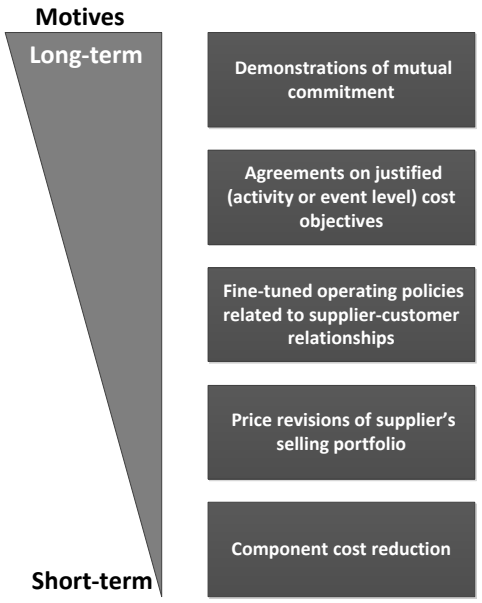


Figure 24. OBA's benefits (Adapted from Suomala et al., 2010).

Therefore, OBA's main purpose as a multi-goal template depends on the motives which are defined by involved stakeholders. In this study, OBA is characterized from buyer point of view which its main goal is obtaining cost-related information to reduce the costs and so generate value and spread it in entire supply chain specifically final customers. In that sense, the competitiveness of a supply chain will enhance.

4.4 The Characteristics of OBA

With regard to the intense competition in the external environment for shortening the costs, the main objectives of OBA are: first, ensuring that the supplier is acting in line with buyers' wishes, second, OBA supports the business partners to make decisions through collaborations which lead to more efficient supply chain. Therefore, the buyer acquires knowledge regarding the upstream networks to cooperate with business partners to improve the products and services flows to increase supply chain's efficiency (Agndal and Nilsson, 2008a). Thus, collaboration and trust are paramount to success under such

arrangements. Kulmala (2002) reviews OBA is a solution for dealing and coping with the challenge of "hidden costs" in supply chain. Cost data is often seen as an extreme confidential information within organizations (Kajüter and Kulmala, 2005) that can expose company's financial constraints and objectives (Seal et al 1999). Hence, OBA has a key role in IOCM studies (Romano and Formentini, 2012; Kajuter and Kulmala, 2005) to disclose and share this confidential cost data with a business partner.

Agndal and Nilsson (2008a) pose four indirect purposes of OBA implementation including: 1) the buyer will be enabled to support the supplier to develop its efficiency like in sub-supplier selection process. Moreover, the buyer can broaden its knowledge upon supply network, 2) as a practical remedy for tensions occasionally occur in negotiation specially regarding pricing. As Ellström and Larsson (2017) explain when the cost data is disclosed by a supplier, the nature of negotiations of price volatility are different. Accordingly, open book practices help the supplier to justify certain offer or a price level, 3) as a supplier evaluation in areas like strategy, costing system and financial position, 4) OBA as a relationship facilitator among business partners by showing openness, trust, and commitment to a long-term relationship.

Moreover, Kulmala (2004) represents a bilateral relationship between trust and OBA which means trust not only is a prerequisite for OBA, but also trust-building is a beneficial result of OBA implementation. However, Kulmala (2004) adds a minimal or adequate level of trust between buyer and supplier to expect openness in needed. Kulmala (2004) poses a model including three factors to analyze the development potential of inter-organizational cost management in various buyer–supplier relationships. This model described in three dimensions representing the three conditions including: 1) **balance of power**: supplier dominant against customer dominant, 2) **trust**: sufficient trust against non- sufficient trust, 3) **volume of mutual business**: high volume against low volume.

While Kulmala (2004) refers customer dominance as a factor for highest potential for OBA practice, Kajuter and Kulmala (2005) raise some other factors rather than customer dominance. As illustrated in Table 2, Kajuter and Kulmala (2005) has developed a contingent model that represents factors which are conditions for OBA implementation in supply network. These factors include: 1) **exogenous environmental factors:** level of competition (higher competition leads to higher cost reduction pressure), economic trends (when the economy is growing, OBA can be easier to execute, because most of the partners can benefit from new business opportunities that are provided within closer cooperation), 2) **network specific factors:** type of network (OBA implementation is easier in mature and hierarchical networks), type of product (discussed in 3.2), infrastructure (tools, inter-organizational support in cost accounting), social nature of network relationships (mutual trust), 3) **endogenous firm-specific factors:** firm size (larger-scale companies benefit from more resources to commit them to their accounting systems), cost accounting systems (capacity to generate accurate cost data), competitive policy and commitment (long-term insight).

Table 2. Pre-conditions for OBA implementation (Adapted from Kajuter and Kulmala, 2005).

	Contextual factors
	Exogenous environmental factors
1	Degree of competition
2	Economic trends
	Network-specific factors
3	Form of network
4	Product type
5	Infrastructure
6	Social nature of network relationship
	Endogenous firm-specific factors
7	Company size
8	Cost accounting systems
9	Competitive policy
10	Commitment

According to Agndal and Nilsson (2010) and Axelsson et al. (2002), sharing information in the context of OBA is dependent on the purchasing strategy chosen by the business partners. An essential aim of the purchasing strategy of a firm is to minimize purchasing costs. The nature of the purchasing strategy can be either transactional or relational. Accordingly, transactional type pattern of behavior which fits well with the traditional management accounting refers to a short-term basis relationship (Axelsson et al., 2002), along with a low-level of commitment in supplier-buyer relationship and focusing on a firm's own benefits. Transactional purchasing strategy is described as an arm's length relationship that the supplier and the buyer follow adversarial roles (Agndal and Nilsson, 2010), and trust is unessential, because the buyer takes advantage of its contractual power and forces the supplier to accept OBA (Romano and Formentini, 2012). However, when the externalities and outsourcing become larger, it is not adequate to manage it through arm's length transactions and more elaborate inter-firm relation is needed (Baiman and Rajan, 2002). Hence, relational pattern of behavior represents a high-level of commitment and focusing on mutual benefits within the customer-supplier relationship.

Agndal and Nilsson (2010) specify "that within market procurement characterized by a transactional purchasing strategy, cost data primarily serves to reduce purchase price". Hence, the scope and scale of disclosed data is limited, and it mostly take place within the supplier evaluation and supplier selection through an adversarial and distrusting atmosphere and short-term benefits for suppliers. On the other hand, relational purchasing strategy emphasizes on data disclosure and so cost reduction as a more comprehensive result in a cooperative and trusting atmosphere and long-term benefits for suppliers (Agndal and Nilsson, 2009). Figure 25 shows briefly the studied characterizes by Agndal and Nilsson (2010) from both purchasing strategies' standpoint.

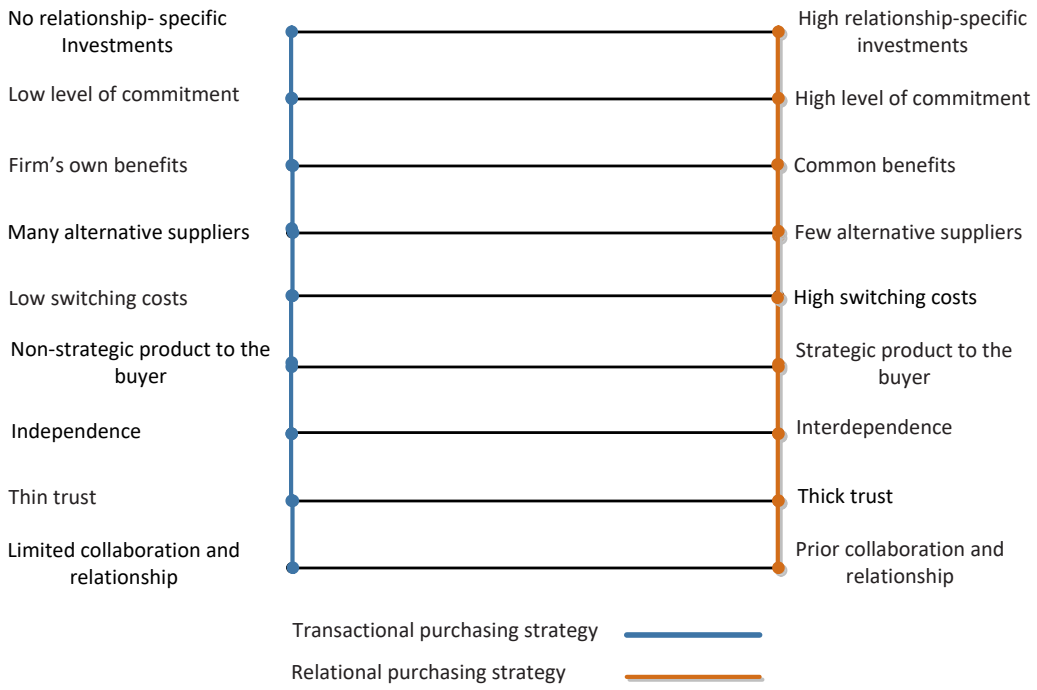


Figure 25. Characteristics of purchasing strategies (Modified from Agndal and Nilsson, 2010).

In the figure above, the characteristics of the purchasing strategies are illustrated. As it is shown, any characteristic represents a continuum instead of discrete categories. Although, the figure demonstrates an extreme view of transactional and relational purchasing strategies which occur at the end of continuum, a purchasing strategy is a tradeoff among its characteristics. Therefore, according to Agndal and Nilsson (2010), the purchasing strategy is relatively one of the transactional and relational purchasing strategies along a set of several dimensions. When the purchasing strategy is figured out, Hoffjan et al. (2011) offer a framework which illustrates different approaches toward OBA in relation to purchasing strategies and key motivation for cost transparency.

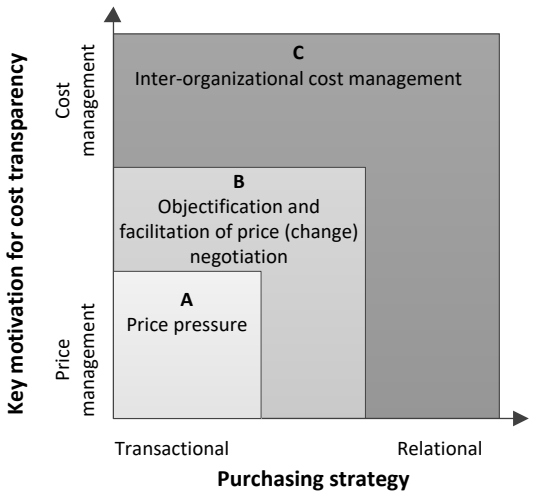


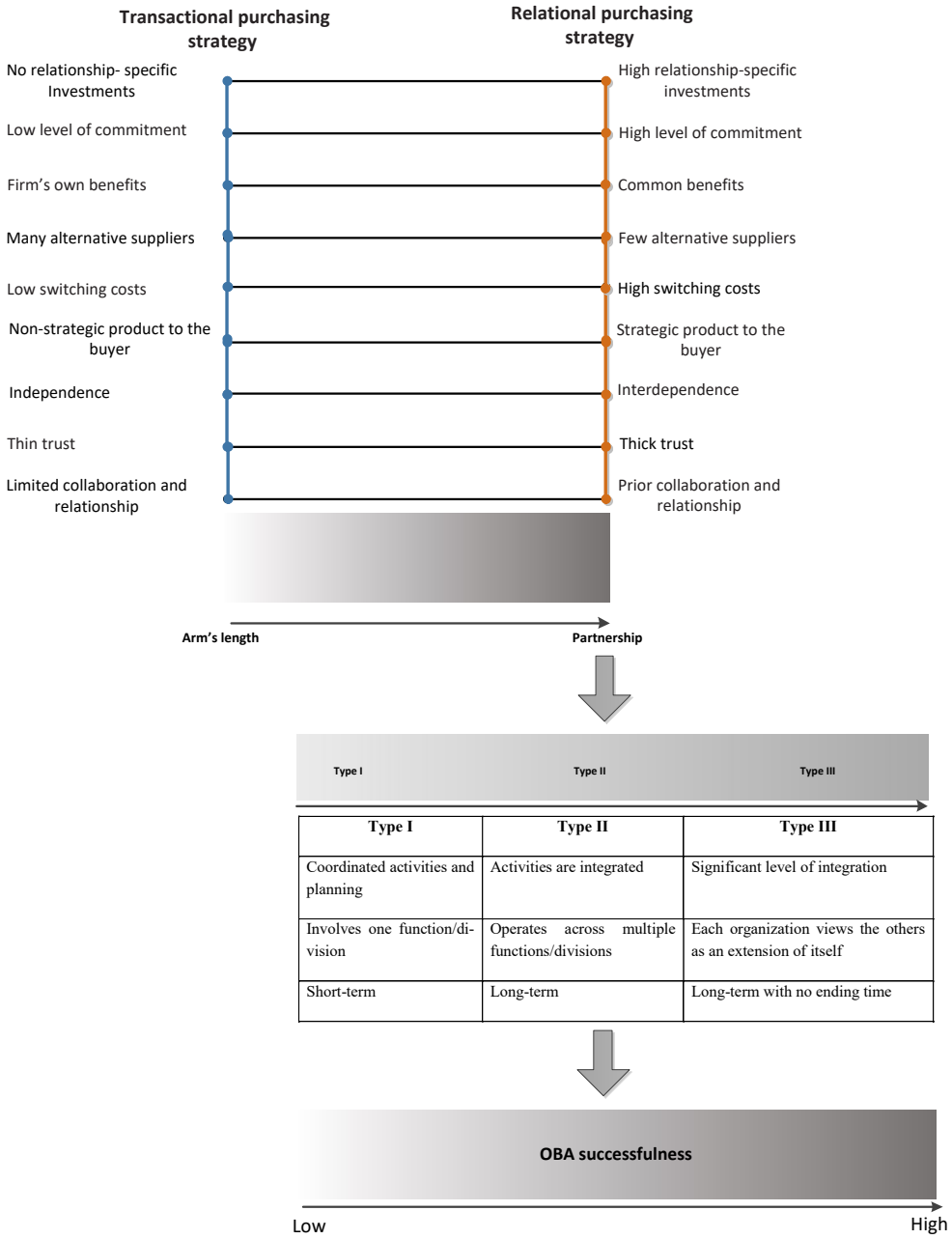
Figure 26. Different approaches toward OBA implementation (Modified from Hoffjan et al., 2011).

As discussed earlier, there are several forms of inter-firm relationships that range from relationships that are market-price based to relationships that partners agree on working closely for a long time (Cooper and Slagmulder, 2004). Through this broadness of inter-firm relationships, employing of management accounting techniques differ significantly. Hence, it is crucial to analyze the inter-firm relationship to elaborate the accounting information flows of that relationship, and later to perform a proper management accounting technique (Ireland et al. 2002 and Grandori, 1997). The management accounting approaches employed need to be consistent with the certain inter-firm relationship (Brunetti, 1989), and that requires be capable of collecting and selecting the necessary accounting information to develop relationship, without generating higher transaction costs (Merchant and Riccaboni, 2001).

The first approach toward OBA is representing the transactional purchasing strategy and the classical use of cost transparency with the purpose of a higher pressure on supplier's price. The second approach represents a more relational purchasing strategy with the focus on reduction of transaction costs which are related to price negotiations under defined common rules. This approach facilitates price fluctuations which are on the basis of cost fluctuations and both business parties can benefit from this exchange relationship. Seal et al. (1999) indicate that sharing information and cost transparency are important factors for a supplier that is asking for higher prices. Because it can be shown that any price change is on the basis of legitimate costs change. The third approach describes an IOCM approach to achieve substantial cost savings and the most cost-efficient aggregate solution. Therefore, as the relational aspects of a procurement increases, the companies are more likely to pick the IOCM practices. As described earlier (Table 2), higher commitment and mutual trust amongst the business actors are the preconditions of a robust OBA implementation. Therefore, it can be expected a robust OBA is more likely to be achieved through relational-oriented purchasing strategies which are built on the basis of an information sharing and collaborative relationship. In other words, forcing a supplier to open its books in a way other than a collaborative way cannot be seen as a perfect OBA, to say the least.

Inter-organizational relationship can be defined a spectrum from arm's length relations to vertical integration and each one needs developing different accounting information flows amongst companies (D'Atri, 2011). Williamson (1991) adds interfirm cooperative relationships are hybrid which include both the application of market incentives and the cooperativeness and coordination of the hierarchy. D'Atri (2011) explain an interfirm cooperative relationship development results in the accounting information flows between companies, which needs their accounting information exchange to reduce costs and obtain value creation. Consequently, a result of this inter-firm cooperative relationships is an incremental interest in the concept IOCM that includes cooperative action of companies to obtain value creation and reduce costs. In addition, on the basis of OBA characterizations, this cost management technique can be a tool offering strong results in inter-firm

cooperative relationships seeking a long-term goal, because joint-cost reductions make benefits for the companies (D'Atri, 2011). Therefore, OBA is most likely successful in rather relational purchasing strategy. A relational relationship falls in a partnership inter-firm relationship introduced in Chapter 2. Hence, Figure 27 helps to first recognize the purchasing strategy of a customer and then locate it on a partnership level to assess the successfulness of OBA implementation.



Type I	Type II	Type III
Coordinated activities and planning	Activities are integrated	Significant level of integration
Involves one function/division	Operates across multiple functions/divisions	Each organization views the others as an extension of itself
Short-term	Long-term	Long-term with no ending time

Figure 27. OBA implementation assessment.

According to the figure above, pointing out the type of customer-supplier relationship ranging from arm's length to type I, type II and type III relationships helps to realize the appropriateness and the degree of successfulness of OBA implementation.

Despite the discussed purposes of OBA implementation, there are several challenges which are associated with OBA implementation. Opportunistic behavior by business partners using disclosed information is an increased supplier's concern. Dekker (2003) argues that shared suppliers' cost information may make the supplier vulnerable to potential opportunistic behaviors by customers because of using this information in future price negotiations.

Kajüter and Kulmala (2005) explicitly mention the main reasons which might lead the books to remain mainly closed are: 1) customers do not distribute the benefits and do not offer win-win solutions to suppliers to benefit from openness, 2) some suppliers believe in keeping accounting information in-house that can be due to the lack of understanding of potential roles of accounting information in the success of firm and network, 3) inability of supplier in generating and providing accurate cost information, 4) the risk of exploiting the cost structures by customers (Lamming et al., 2005) for potential competitive bidding or benchmarking to select the lowest cost supplier (Seal et al., 2004) which jeopardizes the supplier's situation, 5) suppliers' expectation of receiving different resources from customers like human resources and knowledge to build or update their accounting systems, 6) lack of a concurrence between the supplier and the buyer toward how open-book practices should be implemented.

Lamming et al. (2005) argue that there is a potential risk of leaking the disclosed data by the customer to competitors of the supplier to induce the supplier to reduce prices. Lamming et al. (2001) explain a risk for the customer which is associated with demanding the exposure of sensitive data. Providing entirely false books and manipulated data which is seen as a rational behavior by supplier that can be expected because of one-way information flow. Besides the discussed reasons of an unsuccessful OBA practice, Kajüter and Kulmala (2005) mention an enforcing OBA which is the result of asymmetrical balance of power does not necessary lead to a successful OBA practice. They explain it might be possible only within dyadic buyer-supplier relationships. Conversely, in a network made of several indirect business relationships, the use of power is not often helpful.

According to literatures, it can be concluded that in business networks, suppliers can have access to accounting data when buyers trust them (Agndal and Nilsson, 2010). Business networks which are not characterized by a threshold of trust, the use of power is not also an effective means to achieve information sharing. Therefore, a need of an alternative framework to fulfill this need can be realized.

A successful OBA implementation could only be performed if the supplier agrees on the objectivity of the purchaser and also agrees in eliminating inefficiencies by practicing OBA. However, the single-source situation often makes it hard to the purchaser to encourage a supplier to take part openly in a cost data disclosure. Therefore, any lack of openness or accessing to high-quality supplier's cost data limits the purchaser's ability to identify the inefficiencies beyond its frontiers and within the supply network. In addition,

as Windolph and Moeller (2012) review the literatures have widely addressed OBA's implementation problems and prerequisites like difficulties of meeting several success factors of OBA implementation. Kajueter and Kulmala (2005) stress this issue as "[it] is usually taken for granted that it [OBA] yields positive effects for all network members". While, in some cases OBA is not the most efficient and effective approach for cost data disclosure.

For complex and highly engineered products traded in low volumes, OBA is a technique that eliminates cost inefficiencies like profit-whiplash effect across the supply network through openness and transparency of the information among business partners. However, when OBA as a solution for this problem fails, lack of any source to reveal what a product should cost is not pleasant. According to (Mealer and Park, 2013), the alternative to manage such situation is known as should-cost analysis which assists the purchaser to get an exhaustive insight towards the supplier's product cost resulting in a more judicious price negotiation. Carter and Mueller (2011) also define should-cost analysis as one of the most powerful initiatives of better-buying power to incentivize productivity and reduce costs.

Next section contributes to a rather creative study on an initiative discussion upon bringing improvements into the context of cost management by proposing an alternative to OBA arrangements in strategic collaborations. The proposed alternative approach in this study does not discard the discussion of OBA practice, but argues, as practicing OBA might be challenging, so that creating an alternative insight to OBA for more transparent cost information will secure effective price negotiations without damaging a valued relationship

5. REVERSE ENGINEERING

5.1 What Is Reverse Engineering?

In this chapter, the concept of reverse engineering (RE) from a general perspective which fits to the supply chain cost management is studied. Reverse engineering methods are considered as important part of prototyping. Companies are benefiting from reverse engineering for competitiveness and reducing the prototyping time and the real product production time (Dúbravčík and Kender, 2012).

According to Raja and Fernandes (2008), two kinds of engineering are forward and reverse engineering. Forward engineering is described as a process from a high-level model and design to lower-level details and physical implementation of a system. However, in some cases there are physical products with no technical documentation available. These documentations include drawings, BOM (bill-of-materials), engineering data and prior knowledge of the technology involved. In order to duplicate such existing products without mentioned documentations, the concept of RE can be applied.

Moreover, to understand RE as an engineering tool, the concept of forward engineering requires to be characterized precisely. According to forward engineering, the subject system is the result of a development process, conversely, through RE, a subject system is the starting point to determine a system's components and their connections, as well as representation of the system in a new form like a CAD model (Motavalli and Shamsaasef, 1996; Chikofsky and Cross, 1990).

Raja and Fernandes (2008) explain in today's fierce supply networks, product companies constantly try to find new methods to improve lead times of new product development. RE can be considered as a technology to improve product development cycle. RE is seen as a process to build a geometric CAD model based on 3D points acquired by different methods like scanning or digitizing existing products. Therefore, reverse engineering can be applied with the purpose of designing a new part, copying of an existing part and recovering a damaged or broken part and it can be considered as a critical step of the product development cycle. Starting from very beginning to develop a new product is not cost and time efficient. RE is considered as a competitive advantage which reduces maintenance costs and improve quality management.

Motavalli and Shamsaasef (1996) and Eilam (2005) define RE as a necessary engineering tool for manufacturing an object on the basis of a physical model with no available engineering drawing. The reverse engineering process can be accomplished in three phases (Motavalli and Shamsaasef, 1996). First, part digitization by utilizing different devices like coordinate measuring machines and laser scanners. Second, processing the digitized

data points in order to define the surface features of the part. Third, modeling the segmented data in a CAD system model that includes the manufacturing features and design model of the part.

Historically, machine processes often begin from CAD model and end up in a component production, conversely, reverse engineering process starts from a component and gets completed by providing a digital model (Dúbravčík and Kender, 2012) and a product prototype. Figure 28 provides a general idea towards forward and reverse engineering process.

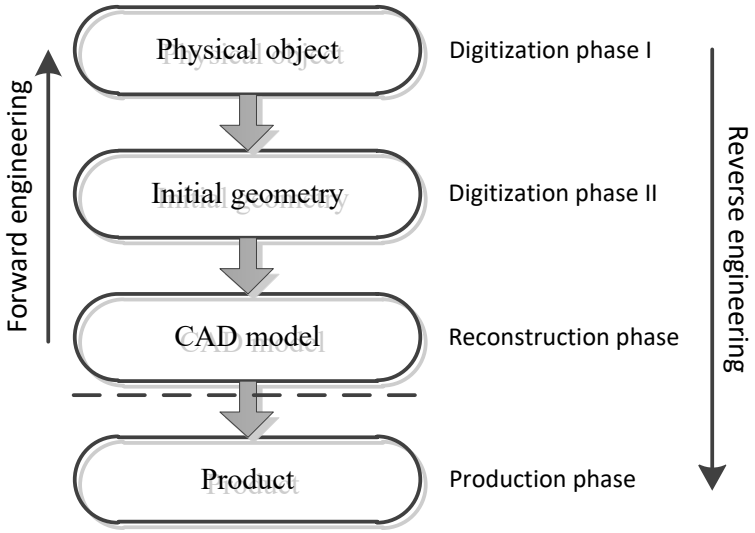


Figure 28. Reverse engineering vs. classic production process (Modified from Dúbravčík and Kender, 2012).

One of RE applications is service operation in production process. Repairing or changing the damaged part is often a time-consuming process and is challenging especially when the spare part is not available. Therefore, RE is an important tool for decreasing the repair time to minimum by prototyping the spare part (Dúbravčík and Kender, 2012).

Main techniques of RE are digitalizing and rapid prototyping. First, digitalizing provides a digital form of real part surface by scanning the points in space and generating a CAD output. The main types of digitalizing include: optical, laser, contact, and destructive. However, the most frequently used techniques are optical 3D scan devices and lasers. Second, rapid prototyping is a fast way to produce prototypes by using alternative materials. 3D printing is a well-known type of rapid prototyping process. Thanks to prototypes production methods which provide functional prototypes that can be used for testing or used directly for short-term purposes (Dúbravčík and Kender, 2012). Figure 29 illustrates how a damaged gear without an available spare part is produced by applying reverse engineering. The digitizing process provided a 3D model as a source for 3D modeling to produce a new gear.

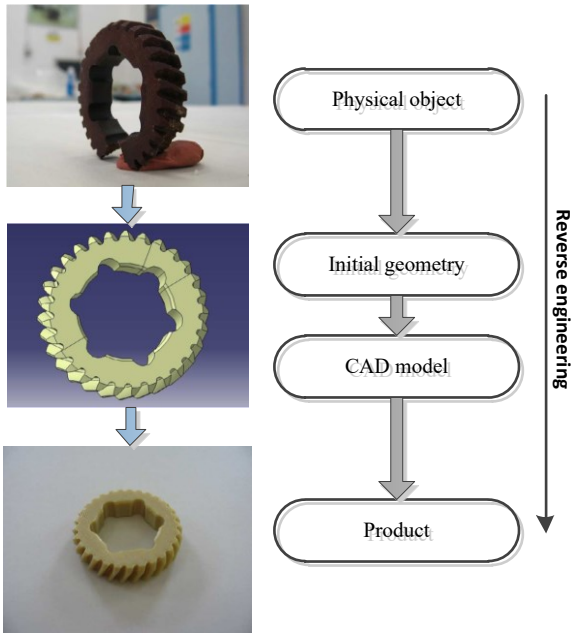


Figure 29. The process of prototype production of a damaged gear (Modified from Dúbravčík and Kender, 2012).

Similarly, according to Motavalli and Shamsaasef (1996), a reverse engineering practice includes two modules. First, the scanning and data processing module which refers machine vision and contact probing which provides a CAD model for digitized part, second, surface modeling design which operates in two parts. The former phase involves capturing an image of the object by a vision system camera. This is used to clarify the boundaries and edges and a 2D drawing of the object. In the latter phase, the 2D view is utilized to conduct a contact probe to gain precise data points related to the surface of the object. The output of these phases is a 3D CAD drawing which represents the available object. According to Raja and Fernandes (2008), the scanning phase points out selecting proper scanning techniques and then preparing the object to be scanned in order to obtain information which represents all geometric features of the object. Contact scanner and non-contact scanner are two distinct kinds of scanners. The former type of scanners follows the contours of a physical surface. The latter type of scanners uses lasers, optics, and sensors to capture point data.

5.2 Applications of Reverse Engineering

Raja and Fernandes (2008) argued that reverse engineering is particularly useful in many areas and some of the reasons of utilizing reverse engineering can be categorized as follow. This list might be not exhaustive and there may be other reasons behind reverse engineering utilization.

- There are demands for a special product, while the original manufacturer does not exist longer
- The original producer is not any more willing to produce a product

- The documentations of an object do not exist or are not available
- For comparing a produced product with standard CAD model of it
- Revealing the good and features of a product
- Studying the weaknesses and strengthens of a competitor's product
- Creating 3D data of a sculpture o reproduce artwork
- Improving quality and efficiency of existing parts.

Reverse engineering is increasingly applied in a large variety of fields due to several technological factors. First, nowadays computing power is more available and data mining and analysis algorithms are more advanced, hence, deriving complex information form data is more possible compared to the past. This information can be used to find out the answers of questions related to function, structure, and behavior of under-study artifacts. Second, technologies like 3D scanners and different types of sensors have become a source of data which have provided a comprehensive insight toward mechanical structures (Telea, 2012).

Telea (2012) represents RE includes all the activities which are set to discover the functional, structural, and behavioral semantics of an artifact. These pieces of information are leveraged for the efficient usage, adaption of that artifact or creating related artifacts. Rediscovering information involves circumstances that the original information is lost or unavailable or cannot be efficiently used within a context. On the other hand, discovering new information occurs when it is aimed to reuse inherently present information in the original artifact, but not made explicitly available for reuse in new context.

Reverse engineering, here, is seen as a cost management tool to analyze an object by disassembling or breaking it down into its sub-components and measuring different features of these sub-components. Reverse engineering in different industries is applied with the goal of achieving specific information like:

- Manufacturing engineering: quantity of parts per product unit, weight, material composition, color and finish, coating, manufacturing process, dimensional measurements to create technical drawings and a 3D virtual model
- Software engineering: to extract a software's design and its implementation information
- Chemical engineering: to determine an object's chemical composition and recipe

The above list is not exhaustive, and it provides an insight towards reverse engineering applications in this study. Schultz (2010) describes the reverse engineering process of a trans axle oil pump gears of a Formula 1 car. Due to rapidly changing technology, operational secrecy, and highly stressed parts it is challenging to obtain spares once the race cars are retired from competition (Figure 30).

Figure 29 a. Formula 1 car

Figure 29 b. Assembled trans axle

Figure 29 c. Oil pump drive components

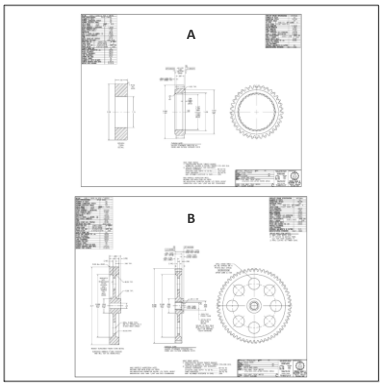


Figure 29 d. Drawings and measurement

AISI 9310 steel and vacuum carburize

Element	Content (%)
Nickel, Ni	3.00-3.50
Chromium, Cr	1.00-1.40
Manganese, Mn	0.45-0.65
Silicon, Si	0.15-0.30
Phosphorus, P	0.025 (max)
Sulfur, S	0.025 (max)
Molybdenum, Mo	0.08-0.15
Carbon, C	0.08-0.13

Figure 29 e. Chemical Composition

Figure 30. Generic process of gears reverse engineering (Modified from Schultz, 2010 and AZoM. 2012).

The figure above shows how a Formula 1 car axle is broken down into its sub-components and then a BOM and chemical composition analysis is conducted.

A general process of RE for the purpose of this study is demonstrated in Figure 31. This approach begins with treating the object as a black box to have an unbiased evaluation through investigation, prediction and hypothesis of the under-study object. The process is continued with disassembling the object into its independent sub-components to discover the engineering specifications and characteristics of the object. Lastly, this obtained knowledge will be used to build a prototype model as the basis for real product production.

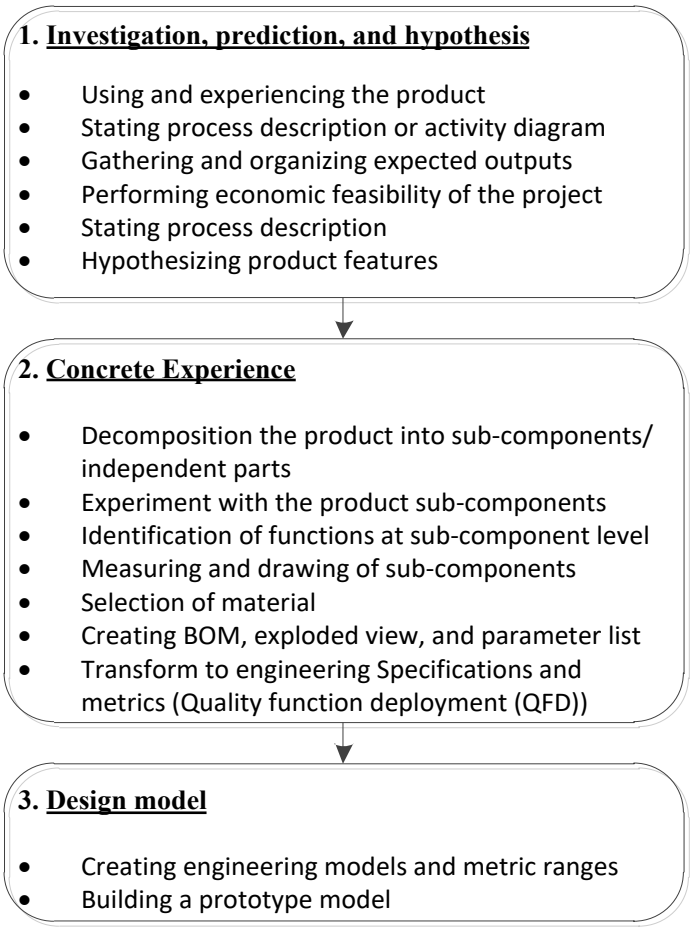


Figure 31. Reverse engineering process (Modified from Otto et al., 1998).

The figure above splits the reverse engineering process into three main steps including investigation and prediction, concrete experience, and design model. The concept of RE is widely discussed and there is a huge volume of literature explaining the reverse engineering concept and its applications in various fields, such as mechanical industries, software industry, medical life science, and film entertainment or animation industry. However, there is no studies of financial aspects of reverse engineering. RE can be utilized when features of a piece of equipment or production are needed to analyze the product's cost structure and the price changes across the supply chain.

The next section calls the attention to discuss cost analysis techniques in absence of a cooperative relationship among business partners. Therefore, should-cost analysis among other introduced techniques fits properly the direction of this study. To the author's knowledge, this relatively infrequent applied approach has received little researches precisely addressing its characterization and practical applications. Therefore, this research contributes specifically to three overlooked and unanswered questions regarding the characterization, applications and a comprehensive implementation process of should-cost analysis.

5.3 Should-Cost Analysis as an Alternative to OBA

Many companies benefit from strategic sourcing to lower their cost of goods sold, tackle unproductive activities and boost a proper competition to maintain an edge in their price negotiation. For example, purchasing from low cost countries like China is a strategy to take advantage of cost differences of different countries. However, this approach is more applicable when the business volume is relatively high, conversely, for more complex and highly engineered products traded in low volumes this approach is not useful. Because the purchasers have the challenge of getting competitive bids from enough number of suppliers. Therefore, making a choice or trade-off on suppliers providing higher competitiveness and less costs would be a difficult practice. As a result, the purchaser is compelled to grapple with a single or few suppliers. While the purchasers are eager to reduce their purchasing costs, lack of any source to reveal what a product should cost is not pleasant.

OBA is a technique that eliminates cost inefficiencies like profit-whiplash effect across the supply network through openness and transparency of the information among business partners. However, when OBA as a solution for this problem fails (or is not an option), lack of any source to reveal what a product should cost is not pleasant. Varadarajan (2013) explains a solution to manage such situation is known as should-cost analysis (SCA) which assists the purchaser to get an exhaustive insight towards the supplier's product resulting in a more judicious price negotiation. Varadarajan (2013) describes should-cost analysis as a process which determines what a product has to cost in terms of drivers such as manufacturing costs, material costs, overheads and an acceptable amount of profit. Moreover, SCA supports the purchaser to build a big-picture of the overall cost break down upon material, labor, process, rejects, setup, overheads, packaging and transportation costs. In that sense, the purchaser will be able to discover the cost reduction opportunities independently.

In today's highly competitive business world, the sales prices are determined by the markets. If the business relationships are not going in a cooperative manner, the product cost data would not be shared, hence, the profitability will continue to shrink. As it was earlier discussed, a detailed knowledge of what goes into the cost structure of products due to the proposed profit- whiplash effect concept becomes very important. Should-cost analysis takes a different approach to price discovery in contrast to strategic sourcing. It means instead of requesting quotes and comparison of price quotations as the basis of strategic sourcing, with should cost analysis the buyer tries to understand the underlying labor and allocates expected profit margins and labor rates to estimate the expected price as the baseline reference to negotiate the final price. As an example, a car buyer looks up the dealer's invoices independently to discover a sales price instead of comparing different dealers' sales prices.

Heid et al. (2018) explain operational excellence in procurement operations is a requirement of the modern procurement operations and supplier relationships. In that sense, should-cost analysis is seen as a required technique for procurement organizations. Advanced should-cost analysis brings a competitive method to supplier negotiations by disclosing what a product or service really costs to be designed, manufactured, and delivered. Should-cost analysis is an intersection of product development, cost engineering, and procurement work, so is considered as a cross-functional collaboration. The obtained insights by it assist procurement managers to get an understanding on detailed cost drivers from the bottom up approach, creating a goal, fact-based perspective expected prices and an effective negotiation with suppliers (Heid et al., 2018).

Choi et al. (2013) in their study have tried to show how the Defense Department of the USA has practiced should-cost management for better buying power (BBP) as many programs were failed to meet budgeted costs, schedule, and performance targets. Indeed, they tried to answer this question: What management practices can be applied to control cost problems? They explain should-cost management is a management system to carefully analyze costs through all product life-cycle stages. Moreover, it is an ongoing improvement process to reduce costs without sacrificing the performance, the quality, and contractor relationships. The concept of should-cost management is an equivalent concept of lean manufacturing, because both focus on eliminating non-valuable processes. Carter and Mueller (2011) also define SCA is a powerful initiatives of better buying power to incentivize productivity and reduce costs. Moreover, Williams (1985) describes SCA a technique to solve several procurement cost problems in United States Department of Defense. `

Choi et al (2013) explain should-cost management implementation is an aspect of better buying power for improvements in contract negotiations and program execution. They review that should-cost analysis is an approach to figure out what a system really costs versus will cost approach based on historical data to estimate what a system probably costs. Yoder (2012) adds should-cost analysis emphasizes on the real work and applies gathered information to support negotiations to ensure contract cost structure. According to Carter (2011; cited in Yoder, 2012), SCA refers to finding particular ways to perform an independent cost estimate and it can be applied for any source of costs. SCA, therefore, is a "fundamental to proactive cost control throughout the acquisition lifecycle" (Kendall, 2013; cited in Choi et al., 2013).

Choi et al (2013) reviews contractor's historical costs are not a reflection of an efficient and economical operation, conversely, SCA as a certain form of cost analysis takes the following items into account: methods, materials, equipment, existing work force, real property, and operating systems. Williams (1985) explains the Department of Defense was one of the first sectors that applied SCA which was done through a team of 50 people and the areas under study were including: labor standards, allowance, plant capacity, ma-

chine utilization, labor cost, general overhead, standard material, material variation, vendor tooling, make-or-buy and purchasing. Williams claims this intense should-cost analysis implementation supported the government to save $100 million on one contract. Moreover, a 15% saving of the proposal price in the department of defense was achieved. SCA was mostly done on a contractor that was the only supplier of a certain item. Because they are not in a market price competition which makes them to charge greater profits and also unincentivized to be efficient. In other words, SCA should be utilized in major procurements due to lack of a competitive price. According to Varadarajan (2013), the objective of should-cost analysis (SCA) is to provide the purchasers with justifiable information for a judicious price negotiation. In addition to the purchaser, the suppliers are also benefited from such product cost estimation in early stages of its product development to justify certain offer or a price level

Choi et al (2013) reviews a multifunctional team formed of the contract administration, pricing, engineering, and audit representatives take responsibilities of SCA practices. Should-cost analysis aims to develop real objectives for negotiation. The team is formed of product experts who know the design characteristics of a product and they implement the reverse engineering phase. They provide the CAD model and several engineering specifications depending on the goals of SCA. Process experts are manufacturing engineers who are experts in providing insights into the supplier's manufacturing process.

The identified benefits of this approach are: first, setting negotiation target which facilitates a price negotiation, second, identifying of non-recurring costs like start-up costs which are easily hidden by the contractor while should not be included in the subsequent operation contracts, third, this technique helps to uncover inefficient operations within the contractor's plant and then providing a solution for those challenges, fourth, should-cost analysis can eventually result in a better industry relations (Williams, 1985).

Moreover, the identified limits of should-cost analysis include: first, high implementation cost is the main barrier of practicing a SCA due to costs related to forming a team of highly skilled specialists for a period imposes several expenses to a company. This team needs to be trained. Second, the companies usually need qualified personnel to achieve the goals of SCA and it is considered as a barrier. Third, a comprehensive planning to avoid any chaos within the implementation, fourth, lack of an exhaustive understating of this approach and its capabilities. (Williams, 1985).

According to the Federal Acquisition Regulation (FAR), should-cost analysis is a cost analysis technique applied to discover inefficiencies and uneconomical practices in the management and operations of contractors. Therefore, it quantifies the costs of those practices and provides an objective for a negotiation to obtain both long-term and short-term improvements in contractors company (Williams, 1985).

Despite the discussed benefits, the preconditions to implement SCA reviewed by Williams (1985) are as follow:

1. Production has taken placed to some extent
2. The contract is upon a sole source
3. Substantial requirement of the product in future
4. The work processes are sufficiently defined
5. No time restriction for should-cost analysis implementation
6. Available skilled team

5.4 Should-Cost Analysis Process

A similar method to the seven-step method proposed by Mealer and Park (2013) for achieving should-cost analysis of a produced product is proposed in this study. Figure 32 demonstrates how a generic process of SCA looks like.

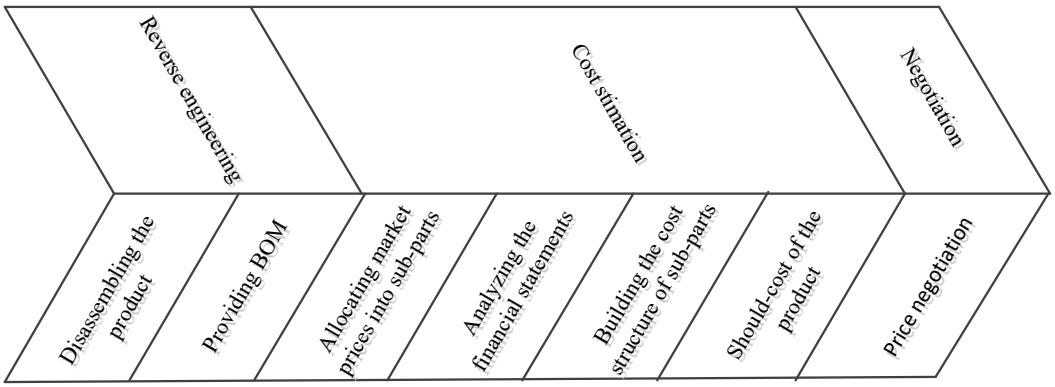


Figure 32. A generic process of should-cost analysis.

Step 1: the complex and non-commodity products consist of several identifiable sub-parts. The materials and production process of several sub-parts assembled into a system or complex product often differ. Therefore, breaking down them into identifiable sub-parts is a critical phase of this technique. **Step 2:** once the product is divided into its sup-parts, the should-cost analysis team determines the manufacturing process of each sub-part. The supplier might provide the purchaser with bill of material (BOM) and manufacturing process maps. However, this information usually needs to be investigated by the allocated team.

The two first steps refer to reverse engineering process. Motavalli and Shamsaasef (1996) define reverse engineering as a necessary engineering tool for producing a part on the basis of a physical model without available engineering drawing and technical documentation. Similarly, in this study reverse engineering is considered as a tool to analyze an object by disassembling or breaking it down into its identifiable sub-components and

measuring different features of these subcomponents. Reverse engineering in different cases is applied with the aim of achieving specific information like quantity of sub-parts per product unit, weight, chemical composition, color and finish, coating, manufacturing process, and dimensional measurements. Therefore, linking this derived information based on reverse engineering to financial data of products provides managers with new insights in the context of cost management.

Step 3: this step refers to finding relevant price information of raw materials of sub-parts from different sources of information like public market prices. **Step 4:** direct material costs by linking the material weight and unit price of different chemicals and raw materials can be estimated. **Step 5:** by analyzing publicly available financial statements of the supplier, the labor cost per product unit to be added on top of the material costs can be estimated. Then the financial statements of the companies within the same industry can be analyzed to define an appropriate contribution margin, taking into account the return on capital deployed in the business. **Step 6:** constructing a cost structure and price estimation of each component. **Step 7:** the team can make an estimation of the throughout SCA of a product by summing up the SCA estimations of whole components. **Step 8.** conducting a price negotiation meeting with the supplier.

Al in all, relying on a supplier's quoted prices as the single source of data may result in a situation that the supplier be incentivized to offer higher prices. However, this is not a behavior in the spirit of a right collaborative relationship through a supply chain. The should-cost analysis technique provides an overall price estimation of the supplier's product that removes the reliance on the cost data information provided by the suppliers.

In addition to Mealer and Park (2013) proposed approach, Williams (1985) sees SCA as a process which needs a careful planning, implementation, controlling and monitoring to be effective. He describes SCA as an on-site work which has to be done in the contractor's company and to some extents needs the consent and an enthusiastic support from the contractor. In contrast to the conceptualization by Williams (1985), should-cost analysis in other literature is defined as an independent and off-site technique when the contractor is not incentivized to cooperate in a cost analysis practice.

When selecting an item or candidate for should cost analysis, some aspects of it need to be considered Williams (1985):

1) absence of price competition
2) enough time for SCA implementation
3) highly valuable procurement
4) available special skills for that item
5) potential for significant business with the supplier
6) identified problems to be solved
7) increasing costs history

8) probability of shifting costs to the contractor
9) existence of historical data
10) stable manufacturing conditions
11) lack of accurate cost estimates
12) having a rather bargaining power

As discussed, should-cost analysis might seem a simple or inefficient technique; however, being involved in a price negotiation with a supplier can prove how critical this concept is to purchasers. This concept is a far more complex than what were explained as a process in this chapter, because should-cost analysis is a logic inevitably depending on the estimations. It includes several assumptions towards physical aspects like the production and assembly line process and its involved workforce, and also financial aspects like cost structure's elements such as material costs, labor rates, overhead and profit. Moreover, when employing should cost models, the accuracy is a key issue in negotiations. Since the supplier is likely to try to challenge the assumptions with the intent of o turning the cost negotiations to its side. Therefore, a poorly implemented SCA can undermine the credibility of the customer.

The triangle below shows the area which is related to the quoted- and negotiation-based prices is leaving a rather large opportunity for the supplier to charge the customer with higher and unfair prices. Nevertheless, as the customer employs the should-cost analysis, its negotiations with the suppliers for more fair and reasonable prices is more likely to be associated with cost reductions and not allowing suppliers to change the prices as much as they wish.

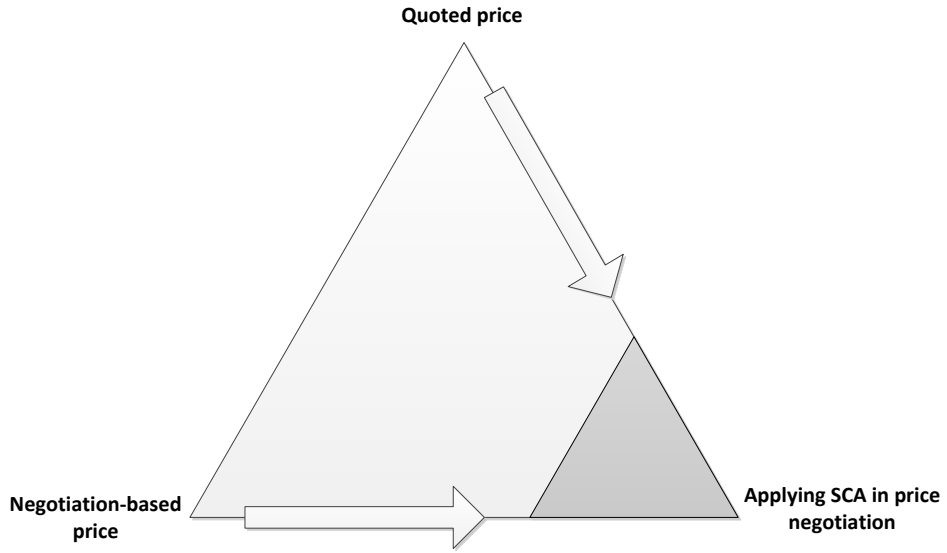


Figure 33. The should-cost analysis as a tool for price negotiations (Modified from Hiller, 2012).

In conclusion, according to all aforementioned analyses, when a rather collaborative relationship is not set between the business partners, OBA is not an option in procurement to access to the supplier's products cost data. Therefore, should-cost analysis can be seen as an alternative to OBA in relationships characterized by transactional relationships and lack of an adequate level of information sharing, Figure 34 is a demonstration of this idea.

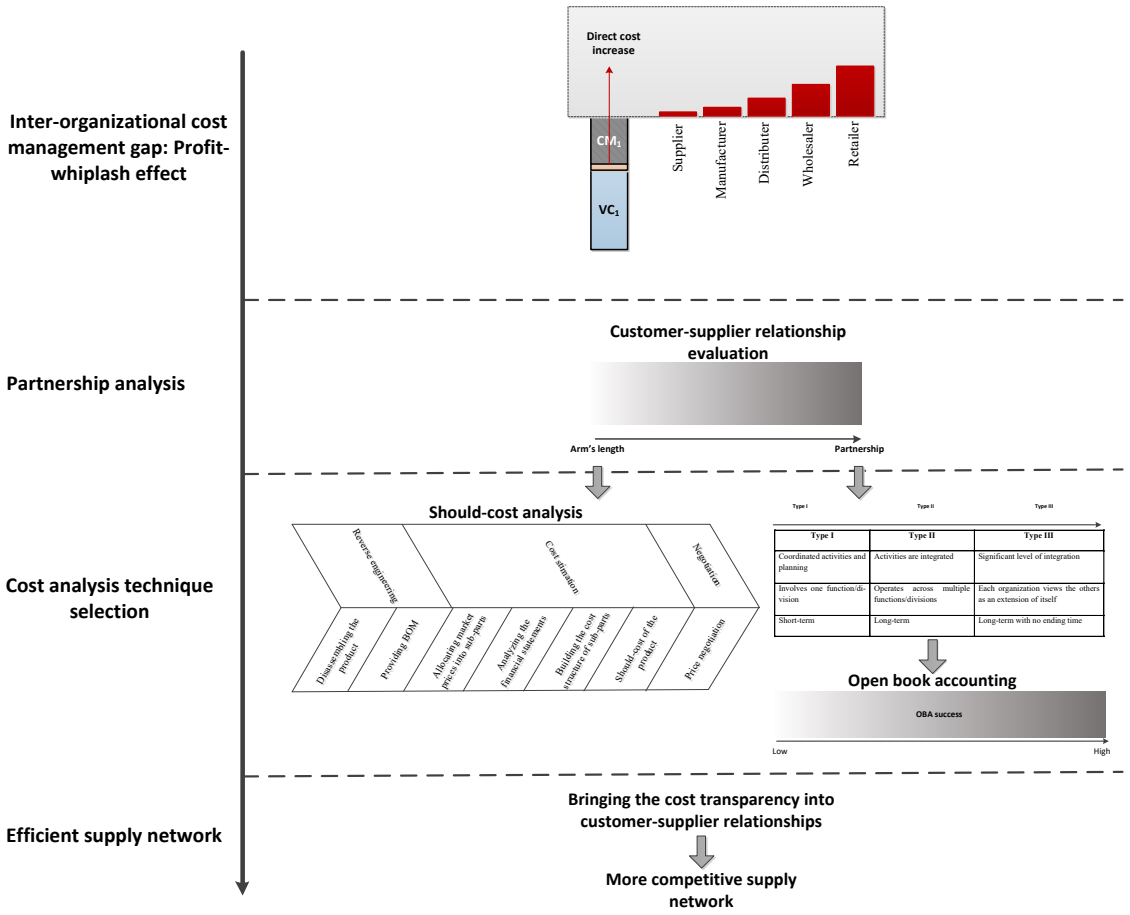


Figure 34. Cost analysis techniques in relation to customer-supplier relationship.

According to the above demonstration, for a non-commodity and highly engineered product with specific cost structure, a small material cost increase leads to profit-whiplash effect that is roughly larger than the original variable costs in early stages of a supply chain. In that sense, this is a major concern for should be the managements. Since this extra profit negatively affects the profitability and competitiveness of a supply network. As discussed, profit-whiplash effect as a phenomenon which occurs in supply networks due to lack of transparency and information sharing.

Inter-organizational relationship could be defined as a spectrum from arm's length relations to vertical integration and each one needs developing different accounting information flows amongst companies. In addition, an interfirm cooperative relationship development results in the accounting information flows amongst companies, which need to exchange and share their accounting information to reduce costs and create value (D'Atri, 2011). Therefore, the companies by conducting a relationship analysis can find

out the degree of their partnership with their suppliers. This analysis can be conducted by several frameworks like purchasing strategy analysis or cost analysis techniques that were introduced in the previous chapters. After conducting this diagnosis, from the open marketplace rules toward other alternatives, a company can distinguish the proper cost analysis technique for that certain type of relationship.

Relationships that are characterized as partnership involve some degrees of information sharing, openness and trust, coordination and shared benefits and risks. Therefore, OBA is seen as a proper approach to bring cost transparency to such supply chain with the aim of diminishing the profit-whiplash effect and so more competitive and efficient supply chain. However, for customer-supplier relationships characterized as arm's length relationships, limited joint development and a large number of suppliers, a focal company is more likely to tackle the profit-whiplash effect through conducting a should-cost analysis as a rather independent cost analysis technique.

6. THE CASE STUDY

6.1 The Case

Hose assembly industry has become a big business with different suppliers within its network and the products have a large market share in many product ranges. The range of hose assembly applications is highly broad which includes: for air and water, for steam and gases, for fuels, for solids and all kinds of chemical products. The case study was implemented in hose assembly sector of cars, heavy vehicles, mining and construction equipment industry. The provided case that was applied and tested is sourced from a company operating in mining and construction equipment industry.

A hose assembly can be categorized based on the material used in its metal and hose part, since depending on the hose assembly application the materials change dramatically. In addition, a hose assembly can be categorized based on being high-pressure or low-pressure based on the fluid pressure carried by the hose. The hose type, thus, changes from three layers to five or more layers. High pressure (hydraulic) hose assemblies are essential components of construction machineries that have a key role as fluid connectors between different parts.

There are a wide range of materials applied in both hose and fitting production industries; however, the options for a certain usage are not wide and there are particular answers for a specific need in a specific industry. A highly important issue is the fitting and the hose should match perfectly. On the basis of the weather exposure, pressure and process conditions, the lifespan of a hose assembly change notably. So, the hose assembly companies always are so careful to employ a proper fitting with a proper hose. Hence, the quality and productivity of the hose assembly can meet the customer needs only when all needs be balanced and considered for a flawless assembly. Figure 35 shows a relatively simple illustration of one of the machines and a hose assembly located in its lift arm.

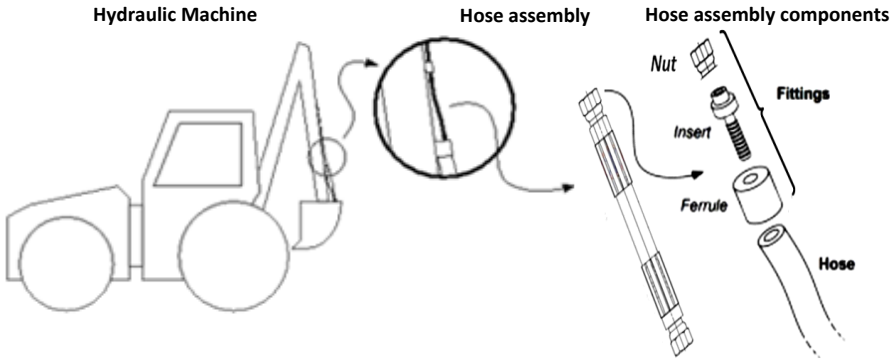


Figure 35. Hose assembly and its key components.

Any hose assembly includes certain type fitting and hose which are specific to an application. As illustrated in figure above hose assemblies, for most industries, are made up of two components: the hose itself and the metal component (fitting) including insert, nut and ferrule. In addition to the components, the way that the hose attaches the fitting is important. Fittings are manufactured in different sizes and from different materials. Fittings are always chosen based on the chemical compatibility and security of their connection with the hose. Therefore, any incorrect selection of the fitting and the hose can lead to catastrophic failures.

The figure also shows an insert and a nut are connected to each other as an integrated component with an extra operation (crimping) by the fitting manufacturer. Later, the hose assembly manufacturer connects the hose to the fitting by crimping the ferrule as the outer part. Any of these fitting's components are produced under specific standards and all mechanical and non-mechanical characteristics such as size, raw material and all the technical features are defined by the customers. Figure 36 shows an end of a hose assembly and its two parts, the hose and the metal part or fitting.

Figure 36. One end of a hydraulic hose assembly.

Depending on the hose assembly application and the gender of the connector (male or female), two fittings for hose's two sides are chosen. Therefore, one hose assembly generally is made up of one specific piece of hose and two types of fittings.

6.2 Supply Network of Hose Assembly

Empirical data was gathered from the hose assembly network including several companies. Companies in the hose assembly network are divided to groups including: an OEM which has the position of main contractor (is called henceforth as the OEM) representing a general view of OEMs in the hose assembly industry which is illustrated in Figure 37. The suppliers and subcontractor levels and customers are other groups than the OEM.

The hose assembly industry contains a series of relationships, material and information flow with the companies that contribute in buying and selling products from each other. As discussed earlier, to develop the supply chain' efficiency, the actors require to agree on increasing collaboration and information sharing. Have an insight over the product and information flow within this the hose assembly industry helps to decompose the supply network into subsystems and system elements from which the interactions are studied. A

relatively simple and general illustration of hose assembly supply network is demonstrated in Figure 37.

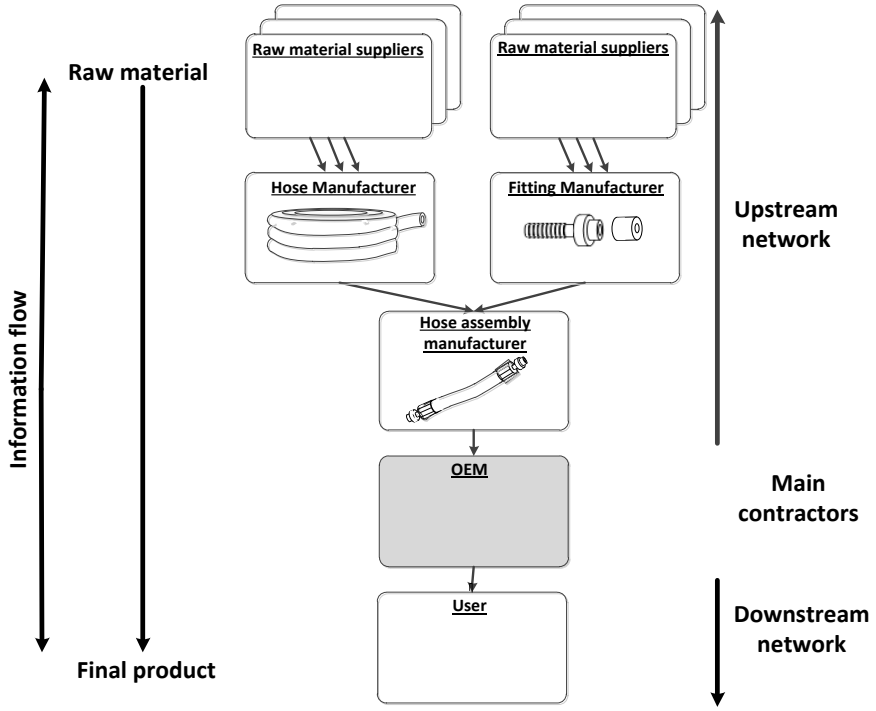


Figure 37. An illustration of hose assembly supply network.

This hose assembly supply network includes a supply side (upstream), production side (main contractor) and a customer side (downstream). In the figure above, the first and second tier hose assembly customers and suppliers are illustrated. The supply network consists of the fitting supply chain and the hose supply chain.

Hose manufacturing is a very capital-intensive business. Therefore, the hose markets are usually oligopolistic with a small number of firms, and the manufacturing companies are powerful players in the industry. The same conglomerates are fittings manufacturers. However, the fitting manufacturing is less capital intensive and, hence, that market is less concentrated. Hence, in addition to the big players, there are numerous smaller size companies which produce fittings. Hose assembly manufacturers, then, are rather small local companies purchasing hose and fittings from various suppliers and assembling them. Nevertheless, hose assembly manufacturing typically is located rather close to the OEMs.

Performance of this network is heavily depending on the effectiveness of communication and coordination among these business members. Since cooperation between the OEM and suppliers spreads upstream in the network, the OEM is also generally involved in sub-supplier's business processes. It refers to the need of a high degree of transparency for the collaboration.

The process of sourcing in the OEM can be roughly divided into three steps: starting the sourcing process, building individual supplier relationships, and occurrence of the procurement and the transactional process. Some conflicts sometimes appear when the price negotiations with suppliers are conducted. Since about some purchasing products like hose assembly, the OEM has access only to quoted prices meaning enough cost information is not available.

6.3 The Customer-Supplier Relationship

To understand the type of customer-supplier relationship in case of fitting supply chain, a general analysis as illustrated in Figure 38 is conducted. In this analysis, the OEM's purchasing strategy and thus the relationship between the OEM and its (potential) suppliers from 9 aspects is analyzed. This evaluation is based on an online and on-site investigation and involvement in the hose assembly industry.

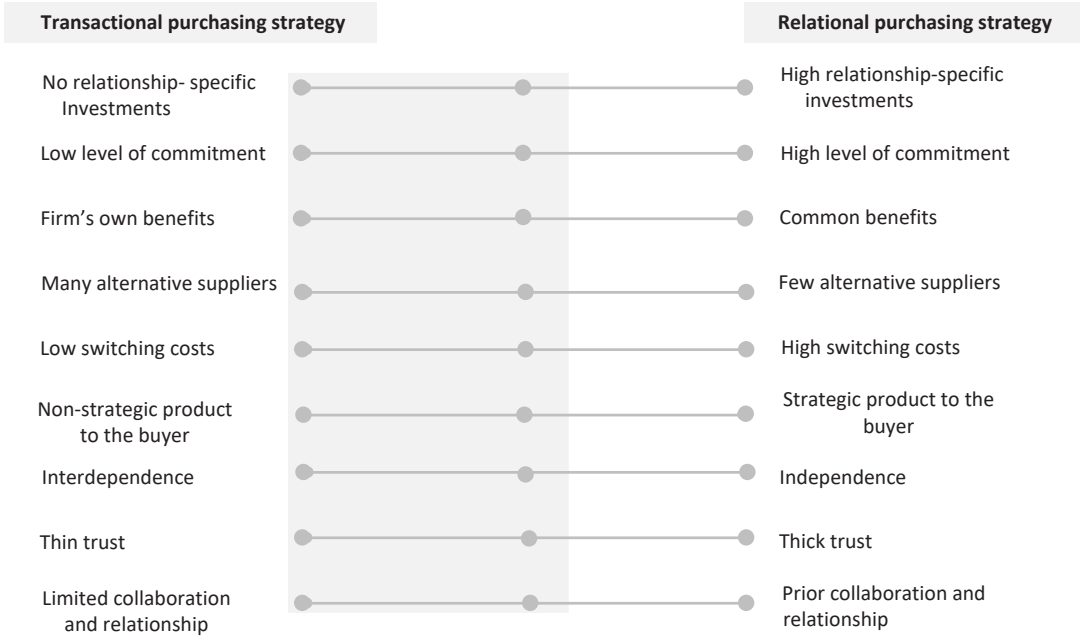


Figure 38. Purchasing strategy of the OEM (Modified from Agndal and Nilsson, 2010).

First, in regard to relationship-specific investments, the supplier and the OEM usually have a limited knowledge over internal processes of each other, and no improvement projects supplier developments are conducted in this industry. However, some production capacity might be allocated to the OEM by the supplier. Hence, a low relationship-specific investment was considered. Second, the OEM and its supplier often have a mediocre level of commitment. Since sharing future plans, extended contracts, and often few-supplier-policy is in the OEMs' favor. Third, the supplier is often expected to undertake continuous improvements through joint improvements. In that sense, the OEM's policy is benefits from joint improvements should be shared through companies involved. However, the large-scale suppliers of fitting are more focused on their own company's benefits

and self-interest. Fourth, for the OEM, there are few qualified alternative suppliers worldwide.

Fifth, changing supplier is associated with supplier evaluation and contracting, developing new relationship, developing control systems, and the brand would be affected when a certain brand is no longer applied. Moreover, strong negative reactions from the OEM can happen due to quality problems. Sixth, the product is rather strategic to the OEM. Seventh, the companies are relatively independent on each other, and short-term interdependencies could be seen. Eighth, openness and trust are important factors in joint problem solving; however, a concrete trust was not sensed in their relationship. Ninth, typically, there is a rathe medium-term relationship with suppliers.

Consequently, the purchasing strategy is more in between transactional and relational strategies rather than a pure transactional or relational purchasing strategy. It can be understood that the OEM and its suppliers have a form of partnership that is in its infancy rather than a mature collaborative partnership. (Figure 39).

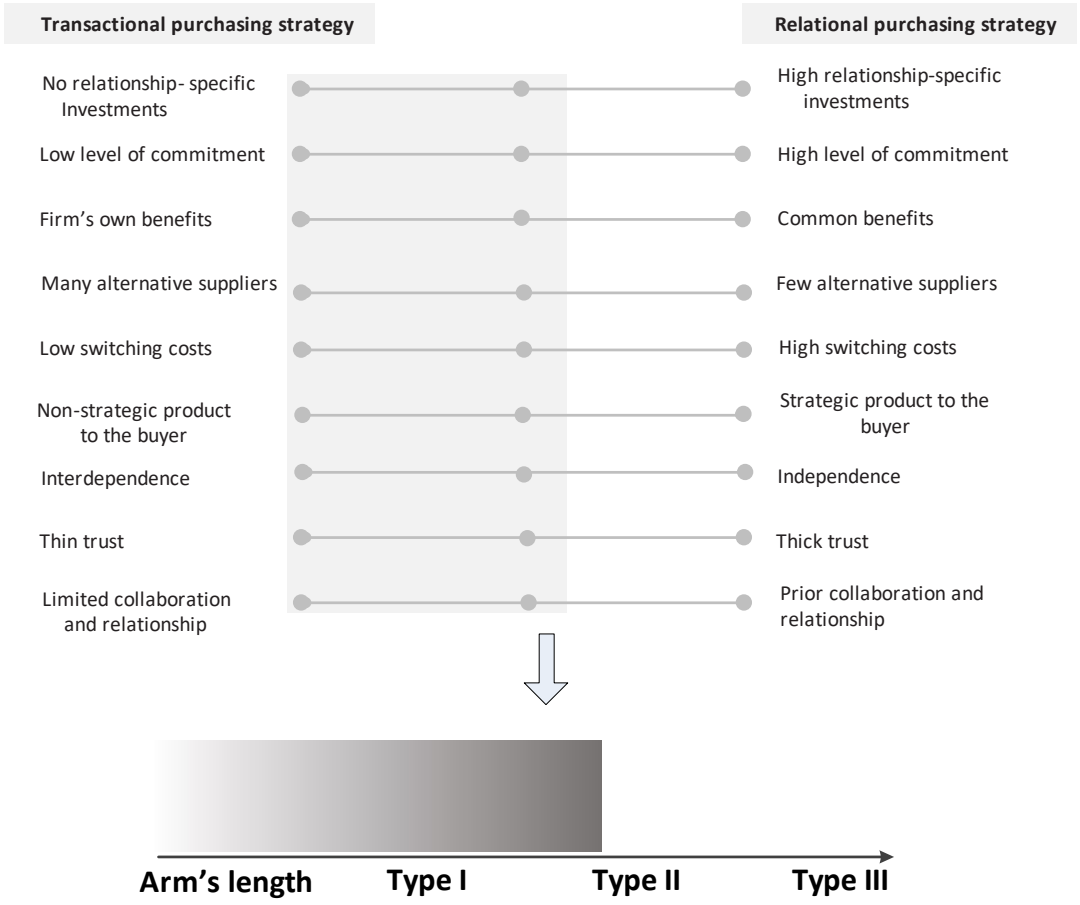


Figure 39. The relationship level of the OEM with its suppliers.

According to the discussion above, the relationship between the OEM and its fitting supplier is not a pure mature nor an arm's length relationship. As illustrated in the figure

above, minor coordinated activities and planning and short-term mutual goals locates their relationship in somewhere between arm's length and Type II partnership.

6.4 Price Sensitivity

In order to find out the degree to which an OEM can be affected by the material price fluctuation, a general-level price sensitivity analysis in hose assembly industry is conducted. On the basis of this analysis, an OEM is comparatively sensitive when the cost of the hose assembly increases unjustified, and it directly affects its willingness to pay for acquiring a product form a certain supplier. Nine factors shown in Table 3 are the indicators for this sensitivity identification. The degree of each factor is scored on the basis of low, medium, high scale.

Table 3. Measurement of price sensitivity.

	Effect	Sensitivity based on the effect
1	Reference price	Medium
2	Difficult comparison	High
3	Switching cost	Medium
4	Price–quality ratio	Low
5	Expenditure volume	High
6	End-benefit	Medium
7	Shared-cost	High
8	Fairness	High
9	Framing effect	Low

First, the fitting is not regarded as a commodity and there are not many suppliers or alternatives in the market. On the other hand, according to the analysis, an OEM has a rather moderate relational purchasing mindset towards its suppliers. Therefore, making an economical decision in selecting the supplier is not an easy task. The OEM, hence, is not affected highly by reference prices. Second, comparing the price and benefits of alternatives is not a difficult practice for the OEM, so, it leads to higher price sensitivity. Third, both monetary and non-monetary costs of changing supplier are relatively medium, because changing the fitting supplier is associated with several analysis and visits to evaluate it. Forth, the fitting quality is an essence for the OEM, while it can supply lower price and quality fitting from several Chinese companies, conversely, they prefer to stick to their slogan and apply high quality materials in their machineries. As a result, this factor has a low effect on price sensitivity. Fifth, the hose assembly supply expense usually accounts a large percentage of the OEM's available budget. In other words, a large percent of an equipment cost is usually the hose assembly costs. Sixth, the set of hose assemblies applied in a machinery are highly important for the OEM, seventh, the OEM usually both chooses and pays so is highly price sensitive. Eighth, the OEM believes the prices are fluctuating unfairly and so this leads to high price sensitivity. Ninth, the hose assemblies

are bought separately rather than as a part of a bundle, and the OEM does not see the price as a loss, so this effect has low effect on price sensitivity. According to this analysis, an OEM in hose assembly industry is relatively sensitive and careful towards the hose assemblies price fluctuations. Therefore, if all the market factors remain constant, a material price increase results in a drop in the demanded quantity by the OEM.

To sum up, this chapter argued the type of relationship of an OEM in hose assembly industry with its fitting suppliers. The analysis showed while the OEMs are often so sensitive towards the purchase prices, the relationship with the selected supplier can be spotted somewhere between arm's length and cooperative relationship. On the basis of this form of inter-firm relationship, the cost analysis technique can be chosen from leverage or strategic cost analysis techniques that was disused already by Ellram (1996).

7. PROFIT-WHIPLASH EFFECT

7.1 Hose Assembly's Price Fluctuation

Regarding the negotiation power, the OEMs are usually very strong players and are able to do OBA exercises with their local hose assembly manufacturers. In OEMs, OBA exercises happen regularly by sending the engineers to the key suppliers to look for ways to reduce costs in a collaborative manner and these engineers are usually welcome also to the hose assembly supplier.

Generally, an OEM uses a large volume of hose and a large number of fittings annually meaning costs of hose assemblies represent a large portion of the total costs of each manufactured machinery. Therefore, the OEM is highly sensitive and careful towards the purchasing price of hose assembly and the fluctuations of purchasing prices are challenging in such a competitive industry.

The problem is a substantial deal of effort and time are mainly needed to conduct a price negotiation. The customer-supplier relationship is highly fragile, because both the OEM as the purchasing company and the fitting supplier have a rather large enough power to force their desirable prices.

However, if the fitting supplier may have a rather larger market power, it sometimes exacts an unfairly high price from the OEM. In such, a business relationship can be easily damaged or at least maximizing long-term mutual benefits can be disappeared. In that sense, there is a need of a quantitative-based and an unbiased cost analysis which can support the OEM to establish a strategic relationship with the key suppliers.

When considering the purchase of products, the OEM has a number of key factors in mind for determining the reasonableness of the prices. It is not rare that the OEM suspects the purchasing price of the hose assembly is not often increasing the same as raw material cost increases in the upstream, which is due to profit-whiplash effect. A general cost structure of a hose assembly is shown in Figure 40.

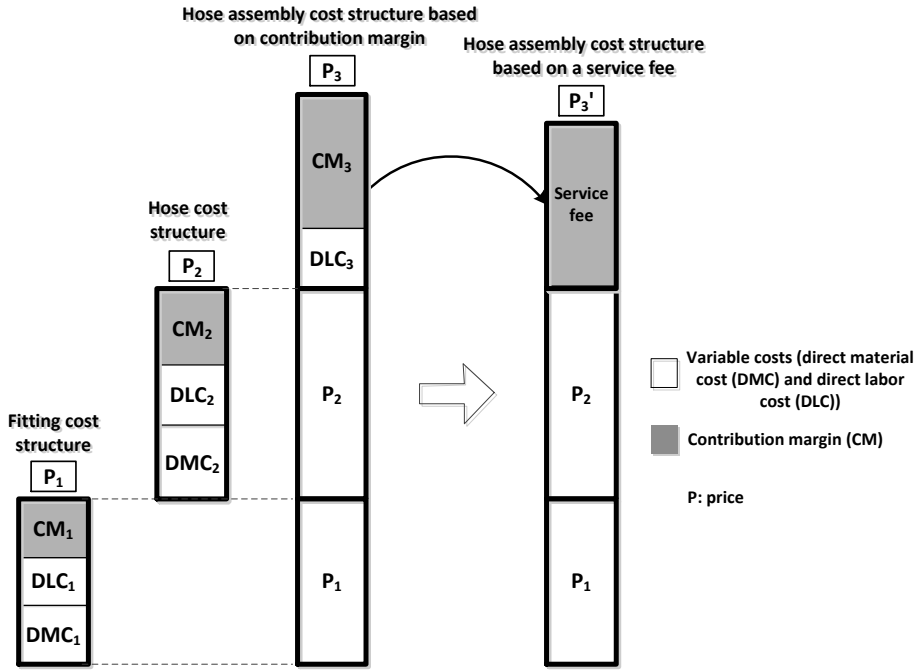


Figure 40. Cost structure of hose assembly constructed of fitting and hose cost structures.

As demonstrated, the purchasing price of a hose assembly is made up of the prices of fitting and hose itself. Due to profit-whiplash effect, any minor "unfair" profit in early stages of supply chain can be largely reflected and indicated inside the purchasing price of the hose assembly. The profit-whiplash effect negatively affects the profitability and competitiveness of the supply network which the OEM is involved. The figure above shows the purchasing price of a hose assembly is made up of the hose and fitting purchasing prices.

Purchasing price of fitting: $P_1 = DMC_1 + DLC_1 + CM_1$

Purchasing price of hose: $P_2 = DMC_2 + DLC_2 + CM_2$

Purchasing price of hose assembly: $P_3 = P_1 + P_2 + DLC_3 + CM_3$

Therefore, the reason of conducting a cost management practice like OBA by an OEM within the supply network is focusing on reducing the purchase price and simultaneously cost reduction as a more long-term benefit for its supply network

7.2 The Need of OBA Practice

For an OEM involved in hose assembly industry, managing the costs of the purchased hose assemblies is a hot issue from the view of supply chain competitiveness. Apart from importance of that issue, there are many approaches to cost management, so using the right cost analysis technique that supports this problem is an important task. As analyzed already, rather weak ties exist in this customer-supplier relationship. As the nature of the purchase is more ongoing and the degree of customer-supplier relationship is rather weak

(discussed in 6.3), a corresponding cost analysis model to this relationship can be OBA practice.

On the basis of this analysis and referring to Figure 39, OBA is a corresponding cost analysis technique that can be applied by the OEM to overcome the profit-whiplash effect. The OEM by applying the OBA practice pursues multi-goals: long-term benefits like advancing a mutual commitment and achieving agreements on the cost objectives and short-term goals such as price revisions of the suppliers' selling portfolio.

Tackling the profit-whiplash effect by bringing cost data transparency inside the fitting and hose supply chains can be the driver of the OEM to ask OBA practices from the hose and fitting suppliers (on behalf of hose assembly supplier). In other words, in order to avoid profit-whiplash effect, the company needs to collaborate with its different tiers suppliers to achieve long-term benefits for the whole supply chain. The reason behind conducting an OBA practice by the OEM within the supply network is usually focusing on cost reductions (rather than reducing the purchase price) as a more exhaustive result in a cooperative and trusting atmosphere and long-term benefits for all suppliers and also the customers.

A creative applied approach to tackle this effect at a dyadic-level relationship with the hose assembly company is discussed here. The hose assembly company can be convinced to charge a pre-defined constant "service fee" (SF) rather than adding contribution on top of variable costs (Figure 40).

$$P_3 = P_1 + P_2 + DLC_3 + CM_3 \rightarrow P_3 = P_1 + P_2 + SF$$

Therefore, the concept of profit-whiplash effect can be wiped off at the first-tier supplier and it needs to be monitored and controlled beyond the first-tier supplier in upstream (fitting and hose manufacturers). This study is continued with the focus on fitting manufacturer, because it provides a rather enough and comprehensive evidences for the practicality of this study.

The hose assembly manufacturers, however, are usually connected to global hose and fitting manufacturers. Hence, they had to use the brands they represented. Furthermore, unlike most local suppliers, those global giants have a bargaining power to avoid opening their books to the OEM. While the OEMs are large users of hydraulic hose, all the negotiations with the manufacturer supplying the fitting to the local hose assembly manufacturer to share cost information to some extent is likely to be failed.

Thus, despite the sales potential, the fitting manufacturer might not be willing to open its books. In Table 4, reasons behind the failure of OBA practices between the OEM and the fitting supplier are discussed, with the factors of 1, 6, 9 and 10 being the main reasons behind the OBA practice failure.

Table 4. Pre-conditions for OBA implementation by the OEM.

	Contextual factors	Description
	Exogenous environmental factors	
1	Degree of competition	High-quality fitting industry has relatively low-competition.
2	Economic trends	The companies can benefit from the growing economy.
	Network-specific factors	
3	Type of network	The network is highly mature.
4	Type of product	Fitting is a functional product. So, cost reduction is a priority.
5	Infrastructure	Involved companies have mostly developed cost accounting system.
6	Social nature of network relationship	A concrete "mutual trust" is not seen, because of an indirect relationship between the involved companies.
	Endogenous firm-specific factors	
7	Firm size	Involved companies are large-scale firms which are able to easily adopt new accounting methods.
8	Cost accounting systems	Involved companies have reliable cost accounting.
9	Competitive policy	The fitting supplier does not have any cooperative approach towards the OEM.
10	Commitment	The fitting supplier does not show a long-term commitment to the network.

Since the OEM strives to ensure fair prices pass through the supply chain, cost data can help it to negotiate for better price or deciding on an alternative product. As discussed, OBA implementation for a variety reasons can be failed, due to not having any of those options available, some other analysis to achieve the cost data are also interesting. Therefore, constructing the suppliers' cost structure independently enables the OEM to estimate all key cost elements of the fitting. The OEM management has an option of should-cost analysis to tackle the lack of OBA in this product category.

In regard to the first-tier supplier, the service fee for making a hose assembly is estimated with analyzing financial statements of hose assembly manufacturers and comparing it with their volumes. The service fee for making a hose assembly can be estimated with analyzing financial statements of hose assembly manufacturers and comparing it with their volumes. In this way, the profit-whiplash effect at first-tier customer-supplier relationship can be solved.

When it comes to implement cost analysis practices within second-tier supplier relationship like fitting supplier which are strong players in this industry, benefiting from creative ways like charging a constant service fee is not easy to accomplish practice. Therefore, a should-cost analysis for the fitting can be done independently by the OEM.

7.3 Should-Cost Analysis: Fitting

The product which is analyzed to develop and refine the should-cost analysis is fitting that is a part of the hose assembly. A hose assembly company buys the fittings from a supplier with a negotiated price. The should-cost of a fitting process is conducted on the

basis of the generic should-cost analysis process that was introduced in Chapter 5. The first step as the basis of reverse engineering involves identification of sub-parts of the fitting or disassembling connected components to their subcomponents. A set of fitting consists of an insert, a ferrule and a nut. Figure 41 is a depiction of a fitting and its sub-parts. This step is performed, and the information can be provided by relying on the should-cost analysis specialists.

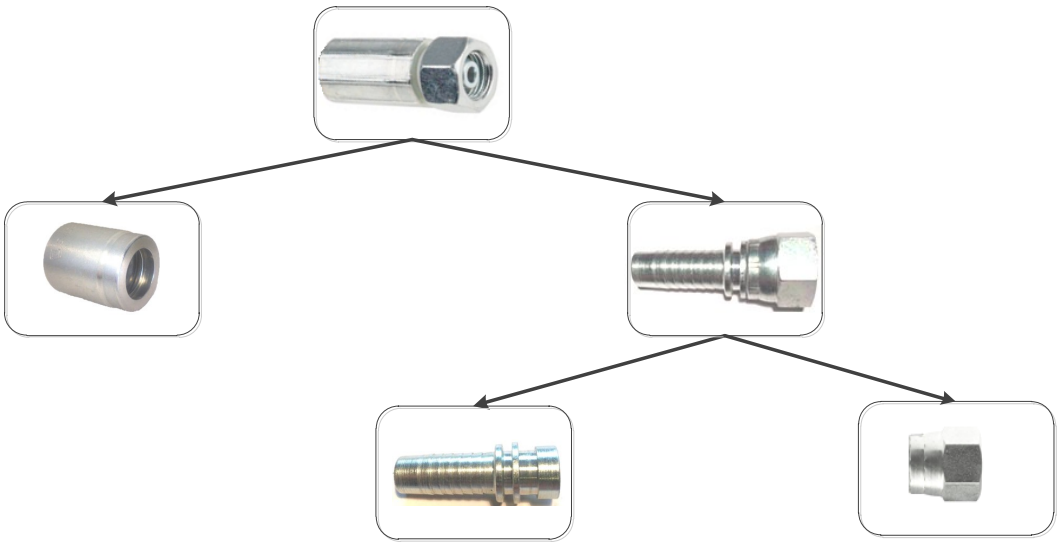


Figure 41. Disassembling fitting to its identifiable sub-components.

This step to get to the lowest level identifiable sub-parts is usually a destructive step. It means the hose assembly first needs to be divided into two parts, the hose and the fitting. Hence, the ferrule needs to be teared up, then, the result includes the hose, the fitting and the ferrule. Later, in order to separate the nut from the insert, the nut needs to be teared up as illustrated right in the figure above. The second step is developed with the aim of estimating the raw materials used to produce insert, nut, and ferrule. This step as the second step of reverse engineering process refers to identification of the raw material and their manufacturing process. For fittings, the primary raw material used is AISI 316 stainless steel. Fittings are mostly fabricated though two manufacturing processes: casting or machining (lathing) or a combination of them. The should-cost team at the OEM are responsible for this investigation. They usually apply the blueprints and BOMs to investigate which process is applied by a supplier. The hose assembly company orders the fittings according to the standards which the OEM provides. The hose assembly company is sourcing the fittings from a supplier which manufactures all three components by lathing or machining. Thus, in order to find out a rather accurate cost structure of fitting's parts, the raw materials used in different parts have to be calculated.

Figure 42, 43 and 44 depict reverse engineering process that the OEM follows to gain the needed cost data of insert, ferrule and nut. The process starts from dimensional inspection to figure out the amount of the raw materials used in each component by fitting manufacturer. So, this step is measuring dimensions of components and their weight for estimating

raw materials used by the manufacturer. The OEM needs to figure out how much raw material is used to fabricate the components.

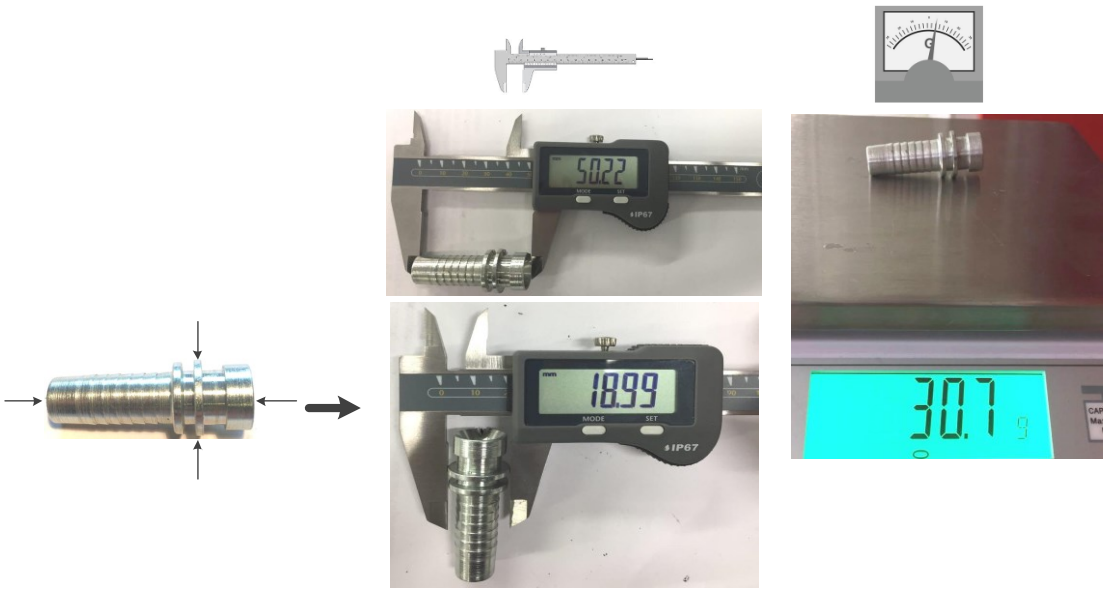


Figure 42. Measurement of dimension and weight of the insert.

As illustrated above, an insert is a round piece of steel which its weight, length and its largest diameter are measured. Similarly, Figure 41 shows a ferrule is a round piece of steel and its length, diameter and weight are measured.

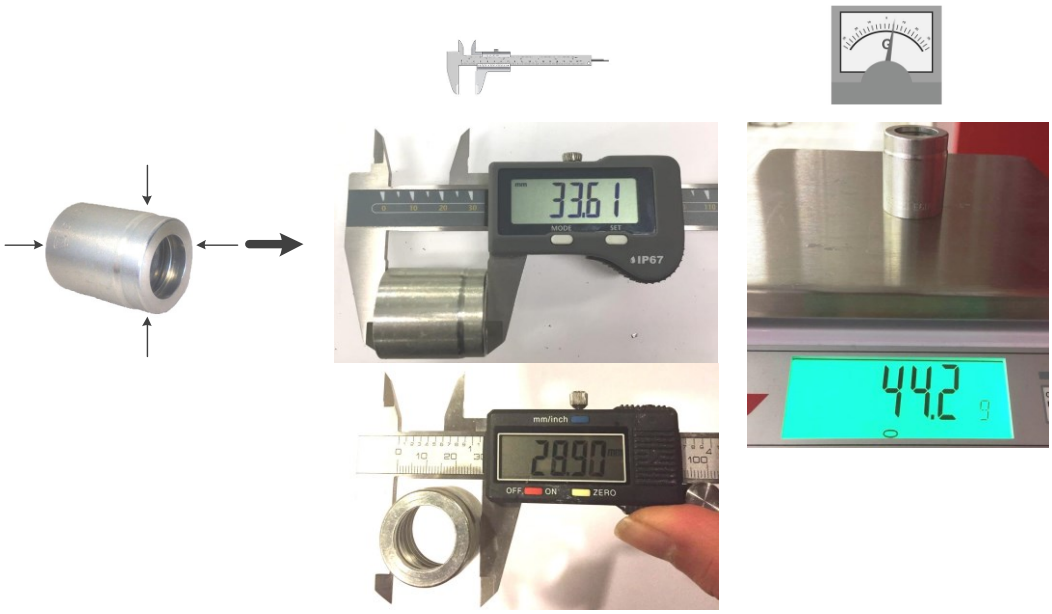


Figure 43. Measurement of dimension and weight of the ferrule.

Finally, As demonstrated in Figure 42, a nut is a component with six sides (hexagon). Therefore, its length and the minimal diameter besides its weight are measured.

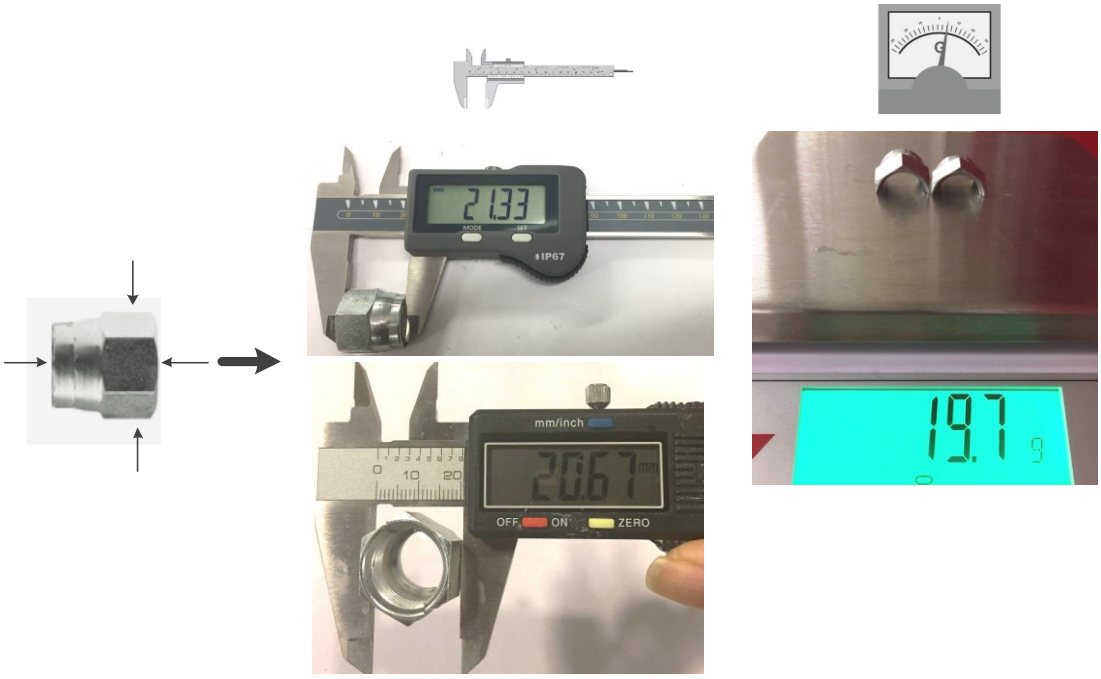


Figure 44. Measurement of dimension and weight of the nut.

Table 5 illustrates a summary of the conducted measurements.

Table 5. Measurement of sub-components.

Sub-component	***Base area***	***Dimensions (mm)***			***Weight (gr)***
		Length	*Diameter*	*Minimal diameter*	
Insert	*Round*	*51*	*20*		*31*
Ferrule	*Round*	*34*	*30*		*45*
Nut	*Hexagon*	*22*		*21*	*20*

This step will be completed after figuring out the amount of raw material used for each sub-component. To estimate the amount of raw materials (round and hexagon steel bars) used in each sub-component the information in table above is applied. As explained earlier, the chemical compound (steel grade) that the OEM foreknows is AISI 316 stainless steel. To ensure the material, the OEM by applying an instrument which is user friendly with easy operation can provide very accurate analysis of metals, quickly and efficiently. Therefore, chemical composition of a piece of steel like fitting is not a complicated and expensive task. However, it should be mentioned that unlike the fitting, the chemical analysis of a piece of hose is a more complicated and expensive practice.

In order to calculate the sizes of hexagon and round bar needed as direct materials to fabricate a set of fitting, dimensions of components are applied. As illustrated in Figure 45, the raw material used to fabricate an insert is a round bar with the diameter of around 20 mm and the length of approximately 52 mm. It is notable that choosing a round bar for this purpose results in easier machining process.

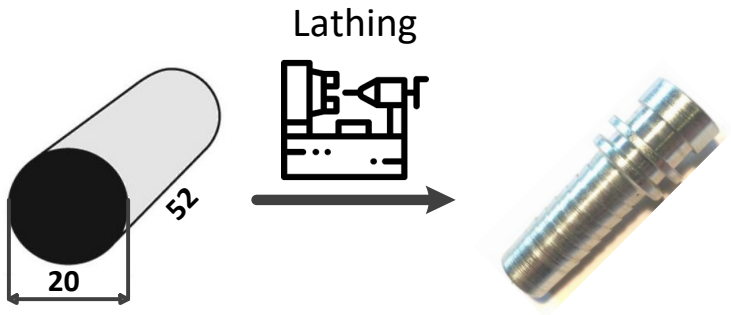


Figure 45. The steel bar needed to produce an insert.

Manufacturing ferrule takes the same logic as insert. A round steel bar with the shown dimensions shown in Figure 46 is the best raw material option to fabricate this component.

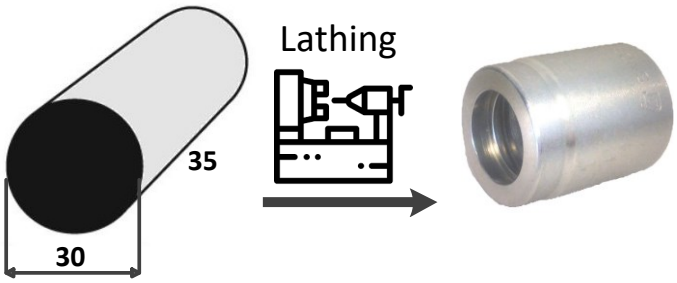


Figure 46. The steel bar needed to produce an insert.

As illustrated in the Figure 47, a nut is a component with six sides, so it is easier to choose hexagon bar as the raw material and then machining that to fabricate a nut. Hence, reverse engineering helps the OEM to figure out how much of hexagonal steel bar is needed to produce a nut. Based on the measurements, the raw material which is used in a nut before lathing is a hexagonal bar with the length of around 22 mm and the diameter of about 21 mm.

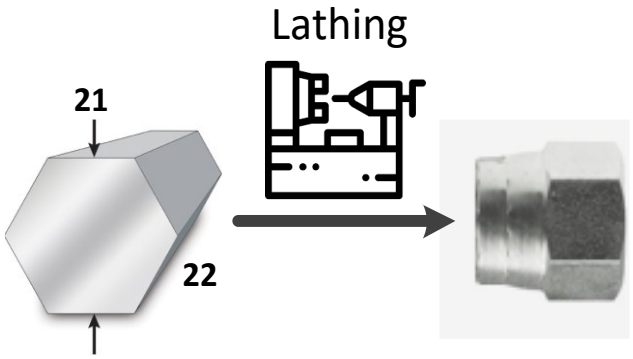


Figure 47. The hexagonal steel bar needed to produce a nut.

As Table 6 represents, sizes of round and hexagon bars needed to produce insert, ferrule and nut are found out. However, it is important to take the cutting-kerf of manufacturing taken into consideration. In that sense, a margin is added to the final products' lengths.

Table 6. Reverse-engineered bill of materials of fitting.

Sub-component	Steel grade	Base area	Dimensions (mm)			Direct material (kg)	Price per kg	Direct material cost ($)
			Length	Diameter	Diameter (side to side)			
Insert	AISI 316	Round	52	20		0.52	6 $	3.13
Ferrule	AISI 316	Round	35	30		0.79	6 $	4.75
Nut	AISI 316	Hexagon	22		21	0.07	6 $	0.4

Besides the direct raw material weight and dimensional information, the direct raw material costs are also represented in the figure above which refer to the third step of should cost analysis. Throughout the manufacturing processes, the procurement specialists involved in the should-cost analysis process determine AISI 316 steel is used in fitting fabrication. Then, this obtained information need to be linked to the market prices of the raw materials to determine also the material cost of each part. As illustrated in the table above, the direct material costs of fitting parts are accurately estimated. However, this is not the end of the should-cost analysis process.

The OEM by analyzing publicly available financial statements of its fitting supplier will be able to also estimate the labor cost per product unit to be added on top of the material costs. Then financial statements of the companies within the same industry can be analyzed to define an appropriate contribution margin, taking into account the return on capital deployed in the business. The result will be the cost structure and price estimation of each component of a fitting. Finally, an estimation of the final SCA of the produced product by summing SCA estimations of the insert, the ferrule and the nut can be available.

As it was earlier explained, the OEM to strengthen its negotiation power needs to conduct a test on the basis of should-cost analysis technique to obtain the necessary visibility to the cost structure of the hose. The reverse engineering of the hose needs to be done in a rubber laboratory which this analysis is considered beyond the scope of this thesis.

7.4 Should-Cost Analysis as a Tool for Cost-Reduction Negotiations

In this section the should-cost analysis, its results and its effectiveness in the hose assembly industry are discussed. As earlier discussed, the estimated price as the should-cost analysis output is considered as an asset for OEMs involved in hose assembly networks. The main aim of conducting a should-cost analysis in this industry was to show how this technique can support the main contractors by employing a detailed understanding on the procurement to deliver the products at a right price which increases the efficiency and effectiveness of a company and its network in the highly competitive market.

According to previous discussions, companies need to have a rather accurate estimate of the real price of products which they purchase. In order to provide it, different alternatives like open book accounting can be used to discover this blind spot of supply chain, however, if the supplier cannot be persuaded to use open book accounting, should-cost analysis framework can play a powerful role in the price negotiation.

It was shown if an OEM does not have access to purchased product cost structure to figure out an accurate cost structure, it is very likely that the fitting producer puts contribution on top of the direct material cost increase called profit-whiplash effect. The results and findings obtained from this study were in correlation with the literature. Dimensional inspections and reverse engineering provided a rather accurate result that shows how important the framework of should-cost analysis is for an OEM to analyze the fitting price fluctuation within the supply network. Stated in another way, when the cost structure is known, the customer can avoid paying more than real sales price and ensure that the price increases are justified.

In an industry like the automobile industry, a private vehicle includes at least four hose assemblies (eight fittings) only for building the brake system of the car. Based on the should-cost analysis calculation performed in this study, the value of only brake system's fittings could be on average over $ 30 (USD) per car. However, there are many other parts like steering hoses that contain many other fittings with particular and more expensive materials because of higher sensitivity. It is also important to notice as explained hose is another main part of a hose assembly which rather expensive component is. Therefore, for a car company with a production volume exceeding 1 million cars, there is a massive potential for cost reduction. Because, this industry is considered as a highly lean and competitive industry. Minor cost reductions, also, can enhance the competitiveness of the network dramatically.

Therefore, should cost analysis can be considered as one of the most important and necessary cost reduction techniques can be employed by the top tier OEMs. Because the OEM by applying this technique will not be any more relying on the price decision that its suppliers make, which sometimes are rather strong players.

After conducting the empirical analysis on the fitting, the obtained cost data information can be a valuable proven tool applied by the OEMs to uncover and lead a successful fair and reasonable price negotiation with their suppliers. In other words, the OEMs access the critical cost information for a judicious price negotiation. However, the result of these price negotiations is not necessary in the favor of the fitting or hose suppliers. Therefore, the OEMs will be able to uncover the best possible value for their purchases meaning convincing the supplier to provide the OEM with justifiable certain offer or a price level. Figure 48 shows this discussion visualized.

On the other hand, many high-quality fitting and hose manufacturers might not be convinced or persuaded to lower their prices or avoid the profit-whiplash effect. Because they may see this phenomenon as a profit in favor of many supply members.

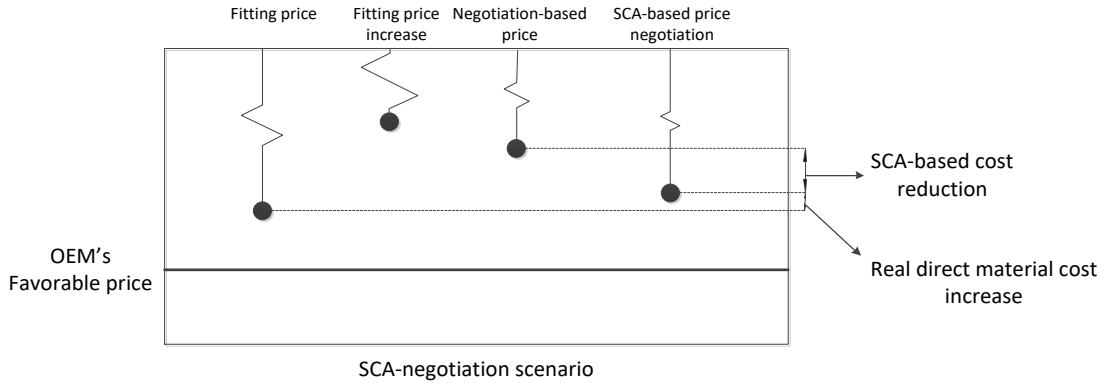


Figure 48. SCA-based price negotiation (Modified from Hiller, 2012).

The figure above is an illustration of comparing the effectiveness of the price negotiation and SCA-based price negotiation over the sales price of a fitting. As illustrated, when the direct material cost increases, the OEM without any access to cost information is not easily able to persuade the fitting supplier to avoid the profit-whiplash effect. On the other hand, a negotiation supported by a rather decent SCA is more likely to lead to a cost reduction by bringing the cost transparency into the customer-supplier relationship. Therefore, the fitting supplier will be in a situation to justify a certain offer or a new price level.

8. DISCUSSION AND LESSON LEARNED

8.1 Overview of the Problem and Framework

Recently, supply chain has been seen as one system as Ritter (2000) stresses no business is isolated and operating independently in business world. All firms are dependent on other firms' collected resources and an individual company is not able to compete in today's fierce business market for the reason of high customer demand and extreme competition. A comprehensive relationship between supplier and customer provides additional values for both customers and supply chains (Banchuen et al., 2017). Moreover, Hall and Saygin (2012) conclude that the literature of SCM present that better information sharing through supply chain results in shorter lead times, lower inventory levels, lower batch sizes, quick product development and shorter order fulfilment cycles. Concerning meeting the needs of customers as the goal of supply chain, both internal and external integrations are required (Harrison et al., 2014). A detailed understanding on the procurement processes and its implementation increases the effectiveness and efficiency of a firm in the highly competitive market. Moreover, companies are facing challenges like products delivery to the customers at the proper time, price and place. Therefore, the need of establishing better models than the existing conventional customer-supplier relationship can be addressed to go through the mentioned difficulties.

Business performance is positively proportional to broadness of partnership and the 'balance' of that, hence, as the integration level with partners within the supply chain increases, the potential benefits also grow. Moreover, the broader integration lowers the uncertainty related to material flow in the supply network (Harrison et al., 2014). Knoke (2001) explains several types of inter-organizational relationships are established with the aim of avoiding market uncertainties and gaining mutual benefits. Cooperative agreements can be classified in main groups that pure market transactions (no need to cooperation, coordination, or collaboration) and hierarchical authority relations are two extremes of this spectrum. Hybrids are formed of different degrees of bureaucratic integration and market transactions are located in this between (Knoke, 2001). A rather clear classifying of varieties of inter-organizational relationships in five groups includes: arm's length, partnership, strategic alliance, joint venture, and vertical integration.

Moreover, the profit- whiplash effect due to the cost increase is often an underestimated concept in the context of IOCM, while it can be significant. The introduced concept of profit- whiplash effect shows a minor "unfair" profit in upstream leads to an amplified profit in downstream bore by final customers which influences negatively the competitiveness of the supply chain.

In addition, an inter-firm cooperative relationship development results in an accounting information flow amongst companies needing accounting information exchange to reach a reduce costs and create value. Consequently, a result of this inter-firm cooperative relationships is an incremental application of IOCM, that includes cooperative activities of companies to obtain value creation and cost reduction (D'Atri, 2011). Hence, the approaches which the companies can take to tackle the profit-whiplash effect is highly relevant to the form of the relationship of the customer and the supplier. Figure 49 shows the major framework proposed by this thesis.

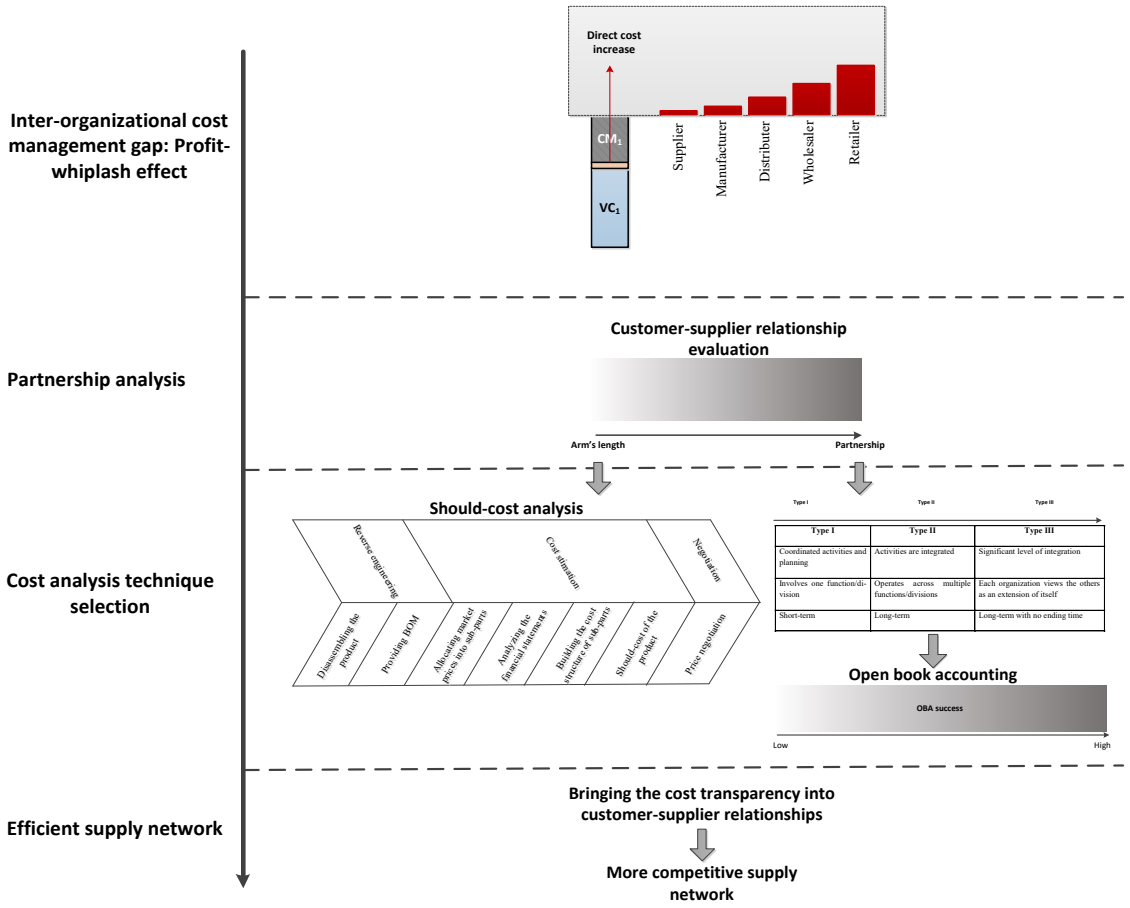


Figure 49. Framework of thesis.

Figure 49 helps to first recognize the purchasing strategy of a customer and so customer-supplier relationship, and then locating it on a partnership continuum to assess the successfulness of OBA or SCA implementation. Relationships that are characterized as partnership involve some degrees of information sharing, openness and trust, coordination and shared benefits and risks. Therefore, OBA is seen as a proper approach to bring cost transparency to such supply chains with the goal of tackling the profit-whiplash effect and so more competitive and efficient supply chain. On the basis of OBA characterizations, this cost management technique can be a practice offering robust outcomes within inter-firm cooperative relationships seeking a long-term goal, because the companies can have the benefit of joint-cost reductions (D'Atri, 2011) like tackling the profit-whiplash effect. Therefore, OBA is most likely successful in rather relational purchasing strategy.

However, for customer-supplier relationships characterized as arm's length relationships meaning a limited joint development and a large number of suppliers, a focal company is more likely to tackle the profit-whiplash effect through conducting a should-cost analysis as a rather independent cost analysis technique.

8.2 Reflection of the Case in Framework

The hose assembly supply network consists of crossing of fitting supply chain and hose supply chain. Firstly, hose manufacturing is a very capital-intensive business requiring large amount of investment in purchasing, capital equipment amortization, and maintenance. In that sense, there are a few numbers of manufacturing firms in this industry and they are rather powerful players. Secondly, while the fitting manufacturing companies are less capital intensive, conglomerates also manufacture fittings and they are still major business players. In addition, capital intensity as a barrier refers it is challenging for new entrants to start operating in fitting (large-volume) and specially hose manufacturing industries. It can be understood, thus, the type of relationship of the focal company and its suppliers is a determinative aspect of the success of its supply network.

Since hose assemblies are important parts in the cost structure of one machinery, the company has interests to open the books regarding hose assemblies to avoid the profit-whiplash effect. Thus, the target was to have visibility on raw material and manufacturing costs of hose and fittings as well as their contribution margin. In addition, the plan was to pay a fixed service fee to the hose assembly manufacturer, again based on open books. In that way, the profit-whiplash effect would no longer increase the contribution in any member within the supply network. In other words, the OEM would accept increases in the global prices of raw materials; however, it would not allow changes in them to increase the contribution in any chain member. The initial cost structure of a hose assembly is illustrated in Figure 50.

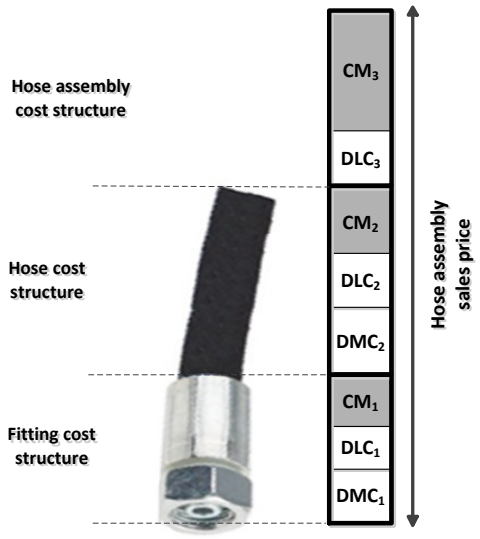


Figure 50. Cost structure of hose assembly.

The above figure shows a hose assembly's cost structure is made up of three sub-cost structures including cost structure of fittings, hose and the service cost of the hose assembly company. The profit-whiplash effect can negatively affect the profitability and competitiveness of the supply network which the OEM is involved. Hence, avoiding this phenomenon by bringing cost data transparency into the fitting and hose supply chains is the motivator of the OEM to ask OBA practices from the hose and fitting suppliers. However, in this study the focus is limited on the fitting manufacturer.

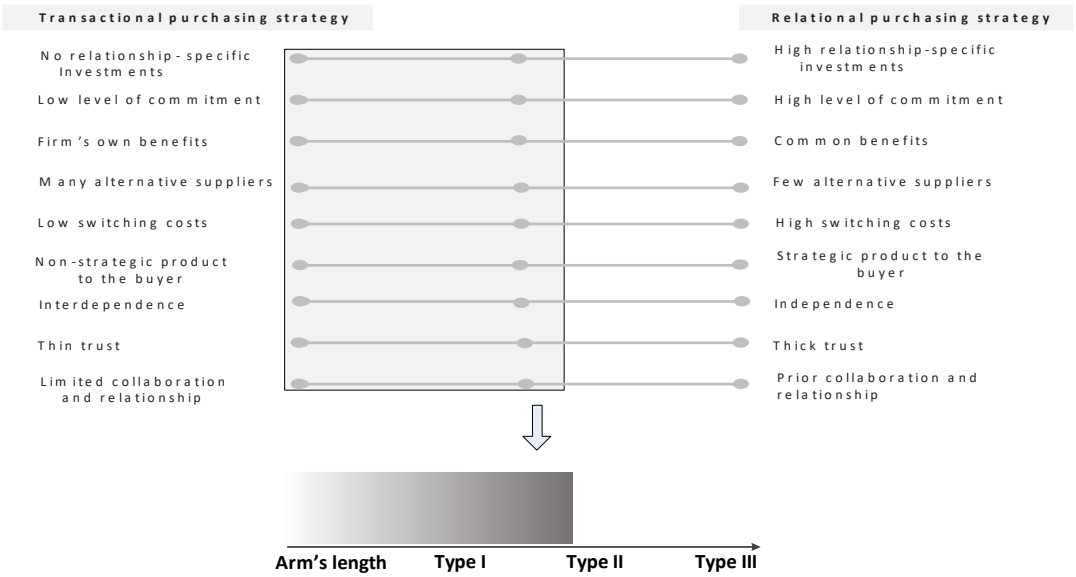


Figure 51. The relationship level of OEM with its suppliers.

Based on the analysis above in Figure 51, the OEM can take either OBA or SCA to take actions against profit-whiplash effect. However, despite the fact that OEMs are mostly large-scale companies, none of the fitting manufacturers might have the willingness to exchange and share their cost data with the company. Reasons of why OBA practice is not an option in such circumstances were discussed earlier. Therefore, the management of the company needs to take the other alternative solution, conducting a should-cost analysis practice. The main reason behind conducting a should-cost analysis is to enhance the supply network's efficiency by bringing the cost transparency into the customer-supplier relationships at different tiers.

8.3 Analysis of the Proposed Solution

As it was explained, for several reasons it was not easily possible to persuade the fitting supplier to open its books. Therefore, the profit-whiplash effect remains a challenging issue in a supply network that do not favor the increase of sales prices. However, employing should-cost analysis to replace the lack of OBA practice in this product category is a proposed alternative. Figure 52 demonstrates the application of the should-cost analysis process in case of the fitting manufacturer. To strengthen the negotiation power, the OEM needs to conduct a should-cost analysis technique to bring the necessary visibility to the

cost structure of the fitting with the aim of conducting a price negotiation to agree with the supplier on a justifiable sales price.

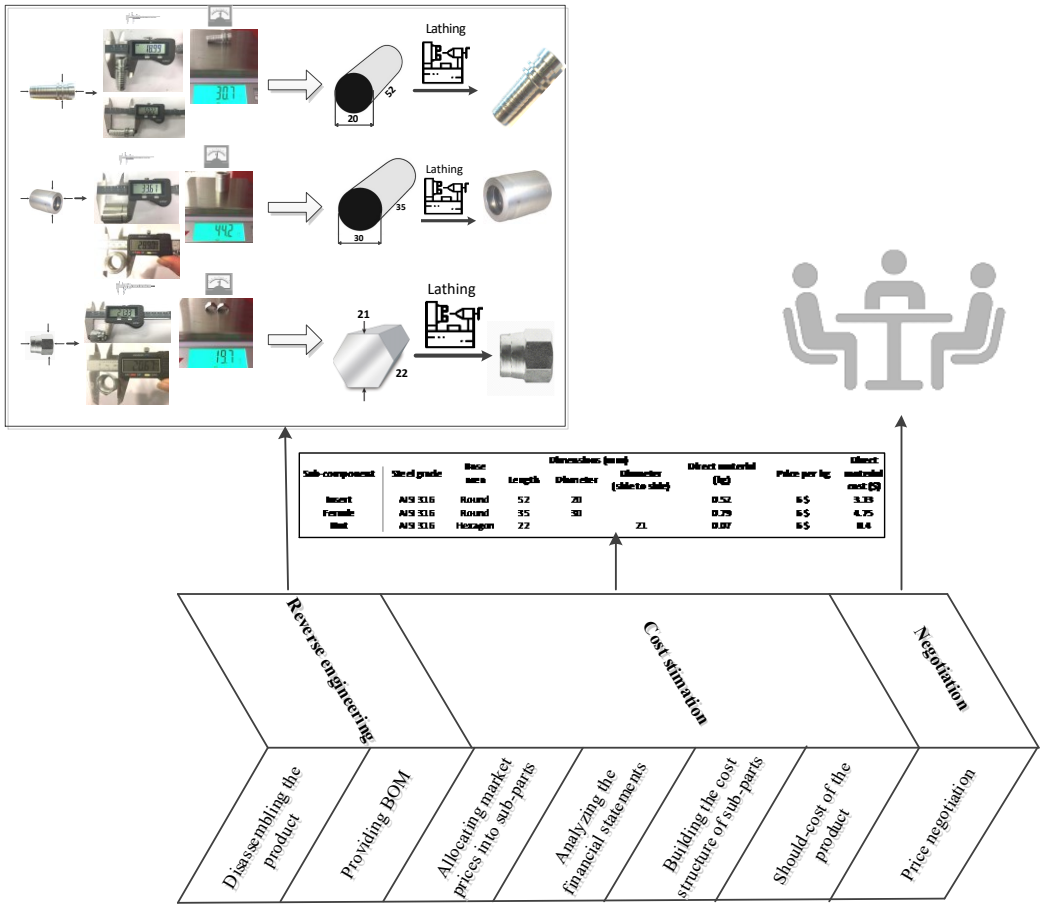


Figure 52. Conducting a SCA by the OEM.

The figure above shows the should-cost process is started by disassembling the fitting into its sub components. This step is to get the lowest level identifiable sub-parts is usually a destructive operation. Hence, the result of breaking down a fitting is three sub-components of insert, ferrule, and nut. The next step is to develop an estimation of the raw materials used to produce insert, nut, and ferrule. This step is the second step of reverse engineering process which refers to identification of the raw material and their manufacturing process. For fittings, the most used raw material is AISI 316 stainless steel. The process continues from dimensional inspection to figure out the amount of the raw materials used in each component by fitting producer. Then, linking this obtained information to the market prices of the fitting's raw materials to point out the material cost of every part, as illustrated the table in the middle of the figure above.

The should-cost analysis continues by analyzing publicly available financial statements of the fitting supplier to estimate the elements of the cost structure of the fitting to be added on top of the material costs, and finally, an estimation of the overall should-cost of

the produced fitting. These steps were considered beyond the scope of the focus of this study. Since the obtained data are satisfactory for the price fluctuation negotiations.

The accuracy of the SCA is a key in successful price negotiations with the suppliers. Since the fitting supplier is likely to try to challenge the assumptions with the intention of turning the price negotiation towards its side. Therefore, having an eye on the accuracy is an advantage which enhances the credibility of the OEM.

A successful negotiation is the last step of the should-cost analysis process. This analysis enables the OEM to negotiate with the fitting supplier for a fair profit margin. Even if the costs analysis is not completely accurate, the fitting supplier might point out precisely what is wrong and back it up with real cost data, and a better understanding of true costs will be achieved.

8.4 Analysis of the Results

A good should-cost model is more than an opportunity for negotiating cost savings during negotiations. Indeed, it is an opportunity for a board cost reduction. This approach enables the OEM to take actions free from the adversarial relationships against the profit whiplash effect which is a sustainable competitive advantage for the supply network. With a good should-cost model, it is not only possible to understand how much is spent on each fitting, but which sub-components are the most expensive. It can then be focused on the most expensive components one by one, determine why that particular component's cost is high and determine if the OEM can help its fitting supplier to reduce that cost or if it should be looked for a supplier substitution. In addition, this tool while having effective consequences for the OEM, has some limitations and inabilities in its implementation process and sourcing decisions.

For OEMs as purchasers time is a vital issue. Hence, the purchases are supposed to optimize the delivery times besides reducing the costs. Hence, it is important to notice this approach should not compromise other important factors in this industry like the quality and delivery time. Thus, the companies need to choose their business partner based on its value, not just lower price.

In addition, there are some limited investigations of SCA in services sector. It means the SCA worked properly for fitting supply chain, but not necessarily for services provided by the fitting supplier. In addition, a full-implemented should-cost analysis for fittings calls for access to the financial statements of the supplier. Geographic limits are another limitation for the should-cost approach, as the publicly available financial statements of suppliers are often needed. However, these sets of information are not always available for potential suppliers from other countries like China.

Regarding the potential future research, according to the research material and interactions with the project representatives, it is identified there are some potential and untouched areas to develop capabilities of SCA to bring up new managerial implications from the outputs and results derived from this study. These addressed implications are somehow on the basis of the limitations were discussed earlier.

Regarding SCA in the service sector, the SCA approach supports properly the products; however, there is an area for further investigation to figure out its application in service context. Hence, the should-cost analysis needs further in-depth studies towards the process of should-cost analysis of services provided by the suppliers.

Considering the geographic expansion, this research shows this process can lead to a favorable result by having access to publicly available financial information of a supplier, like tackling the profit-whiplash effect. Nevertheless, when considering the global sourcing, some limitations can be considered. Therefore, further studies need to be conducted to investigate some general approaches towards the financial analysis of the suppliers with no easily accessible financial information.

Practicing should-cost analysis is associated with an exhaustive understanding on different elements of cost structure like labor costs and overhead. Therefore, more studies towards deriving the cost structure elements from financial statements of companies to introduce new accurate approaches like labor rates should be considered.

Even should-cost analysis as an alternative to open book accounting can be failed. This refers to circumstances when this cost analysis technique conducts price negotiations with asymmetrical suppliers. Therefore, it is not inevitable a high-quality supplier resist against any cost reductions based on the should-cost analysis conducted by the customer. Moreover, the profit-whiplash effect as a rather favorable profit for a supply chain's members might not be seen necessarily as a negative phenomenon and it can bring up some conflicts. Some alternative ways to manage such situations need to be investigated.

Moreover, not many organizations benefit from a well-functioning should-cost analysis in their sourcing activities. It seems this approach is more related to the culture and strategy of a company, hence, a culture of what a product should cost before asking for quotes is another area needing further studies.

Finally, regarding the limitations of the thesis, the empirical study was performed on the basis of interviews with people who have been involved in this area, several visits to the companies and author's three-year-experience in the hose assembly industry. Moreover, the study was conducted and tested on a single product or fitting in this industry. Because the should-cost analysis for other components like the hose is associated with several technical complexity which were beyond the capabilities of this study. Consequently, before generalizing the results and the framework, they might need to be implemented and tested in further cases and industries.

9. CONCLUSIONS

Outsourcing the manufacturing work leads to value creation in the whole supply chain (Baiman and Rajan, 2002). Managing costs and profits within the supply chain is considered as a crucial prerequisite for enhancing the competitiveness of a supply chain. When components and products flow through supply network, the current pricing practices easily result in accumulated profit, called "profit-whiplash effect". Understanding the dynamics of cost behavior as well as the possible profit-whiplash effect is needed for managing those costs and profits (Suomala et al. 2010). Open- book accounting has been used for this purpose and examined in the accounting literature (Agndal and Nilsson, 2010; Kajüter and Kulmala, 2005).

This study was performed to contribute to the inter-organizational cost management literature to classify the customer-supplier relationships based on their level of dependency with the intent of providing a cost analysis technique in correlation with the form of relationship. Therefore, should-cost analysis and open book accounting techniques were located on a continuum of customer-supplier relationship from arm's length-oriented to more partnership and collaboration-oriented relationships.

Under certain circumstances, the parties involved are unable or unwilling to open the books and thus alternative viewpoints are desired for the purpose of competitiveness of the supply chain, and more particularly, to meet the objectives of the OEMs and focal companies. The study presented should-cost analysis technique constructed on reverse engineering process to obtain the necessary visibility to the cost structure of the supplier in an independent manner. Agndal and Nilsson (2008) state ensuring the supplier is acting in line with purchaser's wishes and also increasing supply chain's efficiency through collaborations are some purposes of OBA and data disclosure. Reasonably, following the process of should cost analysis provided similar benefits to OBA, but under different circumstances, without cooperation and long-term commitment of the parties involved.

Moreover, should-cost analysis and forcing OBA are two distinct and different practices of cost management and should not make confusions. Kajüter and Kulmala (2005) mention an enforcing OBA which is the result of asymmetrical balance of power does not necessary lead to a successful OBA practice, and it is more applicable within dyadic buyer-supplier relationships. In this study, however, should-cost analysis was successfully determined beyond the dyadic buyer-supplier relationships or fitting supplier to lessen the possible profit-whiplash effect. Interestingly, defining a service fee for the hose assembly company as the first-tire supplier was an OBA-based approach to tackle possible profit-whiplash effect.

Thus, should cost analysis and its benefits when used in addition to (or instead of) OBA deserve further attentions. More broadly, further studies should examine the choice, use and benefits of different approaches for unveiling and managing the costs and profits within supply chains. Besides the advantages of should-cost analysis, implementation of this cost analysis technique is also associated with several limitations. Compromising the quality and delivery time, geographical expansion limits, should-cost analysis of service sector, and having access to financial information of suppliers are the limitations of this rather overlooked technique.

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