NTNU
Norwegian University of
Science and Technology

Supplier evaluation and development in a lean perspective

Håkon Krogh
Thomas Andre Skogen

Project Management / Global Manufacturing Management
Submission date: June 2016
Supervisor: Ann-Charlott Pedersen, IØT

Norwegian University of Science and Technology
Department of Industrial Economics and Technology Management

Problem description

This thesis will research and utilise literature on the purchasing function, supplier evaluation, supplier development and lean principles with the goal of making a framework to structure supplier evaluation and development initiatives of a purchasing company from a lean perspective. A case study will be conducted and analysed in order to identify similarities and differences between the framework and the case company.

Preface

This master thesis was written at the Department of Industrial Economics and Technology Management (IØT) at the Norwegian University of Science and Technology during the spring of 2016. It was a small part of the project Lean Management, which is carried out by NTNU in collaboration with several of their partners in the Norwegian industry.

The study was a shared effort between the two of us, attending the master programs Global Manufacturing Management and Project Management, specialising in strategic purchasing management and industrial engineering respectively. However, we did not do it alone.

First, we would like to express our most sincere gratitude to our supervisor, Professor Ann-Charlott Pedersen, for her invaluable support, feedback, discussions, and genuine interest in our work. This thesis would not have become what it is without her.

Second, we would like to thank Nammo Raufoss AS for their generous welcome during our time at their headquarters and in general for making our two visits there as interesting as it was. Due to their level of assistance in relation to the data collection, we would like to thank Paul-Erik Hattestad and Erik Høgberget specifically, as they were of much help.

Last but not least, we would like to thank our girlfriends, families, and friends for the support they have provided throughout the process.

Trondheim, June 2016

Thomas André Skogen & Håkon Krogh

Abstract

Through a research project at NTNU, named Lean Management, this thesis was conducted with the purpose of finding out how the purchasing function of a firm, seeking to perform according to lean principles, can structure their supplier evaluation and development initiatives.

To achieve this, a literature study was conducted, which resulted in the development of a framework and subsequently a model. The model is based on themes from conventional and lean theory on purchasing, supplier evaluation, and supplier development.

The model consists of five steps and a continuous improvement methodology, where supplier measurements and evaluation of supplier performances are conducted in accordance with a combination of best practice and lean techniques. Suppliers deemed performing sufficient will be monitored and evaluated in a continuous feedback loop, while suppliers performing insufficient will be developed if possible, or terminated if not. The suppliers kept on will so be subjected through this continuous treatment so to enhance the overall supplier base performance level.

A descriptive case study was performed to validate the proposed supplier evaluation and development model. The data collected in order to build the case was obtained by conducting semi-structured interviews in two rounds with relevant personnel and managers in the case company. Additional data were collected from the corporate web page, through on-site tours, and e-mails with Nammo employees. The case description was subsequently used to analyse the applicability of the proposed model.

The results point towards the fact that the model would be of beneficial use to any purchasing department in structuring their supplier evaluation and development based on lean thinking. However, this requires dedication from the company wanting to utilise the model, and slight modifications to the model itself. Additional results indicate that the model could be used in a modular sense, i.e. parts of it only or focusing on single criteria instead of a holistic system. Limitations and further studies point to e.g. incorporating the aspect of delivery frequency in the model.

Sammendrag

Gjennom forskningsprosjektet Lean Management ved NTNU, ble denne oppgaven utført med det formål om å finne ut hvordan innkjøpsfunksjonen i et firma, som ønsker å operere i henhold til lean prinsipper, kan strukturere sine leverandørevaluerings- og utviklingstiltak.

For å oppnå dette, ble en litteraturstudie gjennomført, noe som resulterte i utviklingen av et rammeverk og deretter en modell. Modellen er basert på temaer fra konvensjonell og lean teori om innkjøp, leverandørevaluering og leverandørutvikling.

Modellen består av fem steg og en kontinuerlig forbedringsmetodikk, hvor leverandørmålinger og evaluering av leverandørenes prestasjoner er gjennomført i samsvar med en kombinasjon av beste praksis og lean teknikker. Leverandører som presterer kvalitetsmessig vil bli overvåket og evaluert i en kontinuerlig tilbakemeldingssløyfe, mens leverandører av utilstrekkelig kvalitet vil bli utviklet hvis det er mulig, eller kontrakten vil bli avsluttet hvis ikke. Leverandørene av tilstrekkelig kvalitet vil så bli utsatt for denne behandlingen kontinuerlig for å forbedre det generelle ytelsesnivået til leverandørporteføljen.

Et beskrivende case studie ble utført for å validere den foreslåtte leverandørevaluering og utviklingsmodellen. Dataene brukt til å bygge caset ble innhentet gjennom semistrukturerte intervjuer i to omganger med relevant personell og ledere i caseselskapet. Ytterligere data ble samlet inn fra bedriftens nettside, gjennom omvisninger, og e-post med Nammo's ansatte. Caset ble senere brukt til å analysere anvendelsen av den foreslåtte modellen.

Resultatene peker mot det faktum at modellen vil være av nytte til enhver innkjøpsavdeling i å strukturere sine leverandørevaluering og utviklingstiltak basert på lean tenkning. Dette krever imidlertid engasjement fra selskapet som ønsker å benytte modellen, og små endringer i selve modellen. Ytterligere resultater indikerer at modellen kan brukes på en modulær måte, det vil si å kun benytte seg av enkelte steg av modellen eller å fokusere på enkelt kriterier istede for et helhets system. Svakheter of fremtidige studier peker til inkorporering av mottaks frekvens fra leverandører i modellen.

Contents

List of Figures

List of Tables

Chapter 1

Introduction

This chapter presents the background for the thesis and the problem statement at hand through a research question. Furthermore, the intended way to answer the question is described, as well as its contribution to contemporary literature, and paper structure

1.1 Background

The thesis is part of a larger research project within the frames of lean management at the Norwegian University of Science and Technology. The project ,*Lean Management*, is part of the *Sustainable Manufacturing research group*. The Lean Management research project has the goal of expanding the understanding of lean management through developing institutional and industry knowledge. The aim is to boost competitiveness in the Norwegian manufacturing industry.

This is to be done by understanding, modelling, verifying and demonstrating lean management roles, responsibilities and practises through focusing on how organisations in Norwegian manufacturing industry can use lean management to:

- Obtain better communication and coordination between the different organisation layers
- Build critical supply chains
- Build organisational competences using extended networks

The defence industry is a highly rigid industry where changes are difficult to conduct. Globalisation and the effects of increased competition is naturally affecting the industry as well. Therefore, companies are looking for new ways to gain competitive advantages. Lean has in many cases been used to improve the competitive edge of companies. The purchasing function have, in this regard, tremendous improvement potential. The opportunity to look at how to develop a lean evaluation and development framework in this setting is difficult yet at the same time enticing. Thus, the background for the paper is grounded in the need to investigate certain parts of management literature and practises under the lean concept in order to structure supplier evaluation and development effort within the confines of lean methodology.

1.2 Problem statement

This thesis will research and utilise literature on the purchasing function, supplier evaluation, supplier development and lean principles with the goal of making a framework to structure evaluation and development initiatives of suppliers from a lean perspective. This is in order to help solve the problem of lean implementation in contemporary management literature.

1.2.1 Research question

How can the purchasing function of a firm, seeking to perform according to lean principles, structure their supplier evaluation and development initiatives?

This thesis will attempt to answer the research question conceptually and practically. This will be done through theoretical and empirical studies.

1.2.2 Tasks

1. Perform a literature study on theory related to the four topics; the purchasing function, supplier evaluation, supplier development, and lean.
2. Construct a theoretical framework, which will culminate in a model, combining the literature into a systematic process for lean evaluation and development.
3. Conduct a case study of Nammo Raufoss AS with emphasise on their purchasing function to understand the evaluation and development systems and procedures.
4. Analyse the case by using the model to identify similarities and differences between the model and Nammo Raufoss AS' operations.
5. Conclude on the relevance and/or applicability of the model, and present possible changes and/or critique.
6. Give recommendations and implication to the case firm as to where there are improvement prospects, and potential areas where Nammo Raufoss AS could consider some changes.
7. Give recommendations and implications for future studies based on the discoveries and the subsequent identification of missing domains.

1.3 Scope

The thesis will be focused on the purchasing function, supplier evaluation and development in a lean perspective. Thus, the paper is limited to discussing key elements of the four areas of research, and how to combine them in a unified framework. The case study includes information about Nammo AS as a whole, but the main focus will be on Nammo Raufoss AS, with its

purchasing functions, and their evaluation/development initiatives, in particular.

1.4 Contribution

The framework presented in this thesis contributes to the literature on lean management theory, namely lean supplier evaluation and development. The thesis contributes with a modular supplier evaluation and development model, appropriate for purchasing functions seeking to perform lean. Furthermore, it can contribute to the development of critical supply chains in the Norwegian industry.

1.5 Structure

The paper will begin with a presentation of relevant literature in order to perform, the previous mentioned, task one through chapter two. Chapter three presents the framework developed with theory from the literature study. Information about the methodology will be presented in chapter four, including how the literature study, and the collection of data were performed. Chapter five will present and describe the case company and the industry it operates in, laying the groundwork for chapter six, where the framework developed in the literature study is discussed in terms of relevance and appropriateness towards the case company. Chapter seven concludes the thesis, presents implications for management, limitations and indications for further studies.

Chapter 2

Literature study

The literature study was conducted in order to answer the research question: *How can the purchasing function of a firm, seeking to perform according to lean principles, structure their supplier evaluation and development initiatives?*

The chapter first defines the purchasing function and explains its evolution. Second, supplier evaluation is discussed where definitions, how to perform, what to measure, and outcomes are presented. Third, supplier development is elaborated upon, where definitions and the distinction between reactive and proactive tools and techniques are explained. Fourth and last, Lean is discussed in terms of its impact on purchasing, evaluation, and development.

2.1 Purchasing function

2.1.1 Definition

According to Van Weele (2010) purchasing can be defined as

> "The management of the company's external resources in such a way that the supply of all goods, services, capabilities and knowledge which are necessary for running, maintaining and managing the company's primary and support activities is secured at the most favourable conditions" (p. 8).

Purchasing is the function in a company that has the responsibility of acquiring the necessary material inputs for all activities that the company performs. This includes materials directly related to the primary activity of the company and to any support activity that the company performs to facilitate the primary activity. Purchasing performs this task by interacting internally with other parts of the company who either sends a requisition of materials to the purchasing function or the purchasing function determines what amount of materials is needed for a activity in collaboration with the other part of the company. Purchasing uses this information to interact externally with existing suppliers to procure the necessary materials, or if not possible with the extant supplier base perform a supplier selection process to find a new suitable supplier. Purchasing is the link between the company and its suppliers and therefore has to interact regularly with the company's suppliers to maintain a business relationship with them (Cousins et al., 2008).

No firm has direct control over every resource they need and no firm has the ability to do everything themselves (Araujo et al., 1999). This makes the act of interacting with other companies essential for firms to obtain their required materials upstream from suppliers to be able to produce their product. Purchasing is now the function primarily responsible for the interaction and management of suppliers. In every type of manufacturing, anywhere, 50 % of the cost of goods sold, is derived from purchased materials (Handfield et al., 1999) and can represent up to 80 % of the total production costs (Burton, 1988), which signifies the importance of the purchasing function and the importance of the supplier base.

2.1.2 Evolution

In the last 40 years the view of purchasing has changed. It was earlier perceived as a strictly clerical operation due to a strong top management focus upon mass production and reducing costs of purchased materials. The purchasing function was to serve the production department by acquiring the lowest priced components or materials (Gadde and Håkansson, 1994).
A change in perception of purchasing started to occur as a result of the oil crisis in the 1970's and of the increasing competition from Japanese manufacturers in the 1970's-1980's. The oil crisis generated a sizable and widespread lack of materials and the Japanese business model was at contrast to the western way of doing business with suppliers. The Japanese had a strong focus upon supplier handling where western companies focused upon cost reduction. The Japanese surge of the 1980's and 1990's brought to light the importance of focusing upon the supply side of businesses (Farmer, 1997).

This change in perception has resulted in making the purchasing function as a whole elevated to a strategic element of companies (Gadde and Håkansson, 1994). Purchasing decisions is now part of a company's long-term strategic planning. As purchasing has evolved, more tasks has come under its management. These include handling supplier relationships, initiating buyer-supplier collaboration, finding and handling potential suppliers in a make or buy decision, and elevated focus upon the total costs related to the purchasing of goods (McIvor et al., 1997). (Cousins et al., 2008) discussed three roles the purchasing function can play in a organisation in relation to its company strategy.

1. The most basic level is that purchasing can *implement* the company strategy, where purchasing is not involved in the development of but only in the implementation of the company strategy.
2. The next level that purchasing can have is to *support* the company strategy. This can be done by aligning their function with the company's strategy.
3. The highest level purchasing can have is to *drive* the company strategy by providing a long-term competitive advantage to the company.

These three levels describe, in short, the different phases the purchasing function has evolved through, where the operational (implement company strategy) phase was predominant in the

1950-70's. The next two levels represents the evolution of the purchasing function since approximately the 80's up until today.

Globalisation and its effects upon markets are ever increasing, by making it easier and faster to communicate and transport goods over long distances globalisation increases the extent of competition companies have (Dicken, 2011). The importance of suppliers has thereby increased with a larger focus on core competencies to find competitive advantages. This drives prices down and the need for efficiency and effective processes up. This pressure extends to the purchasing function, where it often is expected to not only find more economical ways of procuring materials but to increase the innovation, efficiency, and effectiveness of the suppliers (Trent and Monczka, 1999; Cousins et al., 2008).

Due to the strong attention upon learning from the Japanese way of conducting business, an increase in the importance of long-term and close business relationships between buyer and suppliers has shifted the focus from transactional to relational ways of interacting with suppliers. These two are two main and opposing types of business interactions (Svahn and Westerlund, 2009; Cousins et al., 2008). The first is the transactional type, which is based upon the transaction cost economics perspective. This point of view is characterised by focusing on reducing costs by only offering short-term contracts, using tenders to induce competition between suppliers and choosing the supplier with the lowest price (Spekman, 1988). This is a way of conducting business which, as the name implies, focuses on decreasing transaction costs. It does not encourage close business relationships nor the development of inter-company trust.

The second type of business interaction is the relational view, which focuses on long-term contracts. In this view, business relationships are perceived as beneficial to company's competitive edge by enabling the rationalisation of the supplier base and closer cooperation with suppliers (Gadde and Håkansson, 1994). Spekman (1988) and Axelsson and Wynstra (2002) propose that a relational approach should be used when the objective is to achieve co-operation between two companies, while a transactional approach is used when the objective is to gain a cost benefit through market competition. The purchasing function has in short become a major player in companies overall strategic importance as it handles the ever increasingly important suppliers. A vital task of the purchasing function is the evaluation of supplier performance, which is elaborated in the next section.

2.2 Supplier evaluation

Poor supplier performance can result in increased costs to the buying company. When receiving bad quality, or receiving the goods at the wrong time, it results in the buyer having to rework, ship back the faulty goods, or halt production until the necessary input are made available. All of these outcomes are examples of costs not mirrored in the purchasing price that the buying company pays (Monczka and Trecha, 1988). Noshad and Awasthi (2015) specify that most companies do not measure the cost of poor quality, which can be controllable (direct) and customer-incurred and dissatisfaction (indirect) costs. The costs nevertheless eats of the buyer's profit margins. This signifies the importance of measuring and evaluating the supplier base performance.

The measurement and subsequent evaluation of suppliers permits the buyer to decide upon further actions concerning the suppliers in question. Further action involve the choice to try to help and develop the supplier, or possibly to terminate the business relationship. In the case of trying to develop a supplier, the evaluation of performance is key to identifying which capabilities to improve (Sánchez-Rodríguez et al., 2005). The increasing focus upon long-term relationships makes measurements even more relevant as to ensure the stability of long-term suppliers (Monczka and Trecha, 1988). In addition, the importance of good material inputs to a company, as discussed in 2.1, enhances the significance of measurement as to achieve the quality requirements of received goods.

2.2.1 Definitions

Companies finding their suppliers lacking in terms of performance has four options according to Krause et al. (1998), namely:

1. Invest the business' own resources to directly try to improve the suppliers performance (e.g. personnel).
2. Internalise the production of the product or service.
3. Find a new supplier.
4. A combination of the mentioned three options.

As such, the purpose of supplier evaluation is to unveil weak links in the supplier portfolio and communicate this to the supplier(s) to enable development where needed.

To detect poor performance, companies have to monitor their suppliers work in accordance with their customers demands. The purpose of monitoring, and evaluating the performance is namely to assess whether or not, current suppliers, are meeting the requirements and to be able to respond to unexpressed partner needs (Simpson et al., 2002).

In cases where the options to develop a suppliers performance or finding a new supplier are appropriate, a company will need a way of determining where suppliers lack in performance or which suppliers are most suitable to deliver in accordance with the organisations needs. Supplier evaluation approaches are suitable for both purposes. For these approaches to serve the needs of contemporary supply chain management, multi-criteria evaluation methods are needed, as the conventional cost-based approach is not robust enough (Ho et al., 2010).

Supplier evaluation is a requirement for performing supplier development (Hahn et al., 1990; Watts and Hahn, 1993). Shokri et al. (2010) on the other hand, describe evaluation as a support activity/element in supplier development practises along with information sharing, feedback and basic communications. The supplier evaluation in itself are measures conducted to assess the supplier performance within the desired parameters. It relates to improving the information flow from the customer in order to enhance suppliers of different tiers.

Noshad and Awasthi (2015) describe supplier measurement as an own field of operations, and a necessary predecessor to development activities in line with Hahn et al. (1990) and Watts and Hahn (1993). The supplier measurement process involves activities such as; supplier evaluation, certification/qualification of suppliers, performance measurement, and tracking the cost of poor supplier quality. The subsequent process would be to correct or suggest optimisation measures for suppliers. Noshad and Awasthi (2015) see supplier measurement and evaluation as a method of identifying ways to improve suppliers and continuously assessing their production and quality capabilities. The main reason to evaluate suppliers is to assess their quality system against the customers complaints, internal and external product specification and reviewing safety programmes, the performance of suppliers and the satisfaction of customers. This is to minimise supplier risk and ease the implementation process of a company's quality requirements.

Author(s)	Monitoring	Multi-purpose	Required	Support activity
Hahn et al. (1990)			X	
Watts and Hahn (1993)			X	
Krause et al. (1998)		X	X	
Simpson et al. (2002)	X			
Ho et al. (2010)		X		
Shokri et al. (2010)				X
Noshad and Awasthi (2015)			X	

Table 2.1: Definitions of supplier evaluation

Table 2.1 sums up the explanatory focus of the literature contributions. 'Monitoring' means that the customer uses evaluative measure to ensure that the suppliers adhere to the requirements. 'Multi-purpose' means that the customer uses evaluation for multiple purposes, e.g. monitor, development, selection. 'Required' means that evaluation is seen as a necessary predecessor to supplier development. 'Support activity' means that it is seen as a natural part of supplier development measures.

The contributions from the literature have lead to the following definition of supplier evaluation:

Supplier evaluation is the measuring and subsequent assessment of supplier performance, and a necessary predecessor for enabling effective supplier development.

2.2.2 What to measure

Cousins et al. (2008) argues that supplier evaluation is a signalling device for both the supplier and the buying company. As such evaluation criteria should mirror the corporate strategy. These criteria are given in a cascading way, where the corporate strategy would affect what the the purchasing function focuses on. The measures must therefore be carefully designed as to not be misaligned with the company's strategies. For example, performance measures focusing on cost reduction when the overall company strategy bases itself upon ensuring and delivering quality products is a misalignment (Cousins et al., 2008). Noshad and Awasthi (2015), however, suggests that buying companies should measure suppliers in all aspects relevant for their business, e.g. product quality, service quality, process quality, and organisational quality. The

measurement should be of the evaluation metrics relating to the performances impacting the end customers, as to protect their needs (Noshad and Awasthi, 2015; Shokri et al., 2010).

According to Ho et al. (2010) the data collected should be versatile and based on multiple evaluation criteria. These criteria have to be matched with the company stakeholders' requirements and company strategies, i.e. how the suppliers perform, or which part(s) of the supplier performance that impacts company strategies must be identified (Ho et al., 2010; Cousins et al., 2008).

Van Weele (2010) argue that there are four levels that are measurable, namely: product level, process level, quality assurance system level, and company level. Simpson et al. (2002) stress the necessity not to neglect the evaluation of the degree of continuous improvement measures the supplier have implemented, as e.g. technology dependent companies could potentially face technology obsolescence resulting from a lack of continuous improvement initiatives. The different measurement criteria identified in the literature are presented in table 2.2

Measurement criteria	**Noshad and Awasthi (2015)**	**Ho et al. (2010)**	**Van Weele (2010)**	**Cousins et al. (2008)**	**Simpson et al. (2002)**
Continuous improvement / QA	X		X		X
Cost/price	X	X	X	X	X
Delivery/time	X	X	X	X	X
Finance		X	X	X	X
Management	X	X	X		
Manufacturing capability/ flexibility	X	X			
Process quality	X	X	X	X	
Product quality	X	X	X	X	
Relationship/ communication/ service	X	X	X	X	X
Reputation		X			
Research and development/ technology		X			
Risk	X	X			
Safety and environment	X	X			X

Table 2.2: Measurement criteria

Through Figure 2.2, a best practice of supplier evaluation can be ascertained. The best practice is assembled simply by finding the measurement criteria most frequently mentioned:

- Relationship
- Cost and price
- Delivery
- Finance
- Process quality
- Product quality

A company seeking to perform within the best practice of supplier evaluation should therefore measure suppliers on these criteria.

2.2.3 How to perform

The first step in supplier evaluation is to identify and categorise the supplier portfolio. The categorisation should be based on factors such as location, organisation size, product type, and volume (Noshad and Awasthi, 2015), or alternatively in terms of importance as proposed by Kraljic (1983). The essence of this step is to ensure sufficient quality in the supplier portfolio. This can be related to product specifications, safety programmes/standards, customer satisfaction, identifying strategic relationships and help monitor supplier performance (Noshad and Awasthi, 2015). Trent and Monczka (1999) state that a requirement for achieving world-class quality and supplier performance is not only to categorise the company's supplier base, but to rationalise and optimise it. A reduction enables a greater focus upon the remaining suppliers to improve their performance. It is also related to the retainment of the "best" suppliers while the low performing ones are terminated. Krause et al. (1998) on the other hand see portfolio reduction as a result of the evaluation measures implemented. I.e. the process of evaluating the supplier portfolio will naturally result in some of the suppliers being terminated.

The adjacent step is to develop a structured, formal supplier evaluation system. This is a necessity for effective supplier measurement and evaluation. This system should specify who to measure, what to measure, and how to do it. Trent and Monczka (1999) discovered that nearly 80 % of companies perform formal supplier site inspections, where supplier process capabilities and continuous improvement initiatives are among the factors investigated. Simpson et al. (2002) studied to what degree industrial companies had implemented a formal systematic supplier evaluation system, and found that most companies had underdeveloped structures for this purpose. From their study Simpson et al. (2002) found that only half the studied companies had any formal system at all, and one third of this half had evaluation systems the authors recognised

as superficial at best. The importance of formal evaluation systems is rooted in the necessity of being able to compare performance over time. This gives the company an opportunity to engage in regular meetings with their supplier portfolio and give tacit feedback on their performance. In turn, this makes it possible for the suppliers to focus their improvements upon the areas that are most important to the buyer (Simpson et al., 2002). Shokri et al. (2010) are of the same opinion, as they found that effective information sharing in a frequently and timely manner with the suppliers is a necessity in order to conduct supplier development. The supplier development includes supplier evaluation, as such, sharing feedback based on these evaluations is the essence. The process is depicted in Figure 2.1.

However, the most important factor in supplier evaluation, is not how the measurement is performed, but which data are collected and how they are exploited. Not only can purchasing managers utilise supplier measurement and evaluation to identify improvement opportunities in their suppliers, but also discover trends in their suppliers performance, as well as improve their supplier selection processes (Trent and Monczka, 1999). As mentioned, Ho et al. (2010) stress the importance of multi-criteria evaluation. Through their analysis of multi-criteria decision making approaches for supplier selection, they identified several individual and integrated methods for supplier evaluation. The most prevalent individual method was DEA (data envelopment analysis) and the best integrated was AHP-GP (analytic hierarchy process - goal programming). These approaches were found able to handle multiple qualitative and quantitative factors.

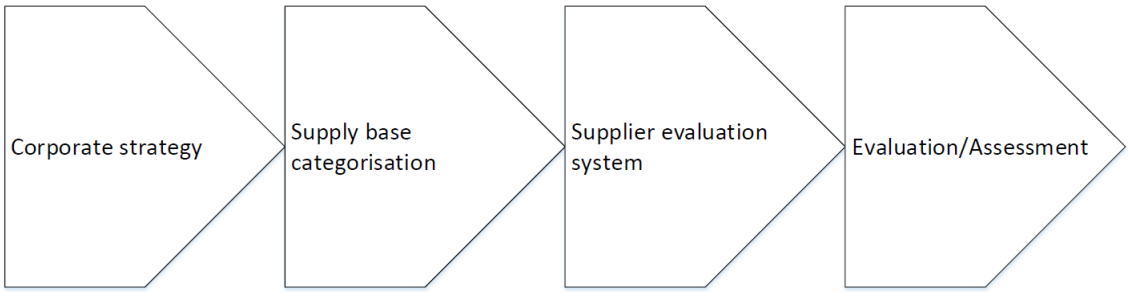

Figure 2.1: Process of supplier evaluation

2.2.4 Outcome

According to Monczka and Trecha (1988) there are several benefits of supplier evaluation. It eases the communication of supplier expectations, enables sourcing risk assessment, increases supplier accountability and supplier control, and can provide positive supplier reinforcement. Noshad and Awasthi (2015) found that successful supplier evaluation will aid companies in minimising potential risks and ensuring effective implementation of company quality expectations. I.e. utilising evaluation results to identify areas where corrective measures are needed and communicate this back to the suppliers. Trent and Monczka (1999) published similar findings. They found that supplier evaluation allow the company to assess and determine supplier performance trends, which in turn speaks for supplier improvement opportunities. It reveals which suppliers that are most beneficial to use and conveys the purchasing company's requirements to the supply base. Purchasing companies can reward and give recognition to suppliers for their exceptional performance, which would not be possible without continuously evaluating their performance(Sánchez-Rodríguez et al., 2005). Common ways to do this would be to negotiate long-term contracts, give public recognition of the supplier, share benefits from improvement programs, purchase more of the share of components from the supplier, and involve the supplier in product development projects, to name a few (Trent and Monczka, 1999).

The correlation between supplier evaluation and improved performance in the areas measured have been proven (Tan et al., 1998), i.e. suppliers evaluated on delivery timeliness will perform better, in that area, than those who are not evaluated. Other studies have shown similar results. Shokri et al. (2010) found that supplier development have dramatic effect on a suppliers performance regarding service and product quality for the final customer. However, this includes the necessity of improving the flow of information from the supplier to the buyer in order to upgrade the supplier when necessary. This need to share the evaluation results with the suppliers was something Simpson et al. (2002) also discovered. By doing so, the suppliers gain a good understanding of their customers needs, which enables them to improve on the dimensions most important to the buyer. This will in turn assist the customer in achieving their overall business objectives. As such, they are of the opinion that evaluation result gives tangible evidence of what needs to be improved, what is good, and where the optimisation potential lies, and so enables supplier development initiatives.

Carr and Pearson (1999) conducted a data analysis of a comprehensive survey where they found a significant positive correlation between supplier evaluation systems and buyer-supplier relationships. This means that a company performing supplier evaluation, on average, would have a better relationship with its suppliers. The same study also found a positive correlation between a good buyer-supplier relationships and increased financial performance of the buying company. I.e buying companies performing supplier evaluation will on average have better financial performance than those who do not.

Ho et al. (2010) suggest that supplier evaluation will ensure global optimal supplier base by retaining and acquiring suppliers based on customer-oriented criteria (quality, delivery, flexibility, etc.). It also gives the buying company a way of comparing performances to other suppliers, and gives the buying company a way of guiding the suppliers to performing better (Krause et al., 2000). Trent and Monczka (1999) states the importance of measuring supplier performances as the basic effort needed in the path to achieve world-class quality.

Stability in delivery and quality points towards proper production control in the suppliers internal processes while variance in quality and delivery precision points to unstable internal processes (Monczka and Trecha, 1988).

Challenges related to supplier quality management, in relation to evaluation, have been reported by Noshad and Awasthi (2015); poorly defined quality evaluation metrics; lack of supplier involvement in identifying quality targets, lack of information sharing, poor communications, lack of supplier motivation to name a few.

2.3 Supplier development

In this chapter the idea of supplier development will be defined, requirements for executing supplier development, and the results of performing it will be discussed.

2.3.1 Perspectives

Supplier development is becoming a necessity, due to the ever increasing competitiveness of the business markets. The quality of the products a company makes is determined by the input from its suppliers (Watts and Hahn, 1993), which signifies the importance of having competent

and qualified suppliers.

Supplier development can be conducted in two ways according to Hahn et al. (1990) namely in a narrow and in a broad sense. In the narrow sense, the buying company creates a supplier where there are none. In a broad sense a buyer can improve the capabilities of a supplier through direct involvement. The focus of this assignment will be upon supplier development in the broad sense.

As shown in table 2.3 the definition of supplier development differs among authors. *Long-term* definitions are those with a long-term perspective of supplier development. *Quality* definitions are those that include a quality awareness or focus in it. *Systematic* is if the definition involves a systematic point of view to the supplier development initiative. *Relational* is the act of recognising the importance of mutual benefit from a supplier development initiative. *Continuous improvement* represents a supply chain wide fixation upon the aim for continuous improvement in the supplier development initiative.

Author(s)	**Long-term**	**Quality**	**Systematic**	**Relational**	**Continuous Improvement**
Ahmed and Hendry (2012)	X	X	X	X	X
Hahn et al. (1990)			X		
Krause and Ellram (1997a)	X				
Lo and Yeung (2006)	X	X		X	X
Noshad and Awasthi (2015)	X	X	X	X	X
Sako (2004)	X		X	X	X
Shokri et al. (2010)	X	X	X	X	

Table 2.3: Definitions of supplier development

As there are several definitions of supplier development, a more general definition based on the fundamental purpose from the theoretical contributions will be utilised:

The act to continuously improve the long-term capabilities and internal processes of a supplier in a systematic way.

2.3.2 Execution

There are many factors which are important to the successful execution of supplier development. Long-term buyer-supplier relationships is important as it enables the development of the necessary continuity, communication, and trust between the two parties (Lo and Yeung, 2006; Krause and Ellram, 1997a; Nagati and Rebolledo, 2013; Shokri et al., 2010; Li et al., 2012). The buyer has to be of importance to the supplier for the supplier to cooperate with such a resource intensive undertaking. An example of this would be that the buyer represents a large percentage of the total volume sold for the supplier(Krause and Ellram, 1997a; Lo and Yeung, 2006).

Noshad and Awasthi (2015) defines a three step supplier development methodology, where the first step is measurements of supplier performance and the identification of potential improvements as discussed in 2.2. Second is the evaluation of suitable corrective measures towards the supplier, and the last step is to implement the corrective measures.

2.3.3 Strategic/Reactive execution

The qualitative analysis conducted in Krause et al. (1998) revealed that of those companies performing development activities, some where using it as a strategic tool, while others used it as a reactive and corrective tool, in line with findings in Hahn et al. (1990). Firms performing strategic supplier development has a focus upon creating world-class suppliers, while reactive development is triggered by suppliers' failure. Companies conducting strategic supplier development are interested in improving the long-term capabilities of their entire supplier base with an emphasis on the most important suppliers, that are found using portfolio assessment or Pareto etc. As such, a strategic supplier development initiative can be called a program. Companies using reactive supplier development, however, have an ad hoc reaction to supplier problems. I.e. any improvement effort is a one-off focusing on a single immediate problem, which results in it being called supplier development projects. A strategic approach to supplier development can give the company a competitive edge, while reactive supplier development can keep the company competitive by fixing immediate problems. An overview of some of the differences is given in Table 2.4.

Factors	Reactive	Strategic
Primary question	A supplier is under-performing. What should be done to correct it?	Which supplier would it be most beneficial to develop?
Primary objective	Improving the lacking performance in existing supplier	Continuous improvement of supplier base
	Short-term improvement	Long-term competitive advantage
Selection	Supplier is chosen based on poor performance	Portfolio analysis Pareto analysis
	Problem driven	Market driven
Drivers (examples)	Quality defects Production disruptions	Technology development Seek competitive advantage

Table 2.4: Reactive and strategic supplier development, (Krause et al., 1998), p. 46

Krause et al. (1998) finds that companies' supplier development activities generally follows an evolutionary route, shown in figure 2.2. A company's development initiative starts with implementing Total Quality Management (TQM) thinking, and continues by assessing and trying to reduce the supplier base. Next the company begins to conduct reactive supplier development. The final stage of the route is to start performing strategic supplier development initiatives. It is thus implied that reactive supplier development is conducted before a company is able to perform strategic supplier development (Krause et al., 1998).

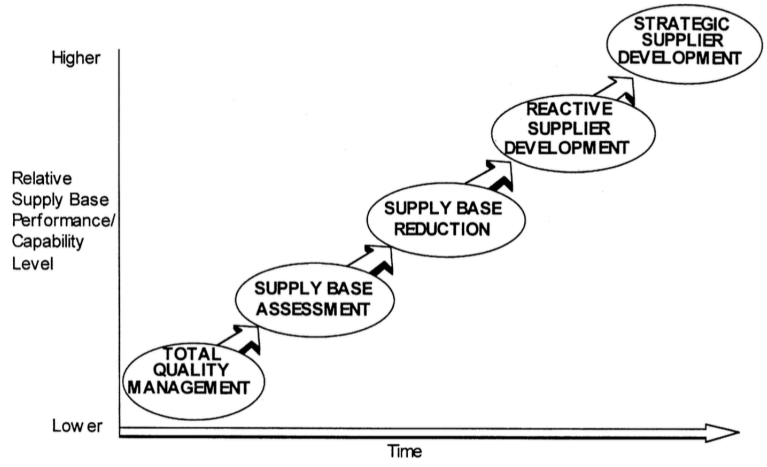

Figure 2.2: Evolution of development initiatives (Krause et al., 1998, p. 44)

2.3.4 Short- and long-term

The tools and techniques utilised for supplier development can be different in term of their time perspectives. In addition, their relation to the strategic and reactive approaches vary.

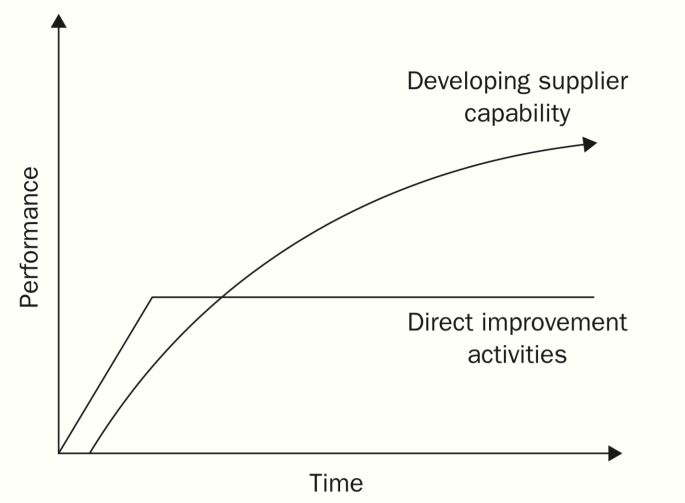

Figure 2.3: Short-term and long-term supplier development (Cousins et al., 2008, p. 79)

Short-term supplier development tools and techniques can be used in a proactive and reactive manner, but long-term can only be used in a proactive manner. This is due to the period of time the technique or tool requires, as mentioned, and what their focus is. Short-term techniques focus upon conducting direct improvement activities that gives an immediate increase in performance. Long-term techniques, however, focuses upon teaching and developing supplier capabilities which in the long run can benefit the supplier and the buyer more than short-term direct improvement activities (Cousins et al., 2008). This is shown in figure 2.3.

To categorise a supplier development tool or technique in terms of proactive of reactive focus is troublesome, as many can be used in both categories. The categorisation used is this thesis is therefore short- and long-term. Table 2.5 shows a number of tools and techniques categorised into the two perspectives.

Training

Hahn et al. (1990) Suggests the use of Just-In-Time (JIT), Quality assurance programs, Quality circles, Statistical Process Control programs, and worker training as tools for training suppliers. Similarly, Noori (2004) found it most efficient to use training tools such as JIT and teaching Lean manufacturing. Both can be short- and long-term depending upon what is taught to the

Short-term	Long-term
Training in technical competence	Training in continuous improvement and problem solving
Reactive supplier audits	Strategic supplier audits
Feedback on poor performance	Sharing long-term goals and quality requirements
Qualification (technical ability)	Certification (management standards)
Recognition	Rewards (contracts)
Ad hoc employee supplier development teams	Established supplier development teams (resource commitment)
Competition amongst suppliers	Involvement in product development

Table 2.5: Examples of short-term and long-term SD

supplier. Is the focus upon teaching the continuous improvement methodology of Lean, Statistical Process Control etc. there will be long-term benefits of the teaching. Is the focus upon teaching the tools of Lean such as 5S there could be short-term improvements benefiting both supplier and buyer. An ideal approach would be to teach both, as such there could be short- and long-term improvements.

Supplier audits

Sánchez-Rodríguez et al. (2005) categorise supplier audits as a moderately intensive form of supplier development, i.e. it requires more of the buying company than only feedback on evaluations, while less than training or involving suppliers in product development projects. Depending on the focus of the event, supplier audits can be either reactive or strategic. A reactive supplier audit will happen because of a drop in supplier performance and the subsequent attempt to fix it. Strategic supplier audits is planned and is conducted with long-term goals in mind, which is in line with the definition of strategic supplier development by Krause et al. (1998). Krause and Ellram (1997b) found in their survey that supplier audits with the intent of improving supplier performances is a regular event in businesses.

Feedback and sharing of information

As discussed in section 2.2, measurement and evaluation of suppliers can be seen as critical to any development initiatives. A form of supplier development is to give feedback on the evaluations conducted by the buying firm. This will provide the suppliers knowledge about where to improve and initiate short-term corrective actions. Krause and Ellram (1997b) found that feedback is one of the most used forms of supplier development. According to Krause et al. (2007)

the sharing of long-term goals and quality requirements which is equivalent to technological road maps are conditional for the transfer of knowledge in supplier development.

Qualification and certification

Qualification is the result of supplier audits. During the audits the supplier is examined with the intent of approving the supplier for a specific part or component. If they are not up to the required standard, enhancements are potentially conducted in order to improve their processes so that they operate within the desired limits. This essentially means that the suppliers internal processes and manufactured products are of the necessary quality. As such this is a short-term development effort (Handfield, 1993).

Noori (2004), Trent and Monczka (1999) suggest developing suppliers through demanding implementation of certificates, such as the ISO 9001 standard. This could indirectly develop suppliers internal processes and the quality of their goods as they have to adhere to the protocols of the certificate. It can also reduce the need for inspection of materials upon receipt. In the long run, however, it can result in lower quality as the certification is a result of a process conducted at a specific point in time. Employees and equipment change and such the performance of the suppliers processes also change. Certification, therefore requires regular assessments to ensure that the supplier upholds the required quality of the certification.

Recognition and rewards

Giving suppliers public recognition is an incentive, for the suppliers, to develop (Trent and Monczka, 1999). E.g. the supplier with the best performance is given recognition, which in turn can give the supplier additional customers through the extra exposure and advertisement (Lo and Yeung, 2006). A different form of supplier development, according to Trent and Monczka (1999), can be to negotiate longer contracts than usual, to give the supplier a larger percentage of the purchased volume, or to share some of the gains that the purchasing company gathered due to the supplier's increased performance.

Using incentives to entice suppliers to increase their performance is a low involvement development tool, where suppliers are promised recognition, higher volumes, or long-term contracts *if* they are able to increase their performance. This also requires limited commitment from the buyer as the supplier is only granted more volume or rewards if they comply with the demands (Krause, 1997).

Ad hoc and dedicated supplier development teams

Hahn et al. (1990) argues for the formation of supplier development teams, either ad hoc or dedicated teams, to conduct the company's supplier development programs. They found that ad hoc teams were more suitable than dedicated teams at some times, and vica versa. Krause and Ellram (1997a) argues for the development team to be cross-functional to ensure the teams ability to face and overcome all the different situations that will arise when dealing with suppliers.

Competition and involvement

A short-term and low involvement way of conducting supplier development is to induce competition between suppliers. This enables the buying company to source from the supplier that delivers the best and lowest cost solution (Krause, 1997). It is however at odds with the relational way of buyer-supplier relationships and inhibits the development of trust and long-term collaboration between buyer and suppliers.

A way of conducting long-term supplier development is to involve suppliers in product development projects, where the supplier can be forced to develop new skills and capabilities. The involvement of suppliers can be beneficial to product development projects due to suppliers expertise in their field of operations, and can greatly reduce the development time of products. At the same time this involvement requires a long-term relationship with the supplier and a high degree of trust between the two parties (Handfield et al., 1999).

2.3.5 Outcome

There is a general agreement on the beneficial nature of performing supplier development initiatives (Shokri et al., 2010; Noshad and Awasthi, 2015; Ahmed and Hendry, 2012). More specifically Krause (1997) found a 79 % increase in on-time deliveries and a decrease of 75% of incoming defects in their survey on outcomes of supplier developement. Anderson and Weitz (1992) found that the act of investing financially and resource wise towards the supplier can be viewed as the supplier gaining confidence in the business relationship, i.e. trust increases. Similarly Krause (1997) found a correlation between supplier development and improved buyer-supplier business relationship and an increase in expected relationship longevity.

Handfield et al. (2000) presents some of the major pitfalls to conducting supplier development. Lack of supplier commitment and trust is an acute challenge to supplier development as it can result in the supplier not believing in the project or program and thus not fully committing its resources to the development initiative. Also, lack of resources at the supplier is another challenge as the supplier might not have the required resources to conduct the supplier development tasks. A lack in alignment of cultures and strategy is a major challenge as the companies can have very different ideas about what the long-term goals are and should be, as well as how to achieve them.

Watts and Hahn (1993) found that buying companies conducting supplier development, in general, are larger in terms of total employment, purchasing departments, and higher annual gross sales than those not performing supplier development. This signifies a tendency where smaller companies are not able to or not focusing on developing their supplier base, i.e. smaller companies can find supplier development initiatives harder to implement., and can result in wasted resources.

2.4 Lean

Jasti and Kodali (2015) collected comprehensive information about the origins and development of "lean". The term lean is a philosophy sprung out of the Toyota Production System (TPS), tailored by Taiichi Ohno to enhance the production effectiveness of the Toyota Motor Company. When seeking to perform lean in any context, there are two main principles needed to consider (Jasti and Kodali, 2015). The first is removal of waste in the process(es), i.e. any non-value adding activity that consumes organisational resources. This was originally known as JIT production. The second is to maintain quality, through waste reduction, but also by the use of various forms of quality enhancing measures to ensure product or service growth. TPS was known to utilise Jidoka, a quality enhancement tool (Jasti and Kodali, 2015).

Through the book 'The Machine that Changed the World', the lean principles became popular in western culture and started spreading to almost all sectors of the industry. Today, companies seek to implement lean thinking within all aspects of their operations, i.e. within the service sector as well as in other less tangible work processes.

Even though the article by Jasti and Kodali (2015) show that the amount of research done on lean concepts in sectors separate from production is very much increasing, the lack of frameworks to support the theory is evident. Despite Womack and Jones empirical evidence that lean practises are transferable to other countries and sectors, it is challenging to tailor the techniques to each specific situation. That might explain much of the success lean practises have had, but also why it is perceived challenging to adopt lean in other parts and processes of the organisation, e.g. purchasing, supplier evaluation and supplier development (Jasti and Kodali, 2015).

2.4.1 Lean purchasing

Lean purchasing was mentioned as early as 1996, thus under the term 'lean procurement' (Lamming, 1996), although similar topics had been studied before, e.g. Burton (1988). Lamming (1996) stated that methods to procure lean should be pursued as to achieve the best prices possible. This was due to new ways of removing waste in supply chains such as new information technologies, vendor manged inventory and efficient consumer response. If the customer are to ensure low piece price cost, they have to refuse price increase based on inflation and modifications to products or services. In addition, cost reduction should not be based on labour cuts or off shoring, as they inhibit the capacity of continuously improving the performance over time (Piercy and Rich, 2009).

Harris (2013) proposed a metric to drive lean purchasing operations. The metric considers four aspects which are put together to ensure the lowest piece price cost, as low inventory as possible, as low transportation costs as possible, and to achieve all this without compromising quality as lean purchasing is about getting the best total solution, not focusing on one of the four. In other words, how do we purchase something in the best way possible for the entire value chain? The only way to achieve this is if all the actors throughout the value stream are performing within the lean framework (Piercy and Rich, 2009). Berenyi and Banhegyesi (2015) however, are of the opinion that merely applying lean methods is not a sufficient solution. The extension of lean thinking into the system is necessary in order for it to work properly. I.e. the mindset must be changed so the methods can be incorporated by the organisation(s).

Harris and Streeter (2010) are of a similar opinion to Berenyi and Banhegyesi (2015). According to them, the implementation of lean purchasing requires a philosophical change, from

conventional buyer-supplier relationship to a supply chain perspective. I.e. mutual partnerships, calculation of true cost (see Table 2.6), understanding information flow, knowing who the customer is, and what they are willing to pay for. As such, the mindset should be focused towards the entirety. They state that in the future, the best supply chain will have the competitive advantage. Not the best company, nor the best facility. The challenges with this type of implementation, in organisational philosophical terms, is that it takes time. However, if the goal of a company is to be successful in the long term, they must commit to the cause, accept that the benefits of the approach is not 'seen tomorrow' and develop suppliers into key partners throughout the supply chain (Harris and Streeter, 2010).

Ongoing cost	**Change cost**	**Risk cost**
Piece price, transportation, inventory carrying cost, customs and duties	Volume, quality, price, resources, tooling	Downtime, poor quality to the end customer, poor end customer satisfaction, expedited air shipments, reworking parts

Table 2.6: Components of true cost (Harris and Streeter, 2010)

To achieve implementation of lean purchasing philosophy, a supply portfolio reduction is necessary as the purchasing efficiency is enhanced through having to work with fewer suppliers (Barla, 2003). Barla (2003) states that most lean producers utilise one lean manufacturer per part/component, trusting them to deliver near perfect products, on time. However, this is only true if the reduced amount of suppliers are of a higher quality, providing better product cost and service in a long-term perspective. She explains three ways of reducing the supplier base;

1. Number of suppliers per part
2. Number of suppliers for each family of parts
3. Outsource fewer parts

Previously, buyers have been known to maintain a supplier portfolio where it is possible to play them off against each other, as dicussed in 2.1.2. Warnecke and Hüser (1995) warns against this approach, as the profits of many suppliers are already very low. As such, the effort should be directed towards supplier evaluation and development, to help the contemporary suppliers become even more effective. The goal for the purchasing department should be to influence the

approaches of the suppliers' sales department as to suit their 'lean' requirements. One solution is to get the supplying company to adopt lean thinking/strategies so to remove waste. This will in the end ensure price cuts for the customer and removal of unnecessary costs (Piercy and Rich, 2009). Therefore, the suppliers and how they deliver their goods is an important factor to consider when working towards lean purchasing.

Lean supply is based on two principles, removing waste in the supply process and enabling pull from the customer to drive the interaction. To achieve this it is necessary to enable flow in operations, i.e. level scheduling. This will ease the identification of waste, and the implementation of waste reduction processes for optimisation purposes. In theory, the results will be improved quality, shortened lead-times and enhanced service levels for the supplying company (Stratton and Warburton, 2003; Lamming, 1996; Bhamu and Singh Sangwan, 2014).

According to Barla (2003) it is the purchasing department's responsibility to apply the lean supply principles. Their objectives are the following; improving the purchasing efficiency; improving the quality and delivery performance of suppliers; isolate factors influencing material cost; and to remove unnecessary cost in the supply system. Barla (2003) propose five tactics as to achieve this purpose;

1. Evolve suppliers to become long-term business partners as they are an extension of the internal manufacturing process
2. Long-term supply and purchasing commitments should be sought
3. Ensuring improvement of buyer/supplier communications
4. Early phase involvement of suppliers in product development
5. Reducing product cost and improving product manufacturability through utilisation of the suppliers expertise, i.e. involve suppliers in product development.

The technical elements of lean supply can be categorised in; zero defects, frequent deliveries of small lot sizes; low total number of suppliers; long-term relationships; geographically close supply sources; and fair prices/costs (Barla, 2003).

The biggest inhibitor for lean supply arrangements is related to product type. As lean supply should be smooth (level scheduling) and provide a continuous flow of goods and material. This kind of set-up can be challenging to pair with volatile demand settings (Bhamu and Singh Sang-

wan, 2014). Another challenge, mentioned by Cox and Chicksand (2005), is potential power circumstances. I.e. if there is a lack of buyer dominance or at least interdependence in the relationship, implementation of lean supply to enhance the output from the supplier is difficult to achieve.

2.4.2 Lean evaluation

Florent and Zhen (2010) highlights some of the differences between traditional supplier evaluation and lean evaluation. The conventional approach emphasises criteria such as cost, quantity, quality and other static indicators. The lean approach encompass the suppliers flexibility in delivery, quantity, technique of production and other dynamic indicators. In addition, the suppliers capability of sharing information, capacity to innovate and develop, and geographical location are important. Furthermore, Florent and Zhen (2010) suggests that suppliers should be divided into the three categories; short-term transactional, long-term cooperational, and strategic. Barla (2003) found that evaluations related to a suppliers internal processes, quality of the organisation and service are the most important factors.

Berenyi and Banhegyesi (2015) suggests that the evaluation should be comprehensive as to fulfil the requirements of quality enhancement in lean thinking. The effectiveness, i.e. removal of waste, depends upon how practical the evaluation criteria are, what the evaluation procedure (timeliness) is, and the background support for this process. In addition, the usefulness of all delivered services and goods must be evaluated as to assess whether they deliver value or not. As such the evaluation should be of functions, instead of product, processes and partner companies. Berenyi and Banhegyesi (2015) proposes the use of value identification, to evaluate products and activities, to be able to relocate or eliminate waste where needed.

The supplier evaluation considers both qualitative and quantitative attributes (Tsai, 2008). Quantitative attributes are comprehensible, well defined, and easy to measure numerically, whereas qualitative attributes are difficult to measure as they are not so easily quantified. Tsai (2008) developed a procedure based on lean concepts where qualitative attributes are quantified through fuzzy set theory. The suggested method is more objective and consistent and so it expresses ambiguous values more specific. In addition to this, the model can process a comprehensive set of attributes in the evaluation.

In line with Berenyi and Banhegyesi (2015), criteria formulation has been argued the most critical aspect of supplier evaluation by Abdollahi et al. (2015). They have through their research identified low cost, high quality, speed, and flexibility as important supplier attributes. The two first are reckoned as lean attributes, whereas the two last are agile attributes. Their lean-agile evaluation method measure the suppliers performance at a specific point in time, and incorporates the two set of attributes by combining several methods. The Analytical Network Process (ANP) is used to weight the criteria, Data Envelopment Analysis (DEA) is utilised to give the suppliers ranking points. The DEA score is based on *"overall competence and capability"*. When this is done, fuzzy decision making trial data envelopment analysis (DEMATEL) is used to determine the inter-dependencies between the criteria measured (Abdollahi et al., 2015).

Barla (2003), on the other hand, conducted a study of supplier evaluation and selection under lean philosophy using the multi-attribute selection model (MSM). The model provides an analytical method to match a company's needs to the suppliers capabilities and enables comparison of several suppliers and their abilities. In addition, it can be used to evaluate the possibilities of improving supplier performance. The model consists of five steps:

1. Generate criteria for pre-screening suppliers
2. Selecting the attributes for the MSM
3. Developing the MSM criteria
4. Determining the proportional value of the attributes
5. Constructing the MSM evaluation form

A company's performance is heavily influenced by its supplier portfolio (Berenyi and Banhegyesi, 2015). As such, enforcing corporate strategy and goals upon the supplier portfolio is not enough in buyer-supplier partnerships. The identification of value is a customer supplier joint effort, as the suppliers are also sources of waste. Berenyi and Banhegyesi (2015) gives the following examples of major types of waste, caused by suppliers:

- Waiting: delay in the production procedure because new parts have to be checked or repaired, etc.
- Excess inventory: stocks are over-sustained to prevent stops in production due to the lack of or improper parts.

- Defects: failure of a component is not revealed and leads to faulty in a product.

As for challenges with lean evaluation Berenyi and Banhegyesi (2015) highlights the fact that not all organisations have the resources to operate with such a system.

2.4.3 Lean development

According to Florent and Zhen (2010) the most important aspects of a lean environment is to ensure strategic partnerships with suppliers, construct long-term and stable strategic alliances, reduce the cost and share the fruits of technological innovation. This can be achieved through collaborative relationships, i.e. partnerships, and through sharing the evaluation results with the suppliers. These are also the most important lean measures in a buyer-supplier relationship as it enables the achievement of mutual beneficial solutions. In addition, waste elimination and partnerships support each other in the long run (Berenyi and Banhegyesi, 2015).

The formation of partnerships is easier through a supplier base reduction (Barla, 2003; Harris and Streeter, 2010). According to Harris (2013), lean development necessarily involves a supplier base reduction. The reason is that there are a lot of wastes connected to a large supply base. E.g. 'noise' surrounding the purchasing department; transportation costs, chaos and inefficiencies in the receiving facility, and potential lower total quality of the supply base. Harris (2013) explains that the theory on being a diversified customer, i.e. having several supply options, is flawed as the suppliers are diversified as well. This means that the diversified suppliers do not have any incentive to give good service to the customer, or can cause product shut-down, causing supplier dominance. This, according to Harris (2013), argues for the need to build mutually beneficial partnerships with fewer, quality suppliers. In that way, the buyer gains more dominance, and the supplier gets an incentive to perform better towards the customer as they buy a bigger portion of their turnover. Thus, letting all the companies in the supply chain to prosper (Harris and Streeter, 2010).

As for more technical methods, Noshad and Awasthi (2015) have identified several best practises for supplier development, in various industries. The ones, from Noshad and Awasthi (2015), that can be implemented in a 'lean' perspective focusing on waste reduction and quality enhancement, are:

- Information sharing
- On-site assistance
- Clear communication of expectations
- Training on quality techniques
- Supplier product development
- Supplier involvement in planning

Shokri et al. (2010), on the other hand, focus on problem solving techniques. They mention the Six Sigma methodology, DMAIC (Define, Measure, Analyse, Improve and Control) improvement circle, as a reactive supplier development method to identify root causes of defects and to find the best solution. As a proactive approach they mention the design for six sigma (DFSS), which helps the suppliers to improve their performance. Barla (2003) suggests some improvement measures based on her lean evaluation criteria. She recommends that incoming control of goods must be eliminated. Instead, the suppliers should handle the control themselves complimented by regular audits from the buying company's engineers. This measure will remove the waste, i.e. the inspection of goods, and show a high degree of trust, an important factor in long-term relationships, and thus affect the quality performance (Barla, 2003). In addition to this, Barla (2003) remarks that reducing inventory waste due to lengthy lead times and elongated due dates is necessary. The supplier and the buying company should collaborate so that timely notifications regarding parts, lead time, material shortages, production shutdown, etc. can be given. Also, the adoption of modern technology and the increase of total monthly capacity can improve performance.

Chapter 3

Theoretical framework

The theoretical framework is a merger of the theory reviewed in the literature study. The framework is developed so to answer the conceptual side of the research question: *How can the purchasing function of a firm, seeking to perform according to lean principles, structure their supplier evaluation and development initiatives?*

The chapter starts by explaining important theoretical aspects and how these aspects were identified. Moreover, the preconditions for the proposed model is introduced. At last, the model itself is explained in detail, elaborating on each of the five steps in the model.

3.1 Important theoretical aspects

Table 3.1 shows the focal areas in the literature related to purchasing, supplier evaluation and development activities. The themes were identified through a qualitative analysis of the literature, where each chapter was reviewed in order to capture the essence of the topics. The themes were then broken down into more specific parts or merged depending on the degree of their overlapping description. The literature was then reviewed once more to identify cross-references.

	Conventional			***Lean***		
Themes	**Purchasing**	**Evaluation**	**Development**	**Purchasing**	**Evaluation**	**Development**
Aligned to corporate goals	X	X		X	X	
Formal / systematic procedures		X	X	X	X	X
Communication / feedback		X	X	X	X	X
Comprehensive criteria		X			X	
Long-term relationships	X	X	X	X	X	X
Practical criteria					X	
Process focus		X	X	X	X	X
Product focus		X	X			
Resource commitment		X			X	
Self-development/ CI		X	X	X	X	X
Service quality		X		X		
Shared company values					X	
Supply chain focus				X	X	
Supplier organisational quality		X	X	X	X	X
Supply base categorisation	X	X				X
Supply base rationalisation	X	X	X	X	X	X
Total cost	X	X		X	X	X

Table 3.1: Conventional and lean commonalities from the literature

3.1.1 Developing the model

In order to develop a model for supplier evaluation and development in a lean perspective, some restrictions had to be made. The literature on lean evaluation and development is in the authors opinion insufficient to solely base the model on this. As a result, the themes which are both mentioned in conventional and lean theory, will be utilised to develop the model, as they will provide enough material to elaborate, from conventional theory, and have been discussed in a lean manner, in lean theory.

3.2 Preconditions

From Table 3.1 it is evident, that the most recurrent themes in the literature are long-term relationships and rationalisation of the supply base. These can be viewed as preconditions for supplier evaluation and development initiatives. Preconditions must necessarily relate to the purchasing function, as such two more themes can be deducted from Table 3.1 of importance in the theory; alignment to corporate goals; and total cost.

These four themes can be understood as a process, where the supplier base is rationalised, and long-term relationships are formed with the remaining suppliers, see Figure 3.1. Both of these processes must be aligned with corporate goals, to ensure pulling the company in the right direction. The total cost factor is mentioned as an important aspect to consider for a purchasing department, as some cost related to suppliers are often neglected. This can be a useful factor to rationalise the supply base on.

3.2.1 Supplier categorisation and rationalisation

The supplier categorisation and rationalisation is a juxtaposed process to the supplier evaluation and development process. The evaluation and development will enable categorisation and rationalisation of the supply base, while the categorisation and rationalisation will ease the evaluation and development initiatives, see Figure 3.1

Before categorising and rationalising the supplier base, the desired outcomes must be aligned to corporate goals and strategies. E.g. company values/strategies focusing on creating products

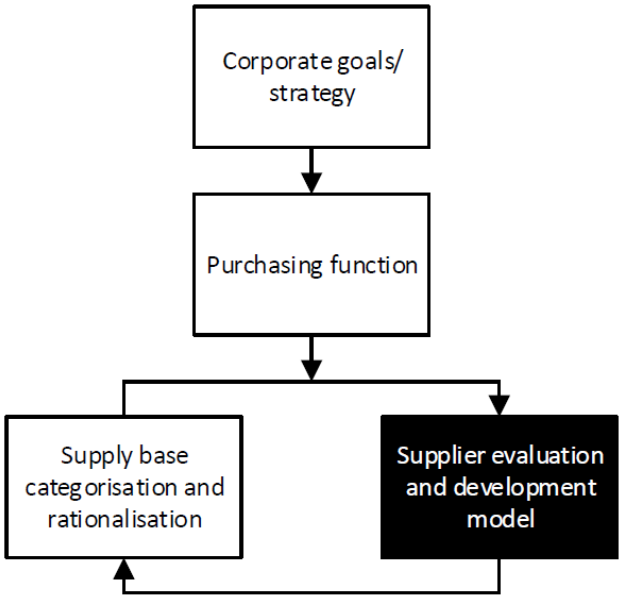

Figure 3.1: Relation of preconditions to supplier evaluation and development

and services of high quality, should sort the suppliers based on their quality performance. This is done in order to ensure a minimum of waste in the process, while maximising quality to enable lean operation. The aligned categorisation will ensure 'focused' groups of suppliers, thus the 'waste' can be removed. The waste can be in the form of unnecessary suppliers, same supplier for multiple projects, low performing suppliers etc. As such, the supply base categorisation and rationalisation goes hand in hand. This removal of waste will contribute to the enhancement of the overall quality of the supply base, due to removing those suppliers not performing sufficiently. It will also let the purchasing function focus on the remaining suppliers and build the necessary long-term and close buyer-supplier relationship through concentrated evaluations and development.

3.2.2 Long-term relationships

The forming of long-term relationships is an important factor for effective supplier evaluation and development. Keeping the same suppliers over long periods of time enables continuity in the evaluation and development process, e.g. trends in performance, comparing performance of multiple suppliers, measuring the effect of development initiatives etc.

The two most important ingredients to a long-term relationship is trust and communica-

tion which can be achieved through supply base rationalisation and supplier development. The important aspects to focus on are listed below. Long-term relationships, through consistency, shared values and goals, as mentioned above, can lead to higher performance and lower costs. The reason why long-term relationships are considered lean as opposed to short-term contracts and a diversified supplier portfolio is the ability to create specialised solutions and to incorporate the supplier in development and planning, which can enable level deliveries and production. Additional reasons are related to the increased attention the suppliers can be given, thus increasing the probability of identifying waste in the intersection between the two companies, through supplier evaluation. It also makes it easier to implement quality enhancement measures with the supplier, i.e. supplier development, as they share the same long-term goals or at least are made aware of the buyers long-term goals.

- Trust
  - Committing resources
  - Long-term contracts
  - Larger shares
- Communication
  - Feedback on performance
  - Sharing goals and strategies
  - Roadmap for requirements

3.2.3 Evaluation and development

Building the ideal supplier base is important when utilising lean. This in order to fulfil the 'flow' and streamlined overview to enable waste reduction and subsequent quality enhancement. The same goes for long-term relationships. The matching of buyers and suppliers in partnerships, where performance and strategies goals are aligned will maximise the outcomes to the focus areas. They are both desired prerequisites for efficient evaluation and development. The proposed model gives a step-wise process as how to evaluate the supplier portfolio, and develop them through a continuous improvement cycle, where lean theory is applied in the technical areas. The model for supplier evaluation and development will be further explained and discussed in the next section.

3.3 Model

The model, as mentioned, incorporates the lean thinking of continuous improvement, which permeates its design. The objective is to achieve waste reduction and quality enhancements through continuously evaluating and developing the portfolio.

It is a five step evaluation and development model, and partially inspired by the 10 step development process developed in Krause et al. (1998). The model is intended to assist companies when structuring their evaluation and development initiatives. However, it is of a general nature, which means that only the most important aspects of the theory is included. The companies utilising this model, must themselves customise the technical solutions, tools and techniques in each of the five steps.

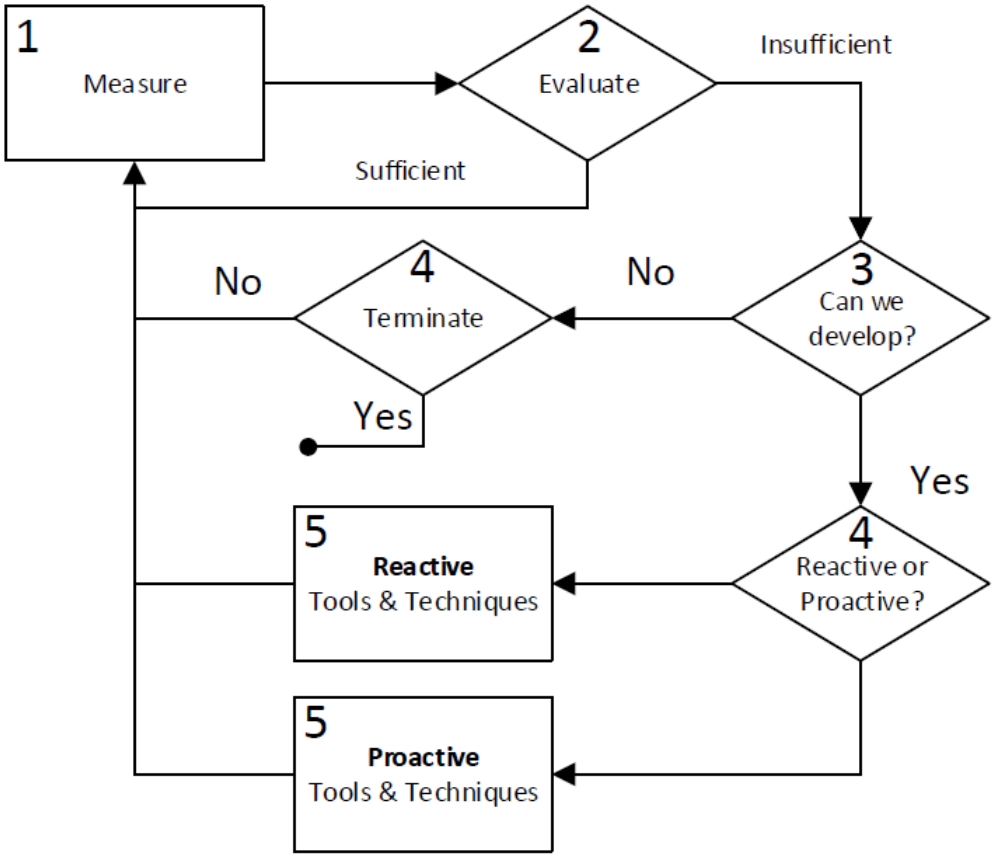

Figure 3.2: Representation of the lean evaluation and development model

The first step in the model is to measure the suppliers performances. Following the mea-

surement, in step two, the suppliers performance is evaluated in accordance with the companies requirements. In step three a decision of whether or not the suppliers can be developed is made. This decision should be in accordance with the horizontal axis of the supplier development focus matrix. Step four is to perform either proactive or reactive development. If this is not possible the decision to terminate the supplier or re-evaluate should be made. Those suppliers sorted in the reactive and proactive quadrants can subsequently be developed in accordance with the tools and techniques discussed in step five. To monitor the implemented improvements, suppliers must be measured and re-evaluated, as such creating a continuous improvement cycle for supplier performance.

Through fulfilling the required preconditions, the purchasing function will be focusing on rationalising the supply base and forming long-term relationships. Their operations will be aligned with corporate goals. As such, it is assumed that all the steps mentioned in this section adhere to these aspects without having to mention it.

The following steps elaborate the technical aspects of the model in accordance with the themes from Table 3.1, as mentioned in 3.2.

3.3.1 Step One: Measure performance

The measurement and evaluation steps, are naturally very tightly related, so that the themes identified from evaluation theory in Table 3.1 are divided between them, or utilised in both sections.

In order to conduct an effective evaluation, a structured measurement system is necessary as well as resource commitment to both processes. The reason is that measurement and evaluation is resource intensive initiatives. I.e. the criteria measured should be comprehensive and process focused as to ensure sufficient data, from the right areas, to make good evaluations. The following criteria are proposed areas to measure the suppliers by:

- Continuous improvement
- Overall supplier quality (organisational)
- Total cost

The continuous improvement should unveil the suppliers capacity to perform continuous improvements, overall supplier quality is related to financial situation, adherence to manage-

ment standards, etc, while total cost is related to the cost of ongoing business, cost of change, and risk cost.

The criteria should first and foremost be aligned with corporate goals, and be of a practical nature. This will minimise the waste in the evaluation step, i.e. ambiguous criteria, or criteria not aiding the goals of the buyer and supplier. In addition they should be process focused, as a suppliers processes are more important to their performance than technical abilities. One of the processes of highest importance, is the suppliers capability to conduct continuous improvement. If the criteria measured encompass a process focus, the suppliers organisational quality will indirectly be registered. The last criteria deemed of importance is the total cost of the supplier. I.e. what are all the cost related to the supplier, both related to the buyer but also other cost imposed on the value chain. All these criteria can be broken down into pieces, to fulfil the requirement of practical criteria, and such the measurement system will be comprehensive, ensuring evaluation of a vast amount of areas of the suppliers.

The system should also be developed with regards to how to do it, and ultimately how to process the data. In other words, the measurement processes used to measure these criteria must be specified as a part of the measurement system, and naturally which data that particular measurement process should be utilised to gather. Furthermore, where the gathered data should be stored have to be clear and concise. Ideally all the data should be gathered in a shared information-system, for easy access and total evaluation of the supplier.

3.3.2 Step Two: Evaluate performance

This stage represent the evaluation of the supplier performance to determine if the performance is sufficient or not with the standards that the company requires. The evaluation is conducted on the basis on the data collected in the previous step and should also be systematic. There are many ways to analyse the criteria measured, and this must be based on the companies priorities and desires, i.e. the criteria should be ranked after importance and their inter-dependencies identified. Some technical tools that can be used to do this is the Analytical Network Process (ANP), used to weight the criteria, DEMATEL, used to determine inter-dependencies, and the Data Envelopment Analysis (DEA), used to rank the suppliers, as mentioned in chapter 2.4.2.

If the supplier is performing at a sufficient level, the feed-back loop (see Figure 3.2), will be

a vital component in creating a continuous improvement cycle through notifying them about their satisfactory performance, re-measure, re-evaluate and so on. In addition, the company should share their long-term goals and strategies, and roadmap for requirements so to increase the level of communication. These suppliers should also be given increased attention, long-term contracts, and larger shares, so to achieve a higher degree of trust. This will lead to long-term relationships, and a somewhat rationalisation of the supplier base over time. As such, the feedback loop can be used as a tool to attain the desired preconditions if they are are not already in place, through relying on suppliers with high capacity to perform consistently and at best to continuously improve.

On the other hand, if the supplier's performance is deemed insufficient, the next step is to evaluate if development is possible or not, as explained in step three.

3.3.3 Step Three: Can we develop?

The act of developing suppliers is highly related to the power relationship between buyer and supplier and what incentives the buyer can give the supplier. Drawing upon the logic from the seminal portfolio matrix developed by Kraljic (1983), and the power balance mentioned in 2.3, a proposal of a portfolio sorting of supplier development focus is presented in figure 3.3. The purpose is to sort the suppliers in relation to the feasibility of supplier development, and what type of supplier development is suitable in regards to the business relationship circumstances.

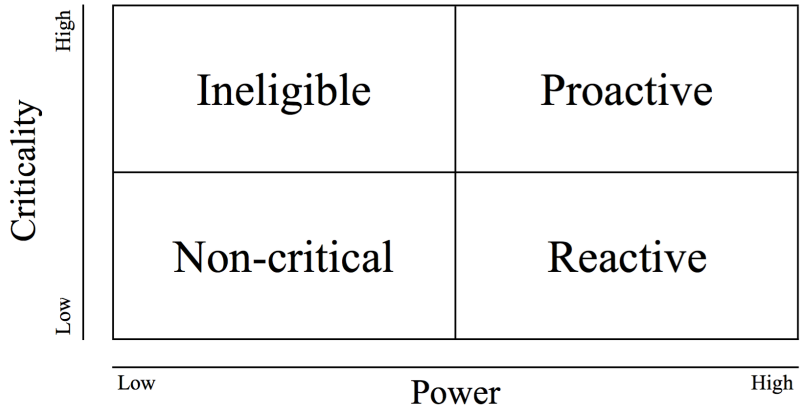

Figure 3.3: Supplier development focus

The horizontal axis of the matrix, shown in figure 3.3, represents the level of power between

the buyer and supplier, which in effect is the company's ability to influence the supplier. Suppliers in the left side of the horizontal axis generally have leverage and power skewed in favour of the supplier. This result in a limited to no possibility for the buying company to initiate supplier development activities. Suppliers placed in the right side of the horizontal axis, the buying-company generally has a position of power and leverage over, which results in the buyer having the possibility of initiating supplier development projects or programs. Suppliers not performing at a sufficient level, should therefore be considered for either development or for a potential termination of contract depending on their placement on the horizontal axis, then move on to step four.

3.3.4 Step Four: Reactive and Proactive development, or Termination?

This stage represents the decision of terminating the supplier, or deciding what form of supplier development is appropriate in relation to the criticality of the supplier. The choice of terminating suppliers is of great importance, but is outside the scope of this thesis and will therefore not be discussed in a detailed matter.

The vertical axis of the supplier development focus matrix, figure 3.3, represents the criticality the supplier has for the buying company's continued operations. Suppliers placed in the lower left quadrant in the matrix is non-critical, it embodies suppliers that have a low criticality in their importance for the company's operations. Suppliers placed in this quadrant will be of little significance to the buyer and can be neglected. Should a substitute be available, they could be replaced in order to enhance the buyers input, but this is not the most important area to improve on, and should not be prioritised. Suppliers placed in the top left quadrant is of high importance for the company's operations but the company has a low degree of power over the suppliers. These suppliers are therefore ineligible for any supplier development efforts from the company, and should therefore be evaluated for potential termination of contract if substitutes are available. In the mean time, they should be 'placed' in the feedback loop, while a replacement is sought, in case of changed circumstances in the future.

Suppliers in the lower right quadrant is of low criticality while the buying company has a position of power over the supplier to conduct supplier development initiatives, but because of their low criticality these suppliers should therefore be given little focus and any effort to de-

velop the supplier should be of reactive nature. Suppliers in the top right quadrant is of high criticality and the company has power to influence the supplier. The company should therefore focus upon creating supplier development programs for long-term improvement of the suppliers' capabilities.

3.3.5 Step Five: Reactive and proactive techniques

According to the theory, through Table 3.1, the supplier development should be a formal systematic procedure. In addition, communication and feedback is very important. The development focus should be centred around enhancing supplier organisational quality through a process focus. E.g. through enhancing the suppliers capacity to self-develop, through continuous improvement. This is an overall guideline.

As discussed in 2.3.3, the techniques for supplier development can be either proactive or reactive, and either long- or short-term. The techniques mentioned in Table 2.5 are sorted by their pro- or reactive applicability in Table 3.2. The techniques deemed both pro- and reactive are as known more suitable for short-term purposes, whereas the techniques that are only proactive can be regarded for long-term purposes. The proactive long-term tools and techniques should be utilised when seeking to adhere to lean principles.

Tools and techniques	**Proactive**	**Reactive**
Ad hoc employee supplier development teams	X	X
Certification (management standards)	X	
Competition amongst suppliers	X	X
Established supplier development teams (resource commitment)	X	
Feedback on poor performance	X	X
Involvement in product development	X	
Qualification (technical ability)	X	X
Reactive supplier audits	X	X
Recognition	X	X
Rewards (contracts)	X	
Sharing long-term goals and quality requirements	X	
Strategic supplier audits	X	
Training in continuous improvement and problem solving	X	
Training in technical competence	X	X

Table 3.2: Reactive and Proactive development tools and techniques

Chapter 4

Methodology

This chapter will discuss the research methodology and its related aspects. First, the research methodology and why it was chosen will be explained and discussed. Then, the research strategy, i.e. the choice to do an abductive study will be presented. Next, the data collection and the process of developing the case and model will be described. The literature search, interview rounds, on-site tours and other information channels are detailed. Last, validity, reliability, ethical issues and limitations is addressed.

4.1 Research methodology

Research methodology is the principles, and structuring, of executing research(Bryman, 2012). Research design is in effect a logical plan to move from research questions to an outcome. When deciding upon which form of research methodology to use, there are three conditions that are decisive. These are:

- The type of research question posed.
- The degree of control that the researchers have over behaviour.
- What focus does the research have, contemporary or historical.

As shown in table 4.1, there are five designs available. *Experiments* are research designs conducted in controlled environments and a single variable is manipulated to determine what effect it has had. Surveys are questionnaires sent to a sample of a population to discover a quantitative answer to research questions. Archival Analysis is a form of research that seeks to find information and evidence from archival records, as opposed to secondary sources. History focuses on revealing the historical reasons for outcomes. Case study research methodology is a type of research design that:

> ...investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident, Yin (2009, p. 18).

4.1.1 Choosing methodology

Case study methodology is suitable when research questions ask "how" and "why" about the topic at hand. Case studies do not require any form of control over behaviour during data gathering, and focus on contemporary events. The thesis planned to only conduct interviews with key personnel to find the rationale as to why the case company does what it does, which includes the historical reasoning for their choices. Therefore, it could be argued that history methodology could be appropriate for the thesis, as it has similar conditions as a case study. The thesis would, however, also focus on the current operational practises of the case company. Therefore case study methodology is the most appropriate for the study at hand, and was subsequently

chosen as the methodology. Additionally, the case will be a descriptive one, as it will describe the company's contemporary situation.

Method	(1) Form of Research question	(2) Requires Control of Behavioural Events?	(3) Focuses on Contemporary Events?
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival Analysis	Who, what, where, how many, how much?	No	Yes/No
History	How, why?	No	No
Case study	How, why?	No	Yes

Table 4.1: Appropriate research methodologies (Yin, 2009, p. 10)

4.2 Research strategy

According to Bryman (2012), there are two opposing approaches to conducting research, namely deductive and inductive. Deductive is based upon building the research solely on theoretical knowledge, and thereby gathering data to verify the hypothesis. Inductive is the opposite. This thesis, however, based the research on abduction, an approach described by Dubois and Gadde (2002). Abduction is the process of going back and forth between empery and theory to match them with each other, and is the foundation of systematic combining (Dubois and Gadde, 2002). Dubois and Gadde (2002) found that this way of conducting case studies, by moving in between research activities, enables the researches to expand their understanding of both the theoretical and empirical data.

The initial goal of this case study was to study the case company's current approaches for supplier evaluation and development, and to develop a lean systematic approach for this purpose. Through the process of writing this paper the aim have changed slightly. The causes for this change has been the literature review and the empirical observations conducted.

The thesis began by conducting a literature review on the main research areas, namely supplier evaluation, and supplier development. In addition, theory about the purchasing function

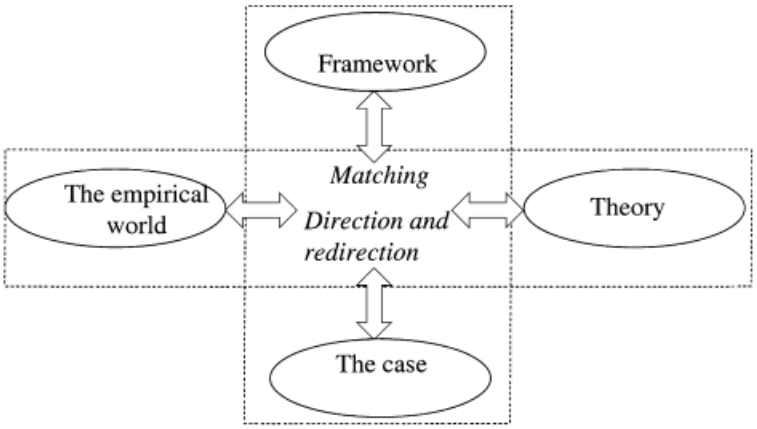

Figure 4.1: Systematic combining (Dubois and Gadde, 2002, p. 555)

and lean methodology was collected, as to better understand, and help, the case company. During the first round of interviews, observations were made that led to what Dubois and Gadde (2002) call "matching theory and reality". This means that all of the data collected did not necessarily fit the initial literature study. Thus, there was a need to expand the theoretical content as to better understand the "active data" that emerged. The phenomenon "active data" are data that are discovered through the empirical research, that were not part of what the researchers initially set out to find (Dubois and Gadde, 2002). The process of collecting empirical data and theory was such a parallel process where theory were sought to explain the empirical findings, which also led to new empirical findings, causing the need to find additional theory, etc. This is in line with the abductive approach previously discussed.

Dubois and Gadde (2002, p. 555-556):

> "As a nonlinear, path dependent process of combining efforts withe the ultimate objective of matching theory and reality"
>
> "Theory cannot be understood without empirical observation and vice versa"

4.3 Data collection

This section will present how the collection of data was conducted, namely how the literature search, interview rounds, on-site tour and supplementing information was collected.

4.3.1 Literature search

The method utilised was a combination of the so called "snow-balling" technique, use of previous read material, and recommendations from the supervisor.

The literature search consisted of three stages. First, theory relevant to the initial research questions and problem statement were identified. This comprised theory on the four main topics; supplier evaluation, supplier development, purchasing function, and lean methodology. The literature were then scanned for relevant material as to build a general understanding and enable the authors to develop interview guides for the first round of interviews in relation to the case study. The data collected in the first round of interviews was used to further scope the thesis. The model of systematic combining, presented in Dubois and Gadde (2002), states that the understanding of the researchers increases during the work, as mentioned. The choice of articles in the first phase were related to titles, summaries, citations, and previous knowledge of the papers. This is a natural consequence, as the authors lacked deep understanding of which theoretical constrictions that were necessary for the purpose of the thesis.

The second stage was in between the two periods of collecting empirical data, i.e. the two interview rounds. The empirical data gathered opened for a broader focus. For example, in the initial stages there were a lot of insecurities related to the scope. After the first round of interviews, the data gathered removed many of the uncertainties. This narrowed the scope of the case. Literature collected during this period was to enhance the understanding of the topics on a more detailed level. Thus, the authors could go back to the previous selected theory and make a narrower selection. In addition, other articles were included, e.g. because they suited the purpose of the thesis better, or served as supplements to the present literature.

The third stage was after the second and final round of interviews and is related to the development of the theoretical framework. To be able to analyse the case conducted, a theoretical framework had to be developed, merging the gathered theory into one model. This time, con-

tent was the main focus, i.e. there was a need for quantity. The different theoretical sections had to be expanded with more perspectives and different views, and other research papers were identified as a means to achieve this goal. The authors had at this point structured the theory in different dimensions, which made it easier to find relevant theory to supplement the existing one. Additionally, the work on the case study had provided new and complementing ways of viewing the problem.

In section A.4 the papers utilised and how they were identified can be examined.

4.3.2 First round of interviews

The first round of interviews where conducted in mid March and comprised 8 interviews. These where all approximately 40-60 minutes in duration and was conducted in cooperation with a second group of students writing a master thesis with the same case company. This resulted in four student interviewers and one interviewee during the meetings. Each interview was recorded for transcription. The topic of every interview was mostly the same, as both student groups where trying to gather basic information about the case company's organisation and operations. The interviews where conducted in a semi-structured way, which according to Bryman (2012) requires the development of an interview guide with somewhat specific topics to cover during interviews. The interviewees have the freedom to reply in the way he/she wants. Questions asked during the interview does not explicitly have to come from the interview guide, but can be to get the interviewee to expand upon topics of interest (Bryman, 2012). In an effort to prepare, the authors tried to familiarise themselves with the case company by studying the information published on their corporate web-page. Information about the interviewees' role in the case company, the duration of the interviews, and the topics covered during the interview is shown in table 4.2. The interview guides is listed in the appendix, see section A.2

4.3.3 Second round of interviews

The second round was conducted in mid April and comprised 11 interviews, all with varying duration and in a similar manner to the first round. That is, semi-structured interviews with interview guides developed in advance,. The interview guides are listed in the appendix, section

Role	Duration	Interview topics
Purchaser, SMCA	53 minutes	Purchasing, suppliers, lean, evaluation, development, product development, drivers for evaluation/development
Senior Purchaser, SMCA	54 minutes	Purchasing, suppliers, lean, evaluation, development, product development, drivers for evaluation/development
Senior Purchaser, LCA	41 minutes	Purchasing, suppliers, lean, evaluation, development, product development, drivers for evaluation/development
Product Director 12.7 mm, SMCA	59 minutes	Suppliers, involvement of suppliers in product development, lean
Product Director 20 - 35 mm, SMCA	47 minutes	Suppliers, involvement of suppliers in product development, lean
Quality manager, SMCA	55 minutes	Suppliers, evaluation/selection, development, lean, drivers for evaluation/development, product development
Supply Chain Director, SMCA	62 minutes	Purchasing, suppliers, evaluation, development, involvement of suppliers in product development, lean
External Consultant	43 minutes	Suppliers, involvement of suppliers in product development, supplier selection, evaluation, development

Table 4.2: First interview round

A.3. The interviews were conducted by the authors of the thesis alone. Each interview was recorded in order to transcribe them. The topics of the second-round interviews were more focused upon gathering information that was lacking from the first round and to expand on the information already known about the case company's operations. Information about the interviewees' role in the case company, the duration of the interviews, and the topics covered during the interview is shown in table 4.3.

4.3.4 On-site tour

During the second round of interviews the authors were given an on-site tour from the director of operations of ammunition. During this tour we were showed the magnitude of Raufoss Industrial park. The focal points were the manufacturing facilities and Sintefs 'Lean Lab' which were enlightening to see. Additionally, the production manager at the mechanical depart gave us a thorough introduction to the manufacturing facilities of SMCA, which let us see their level of lean manufacturing implementation first hand.

Role	Duration	Interview topics
Purchaser, AP	52 minutes	Suppliers, evaluation, development, lean
Senior Purchaser, SMCA	61 minutes	Suppliers, evaluation, development, lean, purchasing, organisational structure
Senior Purchaser, LCA	56 minutes	Suppliers, evaluation, development, lean, organisational structure
Purchasing Manager, AP	60 minutes	Suppliers, evaluation, development, lean
Director of Operations, SMCA & LCA	38 minutes	Mission, vision and strategy, lean, organisational structure
Supply Chain Manager, AP	61 minutes	Suppliers, evaluation, development, lean
Executive Vice President, SMCA	29 minutes	Suppliers, evaluation, development, mission, vision and strategy, lean, purchasing
Executive Vice President, LCA	43 minutes	Suppliers, mission, vision and strategy, lean, purchasing, organisational structure
Quality Manager, AP	69 minutes	Suppliers, evaluation, mission, vision and strategy, lean, purchasing
Project Director AMRAAM, AP	59 minutes	Suppliers, evaluation, development, lean
Production Manager, SMCA & LCA	31 minutes	Lean operations

Table 4.3: Second interview round

4.3.5 Supplementing channels of information

The data collection have not only consisted of interviews and tour observations. In addition, organisation structural charts has been received through email. The official web page of the case company has also been utilised. In the period after the second interview round there has been correspondence between the authors and Nammo personnel, where follow up questions have been sent and answered. Additionally the finished case description was sent to Nammo for their inspection. This in order to ensure that the case description is as close to reality as possible.

4.4 Building the case description

Building the case description was conducted by first writing about specific subjects that multiple interview objects discussed. This was done by reading the transcriptions of the interviews. Due to the structure of the interview guide specific questions asked could be used quickly find

the relevant information in the different transcriptions.

The case description was started on after the first round of interviews. Most of the foundational information was obtained during this round. Subsequently most of the case was built between the interview rounds. The interview guide for the second round of interviews was developed by referencing the case description and the research questions to ascertain what information was missing and were in need of elaboration.

4.5 Developing a theoretical model

The theoretical model was developed based on theory from the topics of the purchasing function, supplier evaluation, supplier development, and lean. The model was a merger of all four theoretical aspects to try and capture the best parts of each 'approach' in one structured system. Since the theory were compiled from many different authors, Table 3.1 was constructed and utilised, as this seemed the most appropriate way to ensure nothing was left unaccounted for. How to merge the theory, and structure it in a new way can be hard. Some of the theory might build on each other, but some of it may also be totally unrelated. As such, the importance to not leave anything unaddressed is amplified. The themes were collected and developed through a qualitative analysis, which might have been influence by subjectivity, and resulted in the mentioned Table 3.1.

The total framework were developed in a backwards fashion. The supplier development focus model in step 4 and 5 was developed first in an effort to help structure supplier development efforts. Thereby the framework was expanded and refined bit by bit.

4.6 Validity and reliability

Reliability and validity is a natural part of qualitative research, while adapting it to quantitative requires some changes (Bryman, 2012). Ensuring the quality of empirical social research which includes case studies can be determined, according to Yin (2009), by four tests, of which three are shown in table 4.4.

Construct validity is the identification of appropriate operational measures in relation to the

Tests	Case Study Tactic	Phase of research in which tactic occurs
Construct validity	-Use multiple source of evidence -Establish a chain of evidence -Have key informants review draft of case study report	Data collection Data collection Composition
External validity	-Use theory in single-case studies -Use replication logic in multiple-case studies	Research design Research design
Reliability	-Use case study protocol -Develop case study database	Data collection Data collection

Table 4.4: Case study tactics, adapted to the purposes of the thesis (Yin, 2009, p. 41)

concept studied in the case Yin (2009). To increase the construct validity Yin (2009) suggests the use of multiple sources of evidence to collaborate the data gathered. In this case study, where interviews was the primary source of data, multiple interviewees, see tables 4.2 and 4.3, where asked the same questions about several themes relevant for the thesis as to verify their answers and to extrapolate differences. Some interviewees where asked about different themes as their position resulted in limited knowledge about some themes and more in others. Additionally, the interviews were conducted with two to four interviewers to secure that the interpretation of what was said were as correct as possible. Furthermore, follow up questions about vague and unclear answers were sent to the interviewees to maximise the accuracy of the case description.

The second tactic to ensure validity is to establish a chain of evidence in the case (Yin, 2009). In this case study all interviews where recorded. These recordings where later used to write transcriptions of the interviews. These transcriptions became the basis for the case description, which was written by continuously reviewing the written interviews to ensure accuracy.

A third tactic, relevant for and used in the thesis, is the use of informants reviewing the case draft (Yin, 2009). First, the case description was sent to the supervisor so that the understanding of the case description conformed with the gathered raw data. When the case description was as completed as possible, with the information obtained through the two interview rounds and emails with Nammo employees, the case description was sent to the Supply Chain Director of SMCA for verification. Feedback from the case company was received less than a week before the completion of the thesis. The feedback was of minor corrections without consequence for

the analysis and conclusion of the thesis. However, the corrections where nonetheless implemented in the case description presented in this thesis to give the most accurate picture of the case company.

External validity handles the issue of how generalisable the findings of a case study is, i.e. in what way is the findings of the case study applicable for others. Case studies rely on analytical generalisation, where the goal is to generalise the results to some broader theory (Yin, 2009). This is a single-case study, as such the theoretical foundation and model, and empirical findings are compiled and discussed in the analysis.

Reliability is to ensure a form of repeatability to a study, and to minimise potential errors and biases which can influence the outcome of the study (Yin, 2009). The fact that the case description was reviewed by both the supervisor and the case company themselves strengthens the outcome of the case, as it will be as close to the attainable truth as possible. In an effort to ensure the reliability of the case study the interview guides are included in the appendix, see sections A.2 and A.3.

4.7 Ethical issues

Names of the interview objects are not included in the thesis, neither is information about who said what. This is done to protect those that has been involved in building the case, from common ethical issues, such as causing stress, breaking confidentiality, or causing internal conflicts. The scope of this case is not in any way controversial, as such, this would likely not be realistic issues. However, the authors took these precautions anyhow.

4.8 Limitations

The study could be influenced by several subjective considerations. For example, the themes in Table 3.1 were chosen based on a qualitative analysis of the theory. Qualitative analysis will always be influenced by subjective opinions.

As of repetitiveness, case studies themselves can be hard to replicate due to their qualitative form. In addition, through the use of the abductive approach, which is characterised by going

back and forth between theory and empirical findings makes the study more difficult to replicate. The reason being, that it would necessarily require that researchers trying to copy or verify the study, would have to experience the same empirical data at the same points in time, in order to select the same theory to be matched with the empirical data.

Furthermore, the authors are untrained in conducting interviews. Subsequently, the interviews conducted in relation to this thesis could have been performed more proficiently, and possibly gaining more enlightening answers if the authors had been more experienced in how to ask questions in such a manner to let the interviewee give the best possible answers.

It should also be mentioned that the documentation of the data collection in relation to the case was unstructured, resulting in limiting both the authors themselves and the readers ability to trace the findings and progress of the study.

Additionally, the transcripts where not sent back to the interviewees for confirmation about their answers, resulting in a lost chance of validating the findings early on. This could have limited any subjectivity of the authors and any perceived path dependence in the minds of the authors.

Chapter 5

Case

This case description will present facts related to the defence industry and Nammo AS as to provide information so that the reader will better understand the environment in which Nammo Raufoss As is in. The main focus of this study is Nammo Raufoss AS, with it's purchasing department and how they perform supplier evaluation and development. As such that will be the dominating parts of the case.

Information about the case company has been collected through interviews and e-mails with Nammo staff and management.

In this chapter we will introduce the defence industry as a whole and thereby shifting focus to Nammo Raufoss AS, namely their purchasing department and their supplier evaluation and development procedures. Similarities and differences between the business units will be emphasised in chapter 5.5 and 5.6.

5.1 The Defence Industry

For their products within ammunition and missile rocket technology, Nammo operates within the frames of the defence industry. That is, they have to take several aspects into consideration regarding their own operations.

5.1.1 Regulations and politics

The defence industry is an industry which is highly regulated by international politics due to its involvement in weaponry and ammunition. These regulations results in limitations concerning who Nammo can purchase from, who they can collaborate with and who they can sell to. For example, having a customer from country X removes the possibility of using a supplier from country Y, and using a supplier from country Z excludes the possibility of selling a finished component/product to country X, because of some regulation prohibiting sales from country Z to X. In addition, Nammo can be subjected to certain political agreements, namely offsets.

5.1.2 Offset agreements

An offset is a compensatory agreement regularly used in the defence industry. An offset agreement involves the transfer of production activities related to components of the product in question, from the exporting country to the importing country. This is done in order to ensure a distribution of value creation and production activities to the importing country. For example, if country X exports a certain amount of a particular product to country Y, country Y can demand that a supplier, also from country Y, supplies some of the necessary material or components to the product.

Offsets can in the long term increase the production and engineering capabilities of the importing country's companies, as it gives the importing country the opportunity to engage in production activities that would be impossible otherwise. For the producing/selling company it can make the work of purchasing more challenging as it limits the number of suppliers it can choose from. The quality of suppliers in a specific country could also be inferior to what the company needs, as the products have to be within certain quality standards.

5.1.3 Proprietary technology

The defence industry is riddled with proprietary technology, where some companies are the sole supplier of a specific technology or process. In other words, much of the power balance is shifted towards the supplier in question as there are no alternatives to their services. This makes it vital to stay on good terms and to develop long-term contracts with the 'single-sources' if not to lose the ability to acquire their services.

5.1.4 Quality assured products

Because of the nature of the products produced and sold in the defence industry, products have to adhere to strict quality standards. A way of ensuring the required quality is to 'qualify' the product, which means that the product has to be rigorously tested and approved by the customer before the start of production. In this qualification process, the engineers are usually working with the customer and/or suppliers to ensure the product is of desired quality. Depending on the complexity of the product, and necessary parts and procedures, different departments within Nammo will be involved in the product development process. When the product is 'qualified', it is qualified with the supplier infrastructure necessary to produce the entire product. Any change in the supplier structure after a qualification will therefore require the product to be re-qualified.

5.1.5 Supplier lock-in

Due to the four circumstances mentioned above, companies operating in the defence industry will often be locked to certain suppliers and sub-suppliers. The necessity to 'qualify' products, in particular, result in a reluctance to change suppliers, as re-qualification is both resource and time consuming for all parties involved. In addition, this dependence on suppliers that are 'quality-assured' for their product groups, can end up in negligence of logistical challenges related to the chosen supplier.

5.1.6 Logistical challenges

As the defence industry deals with materials and products that are highly 'sensitive', transportation is strictly managed by import and export control regulations. Import or export license is a more generally used term. These regulations are utilised to ensure that defence related technology does not get into the wrong hands. An example would be The International Traffic in Arms Regulation (ITAR) used by the US Government. These regulations can combined with the other aspects mentioned above, induce logistical challenges.

For example, gunpowder, which is essential in certain products made by Nammo, must be transported with the utmost of care and can only be transported by land or sea. This means that the goods have long transportation times. Similarly, chemicals used in production processes are purchased in bulk to reduce the transportation handling, and to gain economies of scale.

5.2 Nammo AS

NAMMO, which is short for Nordic Ammunition Company, specialises in production of defence materials, such as small to large caliber ammunition and missile rocket motors, as well as the demilitarisation of old ammunition and space propulsion. In addition, they manufacture commercial products, covering one fifth of their turnover.

It has its beginnings in 1896 as Raufoss Ammunition Factory (Raufoss Ammunisjonsfabrikk). The company grew steadily and expanded into a number of different industries during the twentieth century, but was split in the early 1990's to create entirely new companies or sold portions to other existing firms. Nammo AS was founded in 1998 due to a merger between the remaining ammunition part of what was then called Raufoss ASA, Patria Industries Oyj in Finland and Celsius AB from Sweden. The ownership of NAMMO AS is split 50/50 between the Norwegian government and the Finnish company Patria Oyj. Half the shares in Patria Oyj belongs to the Norwegian company Kongsberg AS, as such 75 % of Nammo's ownership is based in Norway.

During the spring of 2015 Nammo's Board of Directors appointed a new president and CEO, effective from August 26 the same year. With the new appointment, came organisational change.

5.2.1 Reorganisation

As of January 1st 2016, Nammo operates with a new organisational structure. Before, Nammo had five business 'divisions'; Small Caliber Division; Medium & Large Caliber Division; Missile Products Division; Demil Division and Nammo Talley. The old business divisions where overlapping in their business areas, causing unclear responsibilities. Now they have six business 'units', as shown in Figure 5.1. The purpose of the restructuring was to become more market oriented and process focused to be in-line with the company's high priority on product innovation and profitable growth.

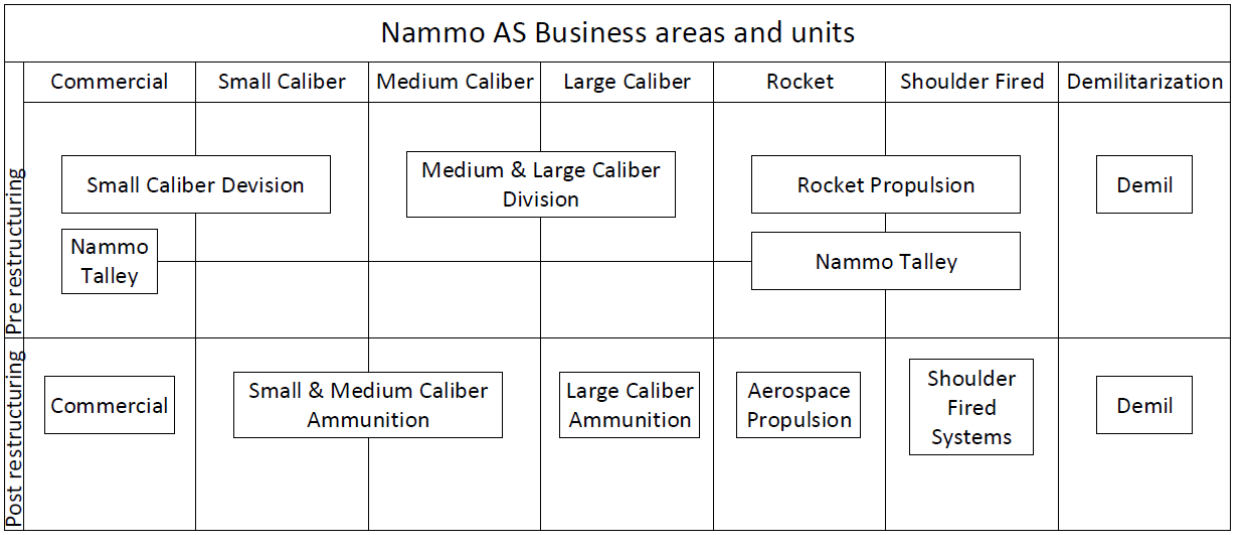

Figure 5.1: Organisational restructuring of Nammo AS

Additionally, it was intended to further increase efficiency and strengthen the market position of Nammo. Each business unit operates with an Executive Vice Presidents, reporting directly to the CEO, to ensure efficiency in communications. This is, however, the same way of operation as before the reorganisation. A short presentation of the business units follows below, Administration and Finance departments excluded:

- **Small & Medium Caliber Ammunition (SMCA) and Large Caliber Ammunition (LCA)**
  The two business units have several shared departments. Table 5.1 illustrates the functional matrix of the two business units, i.e. their shared departments. The small and medium caliber range consists of products from 4.6 mm to 40 mm diameter ammunition.

There are seven main departments; Supply Chain; Production; Global Sales & Marketing; and four Product areas. See Figure A.1. The product areas are organised into medium caliber Ammo (20, 25, 27, 30, and 40), 12.7 mm, 40 mm GL (Grenade Launcher) & Igniter Pellet, and APEX (Armor Piercing Ammunition Explosive).

	SMCA	LCA
Production	X	X
Quality Assurance	X	X
Sales & Marketing	X	X
Supply Chain	X	X
Technology and R&D	X	X

Table 5.1: SMCA & LCA matrix structure

The large caliber product range comprise 40 mm naval to 155 mm ammunition. They are also split into seven main departments; Global Sales and Marketing; Quality Assurance; Artillery and Tank; Technology and R&D; Test centre; Production; and Supply Chain. See Figure A.2. This unit utilises cross functional product groups to develop their commodities. The same applies for QA, R&D, and SCM.

- **Aerospace Propulsion (AP)**

  This unit produces rocket motor for missiles, space applications and for ejection seats. In addition to; Supply Chain; Engineering; Operations (Production); Contract & Business Support; and Product Assurance, they have their own Quality Department (Nara-Q); and a Six Sigma department. They also operate with a Trade Compliance section; Individual departments for their operations in Europe and USA; a Space & Offshore department; as well as New Technologies; Nammo Energetics IH; EMS (Energetic Material Solutions); and part of the M72 Shoulder fired system. See Figure A.3. Their products are made for rocket systems in missiles such as AMRAAM (Advanced Medium Range Air to Air Missile), Sidewinder, NSM (Naval Strike Missile), and separation and acceleration boosters for the European Space Agency's space rocket ARIANE 5.

- **Shoulder Fired Systems**

  Nammo produces several different kinds of shoulder launched rocket systems, which are used by a range of different national military services.

- **Commercial ammunition**

Production of small caliber ammunition and powder used in sports shooting such as biathlon and hunting.

- **Demil, Sea Safety and Services**
  Demilitarisation of obsolescent conventional ammunition. Production of sea safety equipment which includes products such as handheld signals, line throwers, and man-overboard lights and smoke kits.

5.2.2 Customer base

Nammo is a technology driven defence and aerospace group and most of their business comes from national armed forces and national defence industries. Their customers range from the Norwegian military service through the Norwegian National Defence Material Agency (Forsvars Materiell) and the Norwegian Institute of Defence Research (FFI - Forsvarets Forskningsinstitutt) to Asian countries and the United States, to name a few. As mentioned in 5.1.1, politics will dictate who NAMMO can and cannot sell to. This will be in relation to international and national interests, strongly connected to NATO's operations.

The rest of their business is filled up by commercial sales of services, as well as sports and security products.

5.2.3 Ethics and Export

Nammo's products are according to international laws and conventions and all export require an export license from the national authorities. As such, every production site in Nammo must comply with the national export requirement of its country. Furthermore, Nammo's Ethical Code of Conduct applies to all employees and third parties acting on behalf of the company. Nammo has zero tolerance for corruption.

5.2.4 Locations

Nammo AS is located in 12 countries around the world, namely:

- Norway
  - Raufoss
  - Aurskog
  - Løkken Verk
- Sweden
- Finland
- Poland
- Switzerland
- Germany
- Spain
- United Arab Emirates
- India
- Australia
- Canada
- USA

Nammo AS' headquarters are in Raufoss, Norway.

5.3 Nammo Raufoss AS

Nammo Raufoss AS have about 650 employees and conduct development and production activities within the four business units; Small and Medium Caliber; Large Caliber, Aerospace Propulsion, and Shoulder Fired Arms. At Nammo Raufoss they are involved in; small & medium caliber ammunition from 12.7 to 40mm; M72 and sub-caliber training systems; tank and artillery ammunition; rocket motors; Bradalsmyra Test Centre (Environmental and Ballistic testing); mechanical department offering various production services; and Non-Destructive Testing (NDT) facilities

The intent of the recent corporate reorganisation was to optimise the internal operations. Organisational changes as these take time to settle and have a practical effect. Nammo Raufoss is currently in this transitional phase.

5.3.1 Supply chain

Nammo Raufoss operate with two supply chain departments; one for Small & Medium and Large Caliber Ammunition; and one for Aerospace Propulsion and Shoulder Fired Arms. The supply chain department for the ammunition business units handle purchasing, transport, planning (material administration - MA), storage of explosive stock as well as inspection of received goods. The supply chain department for the Aerospace Propulsion and Shoulder Fired Arms

business units is in charge of purchasing, inspection of received goods, planning (material administration - MA) and stock. In addition, they also serve Nammo Raufoss AS with purchasing of indirect materials, which are all the materials that are not directly used in production. This can be anything from pencils, to computers, to paying for housing.

Because of high focus on quality and early product qualification, Nammo Raufoss is highly dependent upon their suppliers for the production of components and materials. Because of their size they do not "own" the supply chain. This can cause logistical challenges or increased expenses, as they are not in the position to choose whichever supplier they would like which also is partly due to the mentioned issues in 5.1. As an example, regarding 120 mm tank ammunition, Nammo Raufoss share the manufacturing responsibility with their supplier depending on the customers location, where Nammo produces half of the finished product and the supplier produces the other half. This way, they are able to reach a wider market. I.e. if the product is to be sold in Europe, Nammo buys the necessary parts from the supplier, assembles the product and sells it to the final customer. If the product is to be sold in the United States, the supplier buys the parts from Nammo assembles the product and sells to the final customer. This is also known as market sharing, but can also be in relation to the mandated offsets, mentioned in 5.1.2. These aspects, in addition to the mentioned regulations and political measures in 5.1.1, poses complex challenges as to the effective operational conduct of the purchasing department. Not only does it impose logistical challenges, see 5.1.6, but Nammo Raufoss' ability to gain bigger control of their supply chain as well.

5.3.2 Product development

The product office is responsible for the development of new products. A development project is triggered by the explicit demand from a customer or based upon the internal development of new technology. The product office then creates a cross functional team for the product development project. These groups comprise of product directors, project managers, engineers, purchasers, planning and quality assurance staff. Under special circumstances they can include suppliers as well. Supplier involvement in product development projects are dependent upon what technology and products the supplier have. Some suppliers are actively involved in a product development project where the supplier can be influential in the actual design of the prod-

uct. Other suppliers are given a more passive role in the project, only delivering components or systems posted by a tender. Suppliers can be selected into a development project in two ways. One is through the direct choice of engineers from the cross functional team deciding upon a specific supplier. The other is through a tender process where purchasing is involved. The engineers in the cross functional teams often decide indirectly upon a lot of important factors during the development project that the rest of the organisation have to handle during the products life time. The supplier selection process is often restricted by the frames of the defence industry. Even though Nammo provide product specification and receive tenders from multiple supplier, the product complexity or industry regulations can result in the fact that only one or two of the suppliers are actually qualified to deliver the necessary service or component. The suppliers that are given the contracts often end up as the components main supplier during the products lifespan which is due to qualification process mentioned in 5.1.4.

5.3.3 Production

Nammo Raufoss have two production departments. One for ammunition, and one for propulsion systems. They have different facilities for different parts of the manufacturing processes.

5.3.4 Improvement programs at Nammo Raufoss AS

TQM and Agile:

Since the mid 1990s they have had several periods focused upon different improvement concepts, mainly in the production department, where the first one was Total Quality Management. However, this did not last for long as it was soon replaced by the Agile concept, due to demand from one of their major customers Raytheon. The agile improvement method is distinctly different from lean, as it revolves around coping with volatile demands, through flexibility in operations, to ensure responsiveness in production.

Lean Six Sigma:

After a few years they shifted their focus towards working on continuous improvement with the Lean Six Sigma concept as a toolbox. This was to effectively optimise their operations through removal of wasteful activities, i.e. those which do not add value. In this period (2000-2006) they

had four Lean Six Sigma 'Black Belts' working full time, as a task-force. The 'Black Belts' where employees, well versed in the Lean Six Sigma techniques and lead projects related to improvement measures. During this period the Black Belts were focused on elimination of waste, 5S, shortening the lead times and reducing 'work in process'. Nammos AS' intent was to export these concepts within the entire corporation. This lead to a restructuring and a new strategy, where the Six Sigma group members were reorganised under Human Resources in the Corporate section, operating alone in different business divisions. The Lean Six Sigma program is structured the same way today.

As a result of the new strategy, from 2004-2006 the team members spent a lot of time outside Nammo Raufoss, working on Nammo's other units in Sweden and Finland. The main Lean Six Sigma techniques used during this period was basic elimination of waste, 5S, low lead times, work in process, Kaizen events, SMED, Kanban, Poka Yoke, line balancing and maintenance management. This focus on the Nammo corporation caused the operational work with Lean Six Sigma at Nammo Raufoss to have less presence. The reason is that they had less actual influence, working on their own, contrary to the previous task-force. Aerospace and Propulsion focused on building a well functioning infrastructure around their 'Black Belt' to ensure continuous improvement within their division, whereas the ammunition side of Nammo Raufoss had a more difficult time implementing the same initiative. Over time the Lean Six Sigma work phased out in routines, and new inspirations emerged bottom-up, where 'lean production' became the new concept, starting with the production factories at the ammunition business units.

Lean production:

This 'Lean' revitalisation happened in 2013 and started, as mentioned, in the production factories in the ammunition factories. They started using lean boards to keep track of tasks, projects, process and deviations in quality and delivery from suppliers. They also used factory operation plans, showing which of the machines that are in use, which that are most critical to operate in relation to orders, and what kind of control they need. This system was developed by one of their partners in Kongsberg. In addition, they created separate Hoshin-plans, keeping track of the dependence between tasks. Value-stream mapping were conducted in the beginning of this process to identify problems in their products' supply chain and internal operations at the site. They are still working on improving the current operations, and have plans of eventually

exporting these techniques to other parts of the Nammo corporation. After the successful implementation of 'Lean production' in the factories, the natural next step would be to impose the same concepts within the administrative functions at Nammo Raufoss.

5.4 Purchasing in Nammo Raufoss AS

5.4.1 Evolution and current situation

Purchasing in Nammo Raufoss AS has changed since its birth in the late 1990's. Purchasing started as purely operational and a support function to the production department. Purchasing have gradually become more involved and are now the "owners" of the suppliers. Purchasing is however still underfunded resource-vice as both purchasing departments seems to be overwhelmed by their workload. Any downtime is used to catch up on the necessary paperwork. There seems to be little extra capacity in the purchasing functions to look ahead and try to be proactive, as most purchasers interviewed gave the impression of mostly focusing upon the short-term and incoming orders as this was what was perceived as most important.

5.4.2 Impact of reorganisation

Nammo's recent organisational restructuring has not resulted in any significant changes for the purchasing operations. In Aerospace Propulsion, the main difference is that Planning is now part of the Supply Chain department instead of Production. The integration of MA into the supply chain department can in the long run give rise to more collaboration between MA and purchasing and a more value chain way of thinking by the MA-group. This was done some time ago in the SCMA/LCA side of Nammo Raufoss AS and has made MA and purchasing closer and more integrated.

5.4.3 Role and responsibility

As stated in 5.3.1 there are two separate purchasing functions in Nammo Raufoss, i.e. one in each of the two supply chain departments. Each of them are responsible of handling the purchasing duties for their respective areas. The purchasing personnel's responsibility in Nammo

Raufoss AS are divided based on products. As such, they are responsible for a certain product range and supply of the requisite materials for its production. Requirements are calculated and determined by the Materials Administration department which then sends the requisition to purchasing who handles further ordering towards suppliers. The purchaser is also responsible for handling the suppliers related to their product range. The purchaser is the main contact person for those suppliers and responsible for any contract negotiation, unless it is classified as a 'strategic' supplier. This is to reduce the total number of channels for interaction. Other purchasers can buy from suppliers they are not responsible for, as many of Nammo's products are in need of the same components. However, only the responsible purchaser will conduct negotiations with the supplier.

There are conflicting views between managers about the use and skill of purchasing in Nammo. Some have a view that purchasing's contribution in product development projects, and in general, only is in operational purchasing, where purchasing is not involved in supplier selection. Others on the other hand believe in the benefit of including purchasing and using their competence and knowledge of the defence industry's market of suppliers to find the ideal suppliers.

5.4.4 The purchasing process

Purchasing in Nammo Raufoss AS is performed in two separate ICT-systems: Oracle and Basware. Oracle is the ERP-system used at Nammo Raufoss and therefore contains the main system-database, whereas Basware is used in product development project.

A standard ordering process is:

1. Order is received at Nammo Raufoss AS.
2. Material Administration plans the production and calculates the required materials for the order.
3. The material requirements are sent to purchasing, who starts the process of sending out either purchasing orders or RFQ(Request For Quotation) to Nammo's suppliers.
4. Purchasing negotiates and comes to an agreement with suppliers.
5. Suppliers start to produce the materials, while Nammo purchasing follows the process, informing the rest of the organisations of any deviations if they occur.

6. Materials are received at Nammo Raufoss AS and inspected if necessary or received with a certificate from the supplier if there is an agreement on certificates.
7. Materials are sent to production and used to produce the order.
8. Order is completed and sent to customer.

5.4.5 AS 9100

AS9100 is an aerospace standard based on the ISO 9001 quality system requirements. AS 9100 builds on the ISO 9001 requirements and expands upon them with additional quality system requirements. This standard is imposed on Nammo by their customers in the Aerospace section, to ensure quality through the entire supply chain. Nammo has been certified in ISO 9001 the last 23 years, but with the conversion to the AS 9100 standard, Nammo was tasked with improving in many areas. For purchasing it comprised of a 120 point list of improvements which they had to implement in order to become certified, which Nammo has complied with and are now certified in AS 9100.

5.4.6 Suppliers

There is a difference in perception of the number of common suppliers between SMCA/LCA and AP, i.e. suppliers used by both SMCA/LCA and AP. SMCA/LCA believe there are more common suppliers than AP. Therefore there has been a limited effort on a collaboration between the two sides because they have believed that the effort would cost more that the gains of building a collaborative supplier handling effort.

The purchasing departments prefer long-term contracts with suppliers, usually with a duration of three years. The rationale is to give the supplier a notion of predictability in terms of what quantities Nammo will order in the coming years. In turn, this gives Nammo a degree of supplier certainty. Nammo have experienced cases of what they call material or product obsolescence, which means that a product is taken out of production by the supplier. To prevent suppliers from terminating production of products that Nammo require, they form these long-term relationships. The demand forecasts are not necessarily a 100 % correct, but serves to give the suppliers an estimate of expected demand in the coming year(s).

The necessity of qualifying suppliers for Nammo's products leads to little desire to switch suppliers, as the re-qualification process is comprehensive. The process is time and resource intensive which limits the amount of suppliers Nammo would want to, and have the resources to perform an initial evaluation upon. This threshold of initiating new suppliers heightens the importance of handling and keeping their suppliers satisfied and competent. As of this, suppliers included or qualified during the development phase of a product is commonly bound to become a long-term supplier to the said product.

Due to this particular preference and circumstances mentioned, Nammo's supplier portfolio is dominated by long-term relationships, some dating back as far as the 1960's.

Nammo classifies their suppliers into three different classes. Article suppliers, which consists of suppliers of standard products. Strategic suppliers, are single source suppliers, suppliers that Nammo purchases over 2.5 million NOK a year from, suppliers involved in defence offset agreements, or suppliers requested by a customer.

5.5 Supplier evaluation in Nammo Raufoss AS

Nammo performs multiple types of supplier measurements, these include quality inspection of incoming goods, supplier delivery precision, supplier self-evaluation questionnaires, supplier performance in product development projects, and audits of supplier production sites. The purchasing departments have the main responsibility of supplier measurements, while managers are the ones who perform the evaluation based upon reports made by purchasing. An aspect that makes supplier evaluation problematic for Nammo is that many of their suppliers only deliver once, or at best a few times a year. Giving feedback and trying to improve any supplier therefore becomes difficult. As mentioned in chapter 5.4.1, the purchasing departments have limited capacity to conduct anything besides focusing upon the immediate events. This is part of the reason why Nammo Raufoss currently does not have a structured evaluation system in place. The different forms of evaluations are discussed below.

5.5.1 Supplier portfolio

Nammo Raufoss AS seldom have a need to find new suppliers, though in some situation this is necessary. This can be related to obsolescence of products, or to new technology not available in existing suppliers. They already have a comprehensive supplier portfolio and the need to cut the amount is bigger than the need for new suppliers. This does not concern the single-source suppliers. In addition, Nammo Raufoss have a lot of suppliers on 'qualified' products, and thus switching suppliers would need a re-qualification. As a result, they can be stuck with under-performing suppliers.

On standard articles like screws and catalogue steel, they want the opportunity to be able to swap suppliers to a higher degree than now. The way they want to do this is by tenders, where they can choose the best option based upon transaction cost.

AP analyse their supplier portfolio on occasion to see if there is a need to trim it. This is in relation to closed production of the products the supplier was linked to etc. They also do this in order to identify the need for new suppliers and to identify the need to change status on some of the suppliers, e.g. to strategic supplier. The reason for this could be changes in the volume size the purchase from the supplier in question, or if the situation regarding the supplied product have changed, or if the supplier suddenly have become a single-source supplier etc.

5.5.2 Incoming material inspection

The SC department for SMCA and LCA have two persons in charge of incoming material inspection, while the SC department in AP have one person.

Not all incoming materials are inspected, as some are received on certificates from suppliers. This means that the supplier has conducted an inspection of the goods upon departure from their facilities and is vouching for the materials being of agreed upon quality and quantity. Receiving goods on certificates from suppliers requires a degree of trust between the two parties. If the component has high criticality, delivering on certificate is not accepted, as this requires an inspection. Components and material that are not received on certificates have their own reception instructions. These instructions are developed by the product groups to ensure sufficient quality on the received goods.

Nammo AS uses a ICT-system for registering deficiencies and non-conformity's in incoming materials and delivery precision. This system is called Rektron, which is a stand alone system not connected to Nammo Raufoss AS's ERP-system Oracle. Any discrepancy is registered towards the supplier, the customer-order and related project in Rektron. This allows Nammo to look at the aggregate non-conformity's of suppliers over time. Since Rektron is not connected to the ERP-system all information about the order must be added manually, and subsequently the aggregate information can only be found in the Rektron system. Everyone involved in purchasing, production, inspection of incoming goods, etc. is able to use Rektron. It is used by both AP and SMCA/LCA.

When a non-conformity is registered, a meeting is called where the responsible purchaser, incoming goods inspector, representative from the connected product group, and from the quality assurance department is present. This meeting is called to decide upon what action should be done with the goods in question. Is it usable, is there need of a sorting of the goods to sift out the defective units, or should it be sent back. The meeting also decides on who should have the responsibility of handling the situation towards the supplier, i.e. who shall contact and try to prevent future problems.

Feedback on delivery non-conformity's is given to the supplier through progress meetings, where the delivery status is discussed with the supplier. The frequency of these progress meetings vary between the different business units and the nature of the supplier and product, some have meetings as frequent as every week and others as rarely as once a year. The suppliers that have problems are focused upon and have more frequent meetings than those who perform as expected. They are working towards more frequent meetings with suppliers, and especially those not performing as required. Nammo personnel register the amount of work-hours needed to inspect, rework and fix any problems related to supplied components. This is done to get a better understanding of the costs related to supplier issues.

5.5.3 Supplier self-evaluation

Self-evaluation forms are sent to new suppliers to get information about what types of equipment that the supplier has, what types of certifications, what the financial situation is etc. Established suppliers are also sent these forms as to give Nammo an update about any changes in

the supplier. Suppliers that are classified as strategic has to perform a self-evaluation every year, while others does not. Earlier Nammo sent out a word-file containing a evaluation form which had to be manually filled out and subsequently sent back to Nammo, with no specific system for evaluating the answers. Nammo is now in the process of transitioning into a new way of sending and receiving supplier self-evaluations. They are developing and testing a electronic system where suppliers can answer the self-evaluation form in a web-based format. The service is delivered by a company called Questback, which delivers configurable online questioners with the possibility of looking at statistics on single suppliers or of the total mass. By using this new way of sending and receiving self-evaluations from suppliers, Nammo's ambition is to increase answering percentages and to gain a better insight into the structural capabilities of the suppliers and possibly future endeavours that the supplier is going to take through the use of the questback system. Supplier self-evaluation forms have to be sent out every year in compliance with the AS 9100 standard that Nammo is certified in and the purchasers are accountable for sending out to the suppliers that they have the responsibility for.

Gaining information about what the supplier is planning to do in the future is essential to Nammo, as some suppliers have *suddenly* in the eyes of Nammo changed their stance on producing and selling to the defence industry which in turn excludes selling to Nammo. This has happened some occasions and has always been in relation to Nammo sending an order to the supplier in question. Nammo has naturally been in the need of the product the supplier is provides and Nammo has therefore been forced to find a new supplier in a hurry.

5.5.4 Supplier project evaluation

During and after every product development project, an excel-sheet is registered with experiences and results of the project. In this sheet the suppliers performance is also evaluated. These sheets are stored in such a way that all employees that need this information have access to it on company servers. The sheets are named in accordance with the project name. These sheets are not searchable, which means that if anyone wants to find the performance of a particular supplier in any project, that person would have to know which projects the supplier participated in. If not the person would have to open and find the information manually in every excel-sheet.

5.5.5 Supplier audits

Nammo also evaluates their suppliers by conducting on-site audits. Nammo plans yearly supplier audit schedules where suppliers are included based on previous performance. Suppliers with historic quality or delivery precision problems registered in the Rektron system is put on the list. Emergency audits are also conducted when a supplier is unexpectedly not performing within the boundaries of Nammo's quality and delivery precision limits. An audit is conducted at the supplier site by personnel from Nammo. The delegate team from Nammo maps the suppliers' processes and potentially suggests improvements. If possible in a short time frame the delegates in collaboration with the supplier will try to execute the improvements. Who is sent on audits and who does what is not formalised in Nammo and is dependent upon the product group. Due to resource limitations only a group of a few people are sent on audits. The usual roles that are sent is the responsible purchaser, a representative from QA (quality assurance), and one of Nammo's dedicated auditors. Some product groups are more formalised and therefore have a policy about who goes on audits, while others do not.

5.5.6 AS 9100 and improvements in evaluation

In accordance with the AS 9100 standard Nammo has to measure their supplier portfolio's performance so that they can perform risk evaluation. This is something that Nammo wants to and have to develop to stay certified in the AS 9100 standard. At this time the risk evaluation system essentially is the supplier project evaluation excel-sheets. These excel-sheets are as mentioned on a project level, not on a supplier level, which is what Nammo needs the risk evaluation system to be on to be in any way usable for evaluating the risk involved with using suppliers.

Nammo is conducting a Six Sigma project to improve the incoming materials inspection process at Nammo Raufoss.

5.6 Supplier Development in Nammo Raufoss AS

5.6.1 Reactive

Nammo's supplier development is in large part reactive, which means that supplier development is done to correct an existing issue that has already resulted in Nammo receiving faulty components or at the wrong time. The focus of this reactive supplier development is to improve the suppliers immediate problem in such a way that they can deliver at the right time and with the right quality. The development work that Nammo does is conducted through the product groups that finances any development projects. These projects are ad-hoc and without any formalised structure to guide them.

5.6.2 In practice

Nammo performs external supplier development in two ways, where the first one is dominant and the other is a rare phenomenon. The first and dominant way of conducting supplier development is done through meetings with the supplier or during audits where the purchaser or quality engineer gives feedback on the supplier performance and offers suggestions about where the supplier should focus its improvement efforts. No follow up is conducted after this suggestion, and no help is offered to the supplier. The second and rare supplier development practice conducted by Nammo is Kaizen events where the purchaser, quality engineer and possibly a six sigma black belt from either the supplier or Nammo is involved in mapping the supplier's production process to find and improve the quality of the end-product.

5.6.3 Lean Six Sigma

Internally Nammo earlier had a dedicated six sigma group, as discussed in 5.3.4, that was involved in improvement projects at Raufoss and at the other Nammo production sites. Some of these sites acts as suppliers for Nammo Raufoss AS as well, for some of the products produced at Raufoss these internal suppliers are the primary supplier. Since the decentralisation of the Six Sigma group as discussed earlier, the continuous improvement work in the other sites has not been followed up.

5.6.4 Development project

A recent incident in supplier development is a project in the LCA business unit where funds have been directly granted from top management to conduct a supplier development project on a certain supplier that has not been performing. This development project has the goal of improving the supplier's quality as it is barely functioning. An issue regarding this development project is the fact that Nammo AS owns half of the supplier in question. This has in fact made it more difficult to initiate the development project as who is responsible for what and who should pay for what has been uncertain.

Chapter 6

Analysis

In this chapter Nammo Raufoss AS' purchasing function, supplier evaluation and supplier development procedures will be discussed in context of the proposed model. Through the discussion, aspects of the model and Nammo Raufoss AS will matched in order to identify similarities and differences. This is done in an attempt to discover whether or not the model can be used by a purchasing function, seeking to perform according to lean principles, when structuring (and performing) their evaluation and development initiatives.

The chapter is organised in the same order as the steps of the proposed model in chapter 3. It will therefore first analyse the preconditions, including the purchasing function, supplier rationalisation and the development of long-term relationships. Second the analysis will examine the five steps in the model related to the evaluation and development Nammo Raufoss AS perform today. Third, a discussion of the model itself is presented.

6.1 Preconditions

The proposed model suggest that the purchasing function should focus on a relational way of handling suppliers as to be able to evaluate, and potentially rationalise the portfolio in addition to sustaining and creating long-term relationships. These are the two most important prerequisites in order to ensure effective implementation and use of the model proposed. However, they will also have to be aligned with corporate goals to ensure that the right suppliers are attained and given attention.

The defence industry and Nammo Raufoss AS has a high priority on developing and producing innovative products of high quality. The suppliers are therefore of paramount importance to companies such as Nammo, as they are the ones providing the necessary quality. Even though Nammo provide product specification and receive tenders from multiple suppliers, the product complexity and/or industry regulations can result in only one or two of the suppliers are actually qualified to deliver the necessary service or component. Furthermore, long-term relationships are usual in the defence industry due to the quality assured products, the supplier lock-ins and proprietary technology. These factors influence the relationships through forming in some instances 'involuntary' long-term partnerships.

This mostly affects the purchasing department, which in some settings are given the role of an operational purchasing service and have to use the suppliers decided upon by the cross functional product teams in development projects. With regards to the purchasing functions role in the company, Nammo's purchasing function would seem to be in the implementational phase, or at least in a limited regard supporting the corporate strategy. This current operational way of the purchasing function includes much supplier handling efforts, expediting and operational purchasing. In addition, the purchasing department is underfunded and at times overwhelmed by their workload.

Their supplier portfolio is comprehensive, which is necessary due to the mentioned product complexity and proprietary technology. They do rationalise their portfolio to some degree, i.e. evaluate the contemporary suppliers to change the suppliers' status to strategic or terminate contracts e.g. As some suppliers are too important to divest or due to the mentioned lock-ins, continuous rationalisation can be challenging. In addition, the high workloads for the purchas-

ing department, as mentioned, can be a hindrance in completing complex supplier evaluation, necessary to rationalise the portfolio. This can inhibit the incorporation of the proposed supplier evaluation and development model as it can be highly resource intensive to perform. If resource commitment and utilising the purchasing function as a driver for company strategies is not an option, the model might be to comprehensive for Nammo to utilise, and could be simplified.

Long-term relational buyer-supplier relationships have several benefits over transactional, especially when trying to conduct operations in accordance with lean principles. Nammo have numerous long-term relationships with suppliers, and it is a stated goal of the company to ensure long-term contracts with suppliers. As such they are already operating in accordance with one of the prerequisites of the proposed model. However, some of their long-term partnerships are 'involuntary', as mentioned, due to the peculiarities of the industry, e.g. defence offsets etc. This can hinder the forming of relational long-term relationships with the perceived *right* suppliers, thus impeding trust and communication.

As mentioned, rationalisation can in some cases be difficult to conduct. Therefore, it reduces the intended effects of relational long-term buyer-supplier relationships with those suppliers performing satisfactory. This would be due to the limited availability of suitable alternatives, and the fact that the purchasing function has to handle more suppliers than should be necessary, and are equipped to handle. This fact could at same time increase the focus on trying to develop those suppliers performing insufficient, if possible. The current situation can be compared to the organisational structure before the reorganisation, where the different business divisions had overlapping areas of responsibility. I.e. the supplier handling appears to be shared between departments, even though the purchasing department has the formal responsibility. Theory stresses the fact that the purchasing function should handle the company's external resources. Thus, Nammo could remove waste, i.e. ambiguity in responsibilities, through defining and performing the roles and responsibilities more clearly.

6.2 Step one: Measure performance

Today Nammo perform supplier measurements in the form of:

- Incoming material inspection
- Self-evaluation forms
- Product development projects
- Supplier audits

The model suggests that criteria should be aligned to corporate goals, comprehensive, and process focused to collect sufficient data from the right areas. They should also be structured in a formal collective system to be able to perform measurements systematically, and ease the evaluation process. The following criteria are proposed areas to measure the suppliers on:

- Continuous improvement
- Overall supplier quality (organisational)
- Total cost

These criteria will unveil the suppliers capacity for self-development, their financial situation and adherence to management standards, etc, and cost related to the cost of ongoing business, cost of change, and risk cost.

Nammo have a strong focus on product quality and measure their suppliers accordingly. As such, their measurements are highly aligned to corporate goals. The quality inspections of incoming goods is an illustrative example. In addition to this Nammo receive some products on certificates. This is a resource saving solution, but it has to be monitored to prevent situations where the quality of the product changes beyond the tolerances set by Nammo. If this occurs and Nammo does not inspect and measure the goods periodically, Nammo could receive and use faulty materials or components in their products. That is why theory calls for a process focus, as to move the measurement step closer to the suppliers operations, so that inspecting the goods becomes unnecessary, thus saving resources. This also requires a high degree of trust, an important component of long-term relationships.

However, the material inspection can be perceived as process focused, e.g. if the delivery is on time, the suppliers' processes are in order. If the delivery is regularly late, supplier processes require improvements. As such, this measurement can be very useful, combined with supplier audits, which adhere to a process focus, where Nammo are able to see and evaluate the operations of their suppliers.

Nammo's yearly plan for supplier audits is currently based on the subjective evaluation from purchasers and employees in the quality assurance department and the data of measurements

in e.g. Rektron. This ensures that the suppliers Nammo have had issues with are more closely inspected than others. Even though experience can be sufficient to determine the plans, Nammo could benefit from basing the supplier audit plan by emphasising on the data, as it does not rely on individual experience.

Except from audits, Nammo is focusing on improving their system for sending and storing self evaluations. Through the self evaluation questionnaires they will gain better insight into changes in their suppliers' facilities, capabilities and future corporate directions. This will be beneficial to the company's ability to make informed decisions about who to measure and audit. It can also be expanded, so to collect more comprehensive data, giving them insight into supplier overall quality and capability to continuously improve.

Moreover, Nammo are getting certified by the AS9100 standard, which requires them to measure their suppliers in order to perform risk evaluation. The proposed model highlights the importance of measuring total cost, which includes risk cost. These can be due to; downtime; poor quality to end customer; poor end customer satisfaction; expedited air shipments; and reworking parts. Thus, these aspects can be useful to the case company as measurement criteria.

Project evaluation could benefit Nammo when choosing who to include in new product development projects, this could in the long-term improve the performance of such projects by retaining and using those suppliers performing adequate. Supplier lock-in can be influential this through reducing Nammo's ability to choose who to involve in such projects. The storing of experiences on the suppliers performance, however, is inhibiting easy access to aggregate data on supplier performances.

Even though Nammo have several individual measurement systems, they are not structured in a holistic manner. According to the model proposed, companies should measure suppliers in a structured, systematic way. This implies that the four forms of supplier performance measurements, should be documented and stored in the same procedure and information system. The proposed model could on the other hand be limited to only look at one criteria at the time, therefore circumventing the need for a comprehensive measurement system. This would however undermine the lean aspects of the model.

6.3 Step two: Evaluate performance

The theory also calls for a systematic evaluation procedure. This can be done through the use of, or a combination of, the ANP, DEMATEL or DEA techniques. In addition, making sure that the supplier receive feedback on all evaluations is important as this could result in a continuous improvement loop for the suppliers deemed sufficient in performance. However, this feedback should be quantified so they are easily comprehended, as qualitative data are more open for interpretation and subjectivity. This is desired so to cohere with lean thinking, e.g. tangible supplier rankings. Nammo's current evaluation that is based on quantified values is the material inspection.

Nammo perform evaluation based on all their measurements, as mentioned in 6.2. Supplier evaluation is conducted by management during evaluation meetings, where they base their decisions upon reports made by the responsible purchaser. This means that they partly base their evaluation upon interpretations done by the purchaser, which in turn is based on measured data and the purchasers own experience. Supplier feedback is based upon the evaluation done in these meetings and are given to the suppliers to a varying degree. Their most important suppliers are given daily to weekly feedback, whereas some are given little to none. Feedback is also given during supplier audits.

As mentioned, lean theory explains the need to quantify the measured data, to achieve consistency in the evaluations. This can serve to remove the variable waste that individual interpretations propose, as the evaluation is an important factor in the development of relational relationships with the suppliers, and can lead to improved performance and cost reduction, through feedback. As such, it is not only the evaluations that should be systematic, but also the feedback. This is to create consistency in the entire process (measurement, evaluation, and feedback), so to ensure the continuous improvement cycle. The model suggests that a systematic evaluation and feedback system, ensures good communication with all the measured suppliers, through both positive enforcement and criticism.

6.4 Step three: Can we develop?

The main point of this step is to find out if it is possible to develop the supplier. This decision is ultimately influenced by the power relationship between buyer and supplier, which can be identified through utilising the supplier development focus matrix' horizontal axis. The ideal situation is to have a portfolio of suppliers where the company have power leverage, or at least mutual dependency. In that way, most of the portfolio can be placed in the right side quadrants, which enables supplier development based on their criticality to company operations. As Nammo are hesitant to re-qualify suppliers, due to product qualifications, having suppliers it is possible to develop is very desired.

However, as Nammo have several suppliers they buy in low quantities, and rarely from, the power balance is skewed in favour of the suppliers and moves them to the left quadrants in the supplier development focus matrix. They are a small actor overall, however big on some products, where they have formed strong partnerships. Nammo's negligent power and control over suppliers limit their ability to perform development projects and programs. As such the appropriateness and practical usage of the model comes into question. However, it should be argued, that it can heightens the importance of knowing what suppliers Nammo are able to develop and who to not focus upon. This means that they not necessarily have power leverage over most of their suppliers, but could develop the ones they have long-term and strong relationships with.

Determining the relative power positions of the buyer and suppliers could pose problematic for the buying company as it e.g. involves determining what percentage of volume the buying company represents for the supplier. This process could be liable to subjective interpretation. As such, including aspects revealing the power relationships could be of significance to include in the formalised evaluation system.

6.5 Step four: Reactive and Proactive development, or termination?

For many of Nammo Raufoss AS' suppliers, termination is not an option due to the mentioned supplier lock-in situations in the defence industry. They do also, naturally, experience under-

performing suppliers, due to their high quality standards. Even though a situation where suppliers cannot be developed in any way, nor terminated, is very unlikely to occur, placing them in the measurement and evaluation feedback loop, serves as a potential solution if it at one point were to happen. This situation represents the suppliers in the top left quadrant of the supplier development focus matrix. The suppliers placed in the lower left quadrant could be suppliers of indirect materials or standard products. They are of low criticality, and can be either neglected or substituted.

The suppliers in the top right and lower right corner of the supplier development matrix is the main focus of this thesis as the suppliers in the left side, as mentioned, are not eligible for development. In a reactive approach to development, suppliers choose themselves for development by not performing at the required level of performance, while proactive suppliers are explicitly chosen for the purpose of increasing the competitive edge of the company. To the extent that supplier development is conducted in Nammo today, it is reactive. As such, Nammo does in a limited sense make an explicit choice about which suppliers to develop.

A reactive approach to supplier performance issues has been an appropriate solution, in line with Figure 2.2 presented in the literature, until now. If Nammo wants to increase their relative supplier base performance and capabilities, through lean supplier development, they have to move towards implementing proactive supplier development of the suppliers they have the ability to improve. For Nammo's part there can be a benefit from implementing proactive development, as it can lead to fewer issues with suppliers (waste), through handling problems before they occur, and at best continuously enhance the supplier. The reactive approach is not an ideal supplier development strategy as it is based on fixing problems after they materialise.

6.6 Step five: Reactive and proactive techniques

The model contains a suggestion of reactive and proactive tools and techniques, which are found in Figure 3.2. The appropriateness of utilising reactive and/or proactive is in the model dependent upon the criticality of the suppliers in accordance with the buying company's operations, see Figure 3.3. Criticality of suppliers is related to the material, component or service they supply to Nammo, and the abundance of it in the market. If this is not known to the company,

the supplier measurement should thus include these factors.

Of the tools and techniques mentioned in 3.2, Nammo Raufoss already give feedback on poor performance, qualification on technical abilities, and reactive supplier audits through ad hoc supplier development teams. Feedback is given to suppliers during meetings or audits, i.e. suggestions where the supplier should focus its internal improvement initiatives, in accordance with Nammo's performance measurements. To improve on this, Nammo could try to involve themselves more in the practical development through mutual effort, utilising strategic supplier audits, comprised by established supplier development teams.

Reactive audits are performed as a result of poor supplier performance, where the supplier has delivered insufficient quality or not delivered at the specified time. The audits contributes to quick fixes for immediate problems and focus resources were they are actually need. However, it is not an ideal situation as it can be more resource intensive than proactive development, and does not necessarily fix the problem in the long-term.

Qualification of products serve as an indirect supplier development tool. The proactive would be to move towards supplier certifications. This, however, includes several aspects. First and foremost, a healthy relationships must exist, with sufficient levels of communication and trust. Next, the evaluations and audits must be processed focused, and feedback given on long-term goals and quality requirements. Rewards should be given to the best performing suppliers to give incentives for continuously good performances. This can be anything from larger shares, to longer contracts. This will enhance the trust, which again positively influences the relationship.

Nammo's challenge becomes to cultivate a proactive supplier development scheme where most of the actual development is performed by the suppliers themselves. This will elevate them to the top level of Krause et al. (1998) model on the evolution of development initiatives in Figure 2.2. Although, it should be mentioned that suppliers of low criticality does not necessarily have to be developed in line with the proactive tools, as the gains are smaller. Attention should be focused towards critical suppliers, through proactive development.

6.7 The model in its entirety

A theoretical model's purpose is to simplify reality and give those using it a framework to base their decisions upon. Supplier evaluation and development are incredibly complex processes and a vast amount of solutions could provide the correct answer. As such, there will always be need for the company to tailor concepts and models to their specific requirements and operations. The model proposed serves as a suggestion composed by theory and contemporary practice to enhance the lean performance within the areas of supplier evaluation and development. The analysis shows that the model does to a certain degree conform with Nammo's operations in several instances, and not so much in others. For example, the structural peculiarities of the defence industry can reduce a company's ability to freely choose suppliers and therefore limit the usefulness of the model. However, if the company focus on the suppliers placed in the top right quadrant of the development focus matrix, they are off to a good start. The model can in many situations enhance their operations, but can also require significant investments in order to be implemented. A simplified version of the model could be utilised, if there is a lack of resources, through only employing the measurement and evaluation loop. By doing so, the company could implement and test a vital part of the model before embracing its entire content.

Chapter 7

Conclusion

This thesis was performed with the intention of developing a theoretical model for the structuring of supplier evaluation and development in a lean perspective. In order to answer the research question, a literature study was conducted to develop a framework, which resulted in the proposed model. Additionally, an empirical case study was conducted in order to compare the model to a real life practical setting. This chapter presents the main findings of the study. In addition, managerial implications, limitations, and suggestions for future research are described.

7.1 The model

The framework requires the two preconditions to be in place before utilising the model. The concept of the model is to ensure measurement of fewer suppliers, making it possible to perform good evaluations. This will enable supplier development in a proactive way, resulting in continuously improving the supplier base (company input). From this, better products/services (company output) follows and in the end culminating in competitive advantage. It is worth mentioning that the model suits Nammo in several ways. The parts that does not fit Nammo so well are attainable, by either adjusting the model, or for Nammo to invest and improve in order to implement the model. Although, it should be mentioned that simplifying the model could inhibit its overall lean implications.

Nammo focus on signing long-term contracts and sustaining relational alliances with their suppliers. This is partly due to supplier lock-ins. However, these circumstances can make supply base rationalisation challenging, for example because of single source suppliers, defence offsets etc. Thus, if looking to implement the model, Nammo must commit resources in order to to give increased attention to their suppliers, as the evaluation and development procedures are resource intensive, and even more so without the reduced supply base. This will additionally influence the ability to sustain the long-term relationships, make good measurements, evaluations, evolve proactive development and over-time securing a competitive advantage/increased performance.

Nammo's current way of measuring suppliers adhere to the model in most aspects, i.e. the model is an appropriate representation on how they can perform measurements. The only part missing in Nammo is from lean thinking. The aspects missing relates to structuring their measurements in a formal systematised process, to ensure consistency, comparison and enabling evaluations on tangible data. This can be done through specifying a measurement process for different categories of suppliers, and storing the data in the same system, for easy access.

Evaluation and feedback is closely related. Nammo perform somewhat systematic evaluation and feedback, although this is not the case for all their suppliers. To evolve this into a lean operation, and be able to give comprehensible feedback to their entire portfolio, Nammo would need to quantify the data so that consistent evaluations can be made, without the need for in-

dividual purchasers experience with the suppliers. Additionally, quantified data are less time demanding to share with the suppliers than qualitative. An example would be to use the tools mentioned, to attain a supplier total performance ranking score (card) and sharing it electronically vs. explaining all the measured data to a contact in the supplier in question.

The term power can be too strong and narrow to be used in the supplier development focus matrix, see Figure 3.3. The reason being that Nammo, or companies in general, does not necessarily have power leverage over all the suppliers they have an influence to develop. Thus, the word 'influence' should replace it. As Nammo have several long-term relationships and many strong partnerships, there will in total be many suppliers Nammo have the influence to develop through mutual effort. This will result in more companies being sorted in the right hand quadrants, and subsequently being subjected to development measures.

Even though termination is not a part of this thesis' scope, it is worth mentioning that if Nammo cannot terminate or substitute many of the suppliers, which they regard to have low influence over but supply critical goods, it could potentially impose a bottleneck in the model. That is, if a lot of suppliers, due to the matrix' openness to interpretation, are placed in the top left quadrant, they could pile up in the evaluation and measurement loop and create unnecessary waste in the system. In case of this, Nammo should consider reducing the measurement, or feedback effort on the suppliers in question. Regardless of the degree, in which Nammo chooses to implement the model, the supplier development focus matrix can be of use, when categorising their suppliers.

The models intended purpose could suit Nammo well overall as the process of implementing proactive development requires the company to move through a stage of reactive development, which Nammo are currently in. The tools and techniques they utilise, are all classified as reactive, in accordance with Table 3.2. Thus, the next step would be a natural one, i.e. to start implementing proactive development measures, see Figure 2.2. As such the model itself could be of use to structure the organisational activities that Nammo needs to perform in order to evolve into a proactive supplier developer.

The proposed model can be of use as a template for purchasing functions, seeking to perform lean, searching for ways to structure their supplier evaluation and development initiatives. It would in most cases require a modification of the model, as to fit the company intending to

utilise it, and their unique conditions. However, the lean aspects of the model are related to its content, and to some degree the intersections between and order of the steps. As such, any modification could inhibit the lean perspective, thus causing the model to not work as intended, or not giving the intended long-term results. In addition, it should be mentioned, that even though the model might give the impression that the utilisation of it is straightforward, the processes it involves are very complex, resource intensive, and require commitment in order to achieve successful implementation. In other words, the company will not only have to tailor the model to their needs, but modify themselves in order to utilise it properly and maximise the results.

7.2 Managerial implications

A model, intended to help a purchasing function, seeking to perform lean, in structuring their supplier evaluation and development initiatives, see chapter 3 and specifically figure 3.2. The model is proposed as a template for managers and companies seeking to implement such an arrangement. The model does need modification to companies trying to implement it, as it is generalised by nature, due to being based upon literature. The analysis revealed that the model can be appropriate for a company in the Norwegian defence industry, while the company would need to invest and structure some of its internal operations for it to work as intended. Alternatively the model could be simplified by initially focusing on implementing step one and two respectively, and subsequently adding the remaining steps on demand. Moreover, the model could be implemented fully, or in part by narrowing its focus on single criteria for measurement, evaluation and development. This would however limit the lean aspects of the model. Additionally, due to the somewhat challenging nature of the defence industry, the model shows promise of transferal to other industries.

7.3 Limitations and indications for future research

Limitations regarding the study itself was presented in chapter 4.8, as such this section will be focused upon the model proposed.

- This thesis is purely theoretical, i.e. no actual experiments or trials have been conducted. Thus, the foundation the model is built upon, the holistic view, might be flawed, meaning that the separate modules of the model might be able to utilise in a lean perspective without implementing the entire model structure. It would therefore be of interest to test the model in practice, or receive feedback from purchasing professionals about its benefits and shortcomings for further development.

- A limitation which can undermine the model is the low number of supplier deliveries that Nammo has from most of their suppliers. This fact is in limited extent incorporated in the proposed model and discussed. As such, it would therefore be of high interest for further studies to incorporate the frequency of supplier deliveries to the model.

- Further studies into the aspect of terminating supplier contracts should be conducted and incorporated into the model as it is presently severely lacking. The decision to terminate a supplier's contract is of great importance and is a subject not handled in the thesis. Any further development of the approach presented in this thesis should therefore expand upon the decision methodology to fit and further improve the usefulness of the approach.

- The model can be further developed in every step, both theoretically and through empirically testing. Certain aspects of the model does, however, need more attention than others. I.e. step three and four, which is mostly based on the supplier development focus matrix, created by the authors.

- The supplier development focus matrix in particular, shown in figure 3.3, can be developed further, as it can have aspects of it that pose as weak links. It can be developed further by either theoretical studies, or from empirical testing of it. As pointed out in the conclusion, changing the horizontal axis from power to influence could increase the usefulness of it.

- The proposed model could, due to the abductive research design, already be influenced by Nammo's operations. As such, the analysis and conclusions will be self fulfilling. Thus, a critique of the model could be conducted to reveal it's flaws and shortcomings, before subjected to empirical testing.

Appendix A

Appendix

A.1 Organisation charts

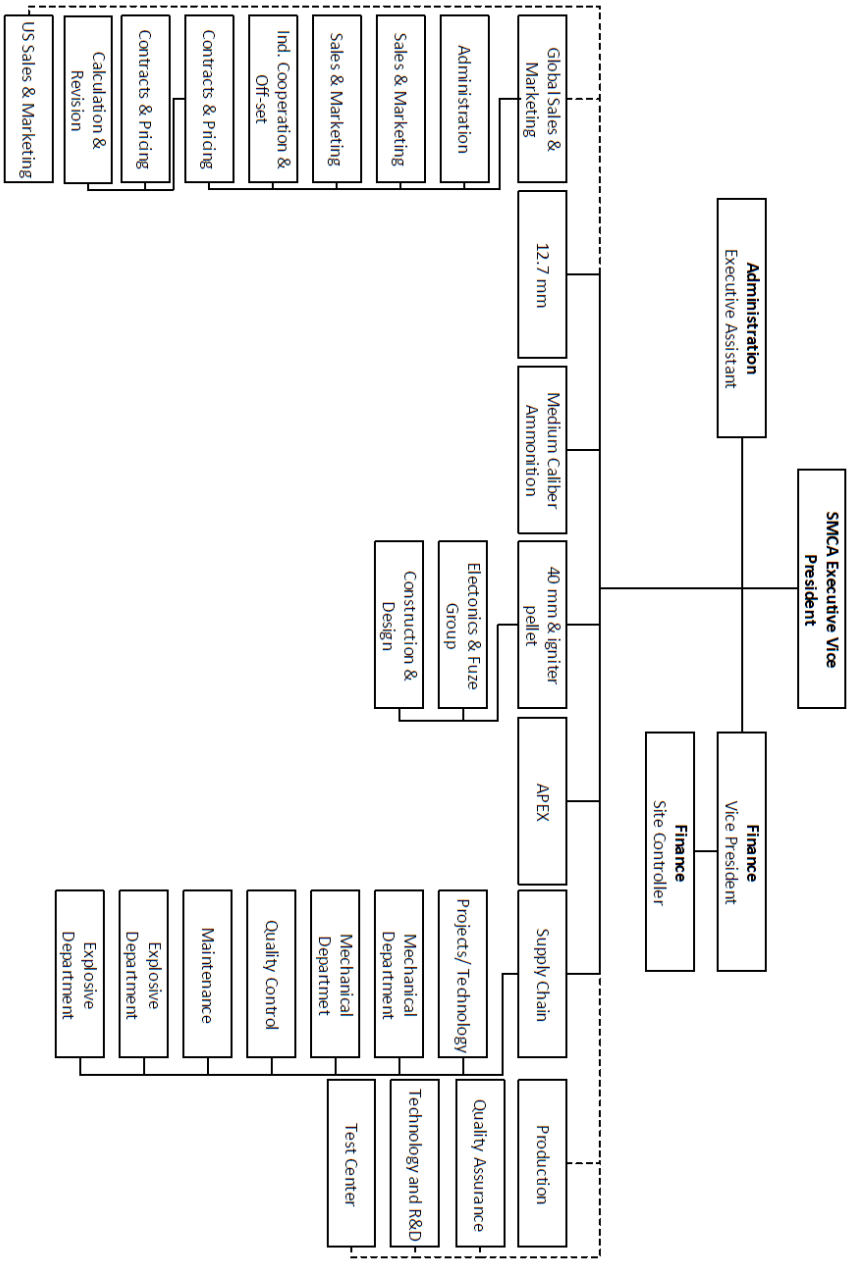

Figure A.1: Organisation chart Small Medium Caliber Ammunition

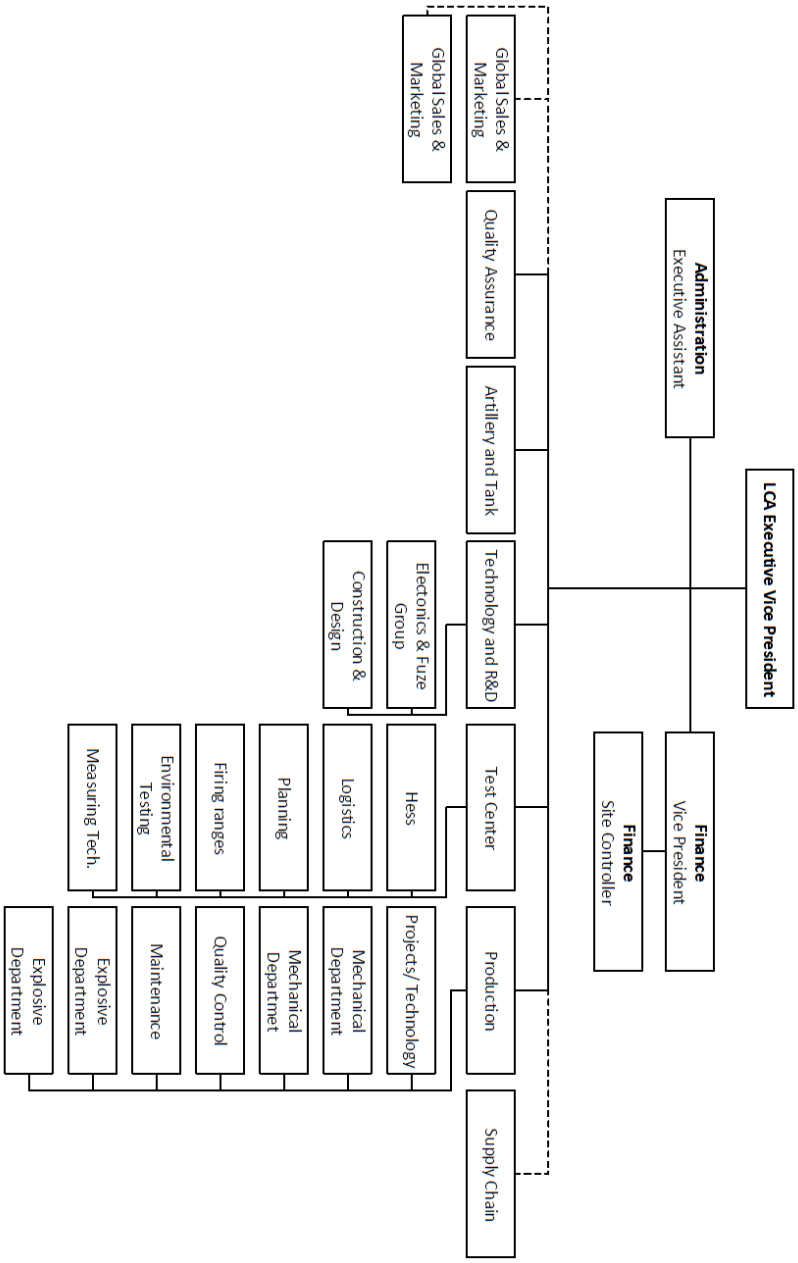

Figure A.2: Organisation chart Large Caliber Ammunition

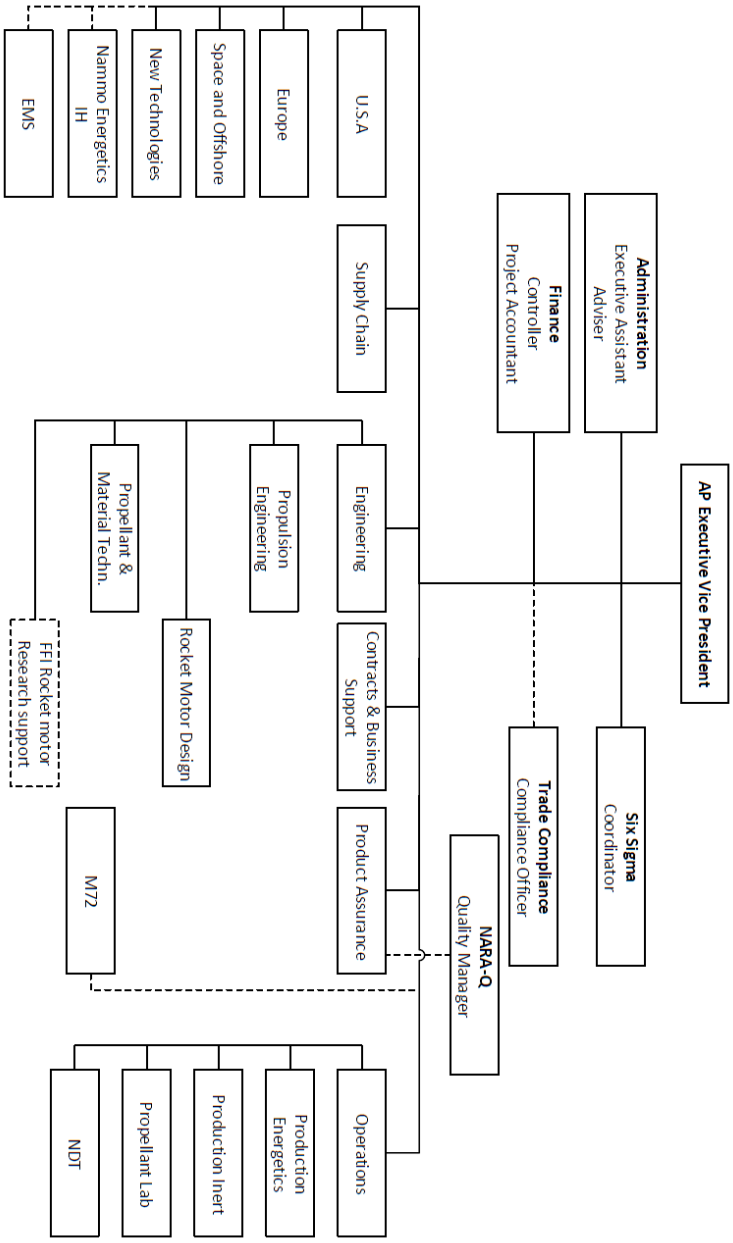

Figure A.3: Organisation chart Aerospace Propulsion

A.2 Interview guides, first round

Due to technical issues and shortage of time, the layout of the interview guides will not be optimal.

A.2.1 Purchasers

Introduksjon

- Spør kilde om det greit at vi spiller inn intervjuet. Forklar hvordan intervjuet vil bli benyttet i den videre prosessen
- Spør kilde om det er greit å identifisere vedkommede (og bedriften) med navn og stillingstittel i sluttrapporten (masteroppgaven), e-mail
- Spør kilde om vedkommende har mulighet til å gå igjennom og bekrefte vår oppsummering av intervjuets innhold ved en senere anledning

Bakgrunnsinformasjon

Hva er din rolle og dine oppgaver i Nammo?

- Hvor er du plassert i organisasjonen? (Hvilken avdeling)
    - Hvordan ser organisasjonskartet ut?
    - På deres hjemmeside, under CSR refererer dere til The procurement forum hvor dere sier "Today, procurement is organized by sites and/or business units" kan du utdype hvordan innkjøp er organisert i Nammo?

Hva er en typisk innkjøpsprossess, hvordan gjøres dette mot din(e) viktigste leverandør(er)? Steg for steg? (Vil gjerne ha en AS-IS av hele innkjøpsprossessen)

- Er det forskjell i fremgangsmåte/metode ut i fra viktigheten av leverandøren?

Hvordan holder du kontakten med dine viktigste leverandører?

- Hvor ofte møtes dere, hvem er med på de møtene?

Hvor lange kontrakter benyttes, omfanget på kontraktene?

Hvorfor byttes leverandører?

Hvordan blir nye leverandører valgt? Anbudsrunde? Politisk styrt?

Hva ligger i begrepet *"strategisk leverandør"*?

- Dere nevner i deres Supplier Conduct Principles dokument, som er å finne på "Who we are" -> "Suppliers", punkt 7 - Consequences of non-compliance: at dere har en partnerskaps fremgangsmåte mot leverandører, hva legger dere i det?

Hvilke leverandører er de viktigste for Nammo?

- (10 viktigste? Skille mellom avdelinger?)

Hvordan jobber du med dine viktigste leverandører?

- Politisk, økonomisk, kvantitativt (volumbestillinger), kvalitativt (kvalitet)?

Hvor mange leverandører har dere?

- Hvor mange interne leverandører har dere?

Hva er de største innkjøpspostene for Nammo? (5, 10, 20 største)?

Hvor stort er det totale innkjøpet Nammo gjennomfører i løpet av et år?

- Hva er summen?
- Prosentandel av total omsetning?

LEAN

Hvordan påvirker Nammos satsning på LEAN forholdet til leverandører?

- Tas det spesielle hensyn til dette ved produktutviklingsprosjekter og involvering av leverandører i disse?
- Hvilke konsekvenser har LEAN-satsningen fått for din avdeling?
    - Hvilke koblinger ser du mellom ditt og LEAN-satsningen?
- Hva heter Nammos LEAN-satsning?

Etter implementeringen av Lean, har dette påvirket innkjøp i dine øyne? Hvordan?

- Har dette påvirket håndtering/fremgangsmetode mot leverandørene?
- Har kontraktene forandret seg nevneverdig pga. lean? Krav, type osv.?

Drivkrefter

Hvorfor ønsker de å bedrive leverandørevaluering og utvikling?

- Ytre/indre drivkrefter? Hvem har tatt avgjørelsene?
- Spesifikke hendelser?

Evaluering

Gjør dere leverandørevaluering idag?

Eget system/opplegg for leverandørevaluering?

- Hvordan gjøres dette?
- Er leveringssikkerhet og service med i vurderingen?

Leverandørutvikling

Gjør dere systematisk leverandørutvikling idag?

- Hvordan?
- Hvordan finner dere ut av at en leverandør kan trenge LU? Evaluering? Hvordan gjennomføres eventuelt en evaluering?

Hvordan er prosessen fra dere identifiserer behovet for leverandørutvikling?

Er det et formalisert utviklingsprogram, eller mer ad-hoc prosjektbasert?

- Passiv/aktiv utvikling? Hva gjøres i praksis? I Supplier Conduct Principles sier dere at dere søker mot kontinuerlig forbedring(CI) og hvis leverandøren ikke klarer å holde tritt med deres standarder, vil dere om mulig ta aksjon mot leverandøren, opp til og med å avslutte kontrakten. Kan du utdype hva dere legger i å utføre aksjon mot leverandøren?

Hva er målet med LU/SD? Holde leverandørenes nivå over deres “Supplier Conduct Principles”, eller heve “topp-nivået” til leverandører?

Leverandørutvelgelse, kan du si litt om fremgangsmåte, kriterier og hvor mye politikk er avgjørende(mandated defence offsets)?

Har politikk mye å si mtp. leverandørhåndtering på generell basis? SE, SS, SD?

Produktutvikling

Hva er din rolle i forbindelse med produktutviklingsprosjekter?

- Når inkluderes innkjøp?
- Hvor aktive er innkjøp i produktutviklingsprosessen?
- Hvem påvirker valg av leverandør for utviklingsprosjekter?

Hvilke typiske utfordringer møter Nammo på ved involvering av leverandører i utviklingsprosjekter i dag sett fra ditt ståsted?

Fortell om ditt syn på involvering av leverandører i produktutvikling

Foregår det samkjørt utvikling av ny teknologi med leverandører (road maps), eller knyttes involvering av leverandører til konkrete produktutviklingsprosjekter?

Involveres leverandører i disse produktutviklingsprosjektene?

- Hvor mange leverandører er aktive i et typisk produktutviklingsprosjekt?
- På hvilket stadie involveres leverandører?

A.2.2 Quality manager

- Spør kilde om det greit at vi spiller inn intervjuet. Forklar hvordan intervjuet vil bli benyttet i den videre prosessen
- Spør kilde om det er greit å identifisere vedkommede (og bedriften) med navn og stillingstittel i sluttrapporten (masteroppgaven), e-mail
- Spør kilde om vedkommende har mulighet til å gå igjennom og bekrefte vår oppsummering av intervjuets innhold ved en senere anledning

Bakgrunnsinformasjon

Hva er din rolle og dine oppgaver i Nammo?

- Hvor er du plassert i organisasjonen?
    - Hvordan ser organisasjonskartet ut?

Hvordan holder du kontakten med dine viktigste leverandører?

Hvor lange kontrakter benyttes, omfanget på kontraktene?

Hvorfor byttes leverandører?

Hvordan blir nye leverandører valgt? Anbudsrunde? Politisk styrt?

Hva ligger i begrepet *"strategisk leverandør"*?

- Dere nevner i deres Supplier Conduct Principles dokument, som er å finne på "Who we are" -> "Suppliers", punkt 7 - Consequences of non-compliance: at dere har en partnerskaps fremgangsmåte mot leverandører, hva legger dere i det?

Hvilke leverandører er de viktigste for Nammo?

- (10 viktigste? Skille mellom avdelinger?)

Hvordan jobber du med de viktigste leverandører?

- Politisk, økonomisk, kvantitativt (volumbestillinger), kvalitativt (kvalitet)?

LEAN

Hvordan påvirker Nammos satsning på LEAN forholdet til leverandører?

- Tas det spesielle hensyn til dette ved produktutviklingsprosjekter og involvering av leverandører i disse?
- Hvilke konsekvenser har LEAN-satsningen fått for din avdeling?
    - Hvilke koblinger ser du mellom ditt og LEAN-satsningen?
- Hva heter Nammos LEAN-satsning?

Etter implementeringen av Lean, har dette påvirket innkjøp i dine øyne? Hvordan?

- Har dette påvirket håndtering/fremgangsmetode mot leverandørene?
- Har kontraktene forandret seg nevneverdig pga. lean? Krav, type osv.?

Drivkrefter

Hvorfor ønsker de å bedrive leverandørevaluering og utvikling?

- Ytre/indre drivkrefter? Hvem har tatt avgjørelsene?

- Spesifikke hendelser?

Evaluering

Gjør dere leverandørevaluering idag?

- Gjennomfører dere “audits”?

Eget system/opplegg for leverandørevaluering?

- Hvordan gjøres dette?
- Er leveringssikkerhet og service med i vurderingen?

Leverandørutvikling

Gjør dere systematisk leverandørutvikling idag?

- Hvordan?
- Hvordan finner dere ut av at en leverandør kan trenge LU? Evaluering?

Hvordan er prosessen fra dere identifiserer behovet for leverandørutvikling?

Er det et formalisert utviklingsprogram, eller mer ad-hoc prosjektbasert?

- Passiv/aktiv utvikling? Hva gjøres i praksis? I Supplier Conduct Principles sier dere at dere søker mot kontinuerlig forbedring(CI) og hvis leverandøren ikke klarer å holde tritt med deres standarder, vil dere om mulig ta aksjon mot leverandøren, opp til og med å avslutte kontrakten. Kan du utdype hva dere legger i å utføre aksjon mot leverandøren?

Hva er målet med LU/SD? Holde leverandørenes nivå over deres “Supplier Conduct Principles”, eller heve “topp-nivået” til leverandører?

Leverandørutvelgelse, kan du si litt om fremgangsmåte, kriterier og hvor mye politikk er avgjørende(mandated defence offsets)?

Har politikk mye å si mtp. leverandørhåndtering på generell basis? SE, SS, SD?

Produktutvikling

Hva er din rolle i forbindelse med produktutviklingsprosjekter?

- Når inkluderes innkjøp?
- Hvor aktive er innkjøp i produktutviklingsprosessen?
- Hvem påvirker valg av leverandør for utviklingsprosjekter?

Hvilke typiske utfordringer møter Nammo på ved involvering av leverandører i utviklingsprosjekter i dag sett fra ditt ståsted?

Fortell om ditt syn på involvering av leverandører i produktutvikling

Foregår det samkjørt utvikling av ny teknologi med leverandører (road maps), eller knyttes involvering av leverandører til konkrete produktutviklingsprosjekter?

Involveres leverandører i disse produktutviklingsprosjektene?

- Hvor mange leverandører er aktive i et typisk produktutviklingsprosjekt?
- På hvilket stadie involveres leverandører?

A.2.3 Product directors

Introduksjon

- Spør kilde om det greit at vi spiller inn intervjuet. Forklar hvordan intervjuet vil bli benyttet i den videre prosessen
- Spør kilde om det er greit å identifisere vedkommede (og bedriften) med navn og stillingstittel i sluttrapporten (masteroppgaven), e-mail
- Spør kilde om vedkommende har mulighet til å gå igjennom og bekrefte vår oppsummering av intervjuets innhold ved en senere anledning

Bakgrunnsinformasjon

Hva er din rolle og dine oppgaver i Nammo?

- Hvor er du plassert i organisasjonen? (Hvilken avdeling)
    - Hvordan ser organisasjonskartet ut?
    - På deres hjemmeside, under CSR refererer dere til The procurement forum hvor dere sier "Today, procurement is organized by sites and/or business units" kan du utdype hvordan innkjøp er organisert i Nammo?

Hva er en typisk innkjøpsprossess, hvordan gjøres dette mot din(e) viktigste leverandør(er)? Steg for steg? (Vil gjerne ha en AS-IS av hele innkjøpsprossessen)

- Er det forskjell i fremgangsmåte/metode ut i fra viktigheten av leverandøren?

Hvordan holder du kontakten med dine viktigste leverandører?

- Hvor ofte møtes dere, hvem er med på de møtene?

Hvor lange kontrakter benyttes, omfanget på kontraktene?

Hvorfor byttes leverandører?

Hvordan blir nye leverandører valgt? Anbudsrunde? Politisk styrt?

Hva ligger i begrepet *"strategisk leverandør"*?

- Dere nevner i deres Supplier Conduct Principles dokument, som er å finne på "Who we are" -> "Suppliers", punkt 7 - Consequences of non-compliance: at dere har en partnerskaps fremgangsmåte mot leverandører, hva legger dere i det?

Hvilke leverandører er de viktigste for Nammo?

- (10 viktigste? Skille mellom avdelinger?)

Hvordan jobber du med dine viktigste leverandører?

- Politisk, økonomisk, kvantitativt (volumbestillinger), kvalitativt (kvalitet)?

Hvor mange leverandører har dere?

- Hvor mange interne leverandører har dere?

Hva er de største innkjøpspostene for Nammo? (5, 10, 20 største)?

Hvor stort er det totale innkjøpet Nammo gjennomfører i løpet av et år?

- Hva er summen?
- Prosentandel av total omsetning?

LEAN

Hvordan påvirker Nammos satsning på LEAN forholdet til leverandører?

- Tas det spesielle hensyn til dette ved produktutviklingsprosjekter og involvering av leverandører i disse?
- Hvilke konsekvenser har LEAN-satsningen fått for din avdeling?
    - Hvilke koblinger ser du mellom ditt og LEAN-satsningen?
- Hva heter Nammos LEAN-satsning?

Etter implementeringen av Lean, har dette påvirket innkjøp i dine øyne? Hvordan?

- Har dette påvirket håndtering/fremgangsmetode mot leverandørene?
- Har kontraktene forandret seg nevneverdig pga. lean? Krav, type osv.?

Drivkrefter

Hvorfor ønsker de å bedrive leverandørevaluering og utvikling?

- Ytre/indre drivkrefter? Hvem har tatt avgjørelsene?
- Spesifikke hendelser?

Evaluering

Gjør dere leverandørevaluering idag?

Eget system/opplegg for leverandørevaluering?

- Hvordan gjøres dette?
- Er leveringssikkerhet og service med i vurderingen?

Leverandørutvikling

Gjør dere systematisk leverandørutvikling idag?

- Hvordan?
- Hvordan finner dere ut av at en leverandør kan trenge LU? Evaluering? Hvordan gjennomføres eventuelt en evaluering?

Hvordan er prosessen fra dere identifiserer behovet for leverandørutvikling?

Er det et formalisert utviklingsprogram, eller mer ad-hoc prosjektbasert?

- Passiv/aktiv utvikling? Hva gjøres i praksis? I Supplier Conduct Principles sier dere at dere søker mot kontinuerlig forbedring(CI) og hvis leverandøren ikke klarer å holde tritt med deres standarder, vil dere om mulig ta aksjon mot leverandøren, opp til og med å avslutte kontrakten. Kan du utdype hva dere legger i å utføre aksjon mot leverandøren?

Hva er målet med LU/SD? Holde leverandørenes nivå over deres “Supplier Conduct Principles”, eller heve “topp-nivået” til leverandører?

Leverandørutvelgelse, kan du si litt om fremgangsmåte, kriterier og hvor mye politikk er avgjørende(mandated defence offsets)?

Har politikk mye å si mtp. leverandørhåndtering på generell basis? SE, SS, SD?

Produktutvikling

Hva er din rolle i forbindelse med produktutviklingsprosjekter?

- Når inkluderes innkjøp?
- Hvor aktive er innkjøp i produktutviklingsprosessen?
- Hvem påvirker valg av leverandør for utviklingsprosjekter?

Hvilke typiske utfordringer møter Nammo på ved involvering av leverandører i utviklingsprosjekter i dag sett fra ditt ståsted?

Fortell om ditt syn på involvering av leverandører i produktutvikling

Foregår det samkjørt utvikling av ny teknologi med leverandører (road maps), eller knyttes involvering av leverandører til konkrete produktutviklingsprosjekter?

Involveres leverandører i disse produktutviklingsprosjektene?

- Hvor mange leverandører er aktive i et typisk produktutviklingsprosjekt?
- På hvilket stadie involveres leverandører?

A.2.4 Supply Chain Director

Introduksjon

- Spør kilde om det greit at vi spiller inn intervjuet. Forklar hvordan intervjuet vil bli benyttet i den videre prosessen
- Spør kilde om det er greit å identifisere vedkommede (og bedriften) med navn og stillingstittel i sluttrapporten (masteroppgaven), e-mail
- Spør kilde om vedkommende har mulighet til å gå igjennom og bekrefte vår oppsummering av intervjuets innhold ved en senere anledning

Bakgrunnsinformasjon

Hva er din rolle og dine oppgaver i Nammo?

- Hvor er du plassert i organisasjonen?
    - Hvordan ser organisasjonskartet ut?

Hvordan jobber Nammo i dag med leverandørene sine?

- Hvordan forholder din rolle seg til innkjøp?
    - Hvilke føringer, mål og rutiner styrer innkjøpsbeslutninger fra ditt ståsted?
    - Hvor mange leverandører har du å forholde deg til? Hvem er de viktigste, og hvorfor det?

Hva ligger i begrepet *"strategisk leverandør"*?

- Hvordan klassifiserer dere leverandørene deres?

Generell informasjon

Hvordan velges leverandører for denne produktgruppen i dag?

- Hvilke kriterier og føringer finnes for leverandørvalg? (Anbudsrunde? Politisk styrt?)
- Er det typisk leverandører dere har et etablert forhold til?
    - Hvordan holder man oversikt over tilgjengelige/alternative leverandører?
- Benyttes samme leverandør flere ganger?
- Hvems ansvar er leverandørutvelgelsen?
    - Produktutviklingingeniører? Innkjøpsavdelingen?
- Er praksisen for det overnevnte ulik når det kommer til utviklingsprosjekter?

Hvilke konsekvenser har lovverk og reguleringer for valg og involvering av leverandørene?

- Kan man benytte prekvalifiserte leverandører eller må de sikkerhetsklareres for hvert nytt prosjekt? Hvis ja, hvor omfattende er dette?

Hvordan påvirker gjenkjøpsavtaler valg av leverandører?

- Hva er en gjenkjøpsavtale?

Hvordan holder du kontakten med dine viktigste leverandører?

- Jobbet det annerledes mot de viktigste leverandørene enn mot mindre viktige?
- Hvorfor byttes leverandører?

Hvor lange kontrakter benyttes, omfanget på kontraktene?

Hva er ditt syn på evaluering av leverandører?

- Er du involvert i dette?
- Hvordan gjøres dette?

Hva er ditt syn på utvikling av leverandører?

- Er du involvert i dette?
- Hvordan gjøres dette?

Leverandørinvolvering i produktutvikling

Hva er din rolle i forbindelse med produktutviklingsprosjekter?

Hva utløser behovet for et produktutviklingsprosjekt?

Hva er et typisk utviklingsprosjekt i Nammo?

- Dreier det seg om revisjoner av eksisterende produkter? (se rammeverk)
    - Helt nye produkter?
    - Preges disse av høy grad av teknologisk usikkerhet (helt nye teknologier)?

Foregår det samkjørt utvikling av ny teknologi med leverandører (road maps), eller knyttes involvering av leverandører til konkrete produktutviklingsprosjekter?

Hvordan foregår et *typisk* utviklingsprosjekt hos dere i dag?

- Stemmer dette overens med fremstillingen av en generell NPD-prosess (se rammeverk) ?
- Hvor lang tid tar disse?
- Involveres leverandører i disse prosjektene?
    - Hvor mange leverandører er aktive i et typisk produktutviklingsprosjekt?
    - På hvilket stadie involveres leverandører?

Hvilke typiske utfordringer møter Nammo på ved involvering av leverandører i utviklingsprosjekter i dag?

- Hvordan forholder din rolle seg til produktutviklingsarbeid?
    - Hvilke føringer, mål og rutiner styrer arbeidet med utvikling av nye produkter?

Fortell om ditt syn på involvering av leverandører i produktutvikling

Hvilke typer kompetanse ser dere etter i leverandører som skal involveres i utviklingsprosjekter?

- Dreier det seg om leverandører av teknologier Nammo selv ikke innehar kompetanse på?
- Dreier det seg om kompetanse Nammo innehar, men hvor leverandøren inkluderes for å sikre god produserbarhet? (Outsourcing av selve produkjsonen)
- Hvor mye ansvar får en leverandør? (se black-box rammeverk)
- Hvor mye vet leverandøren om sluttproduktet og hvordan det skal brukes?
- Er det typisk modulære enheter som kan utvikles uavhengig av andre aktiviteter, eller er leverandørens bidrag av en mer integrert karakter? (definisjoner trengs)
- Bidrar leverandører typisk med:
    - Problemløsning?
    - Ressurser? (Menneskelige, kapital?)

        - Prosessteknologisk kunnskap? (Manufacturability)
        - Sluttmarkedskunnskap?
        - Materialkunnskap?
    - Hvordan bidrar leverandørene? (Kommunikasjonsform)

LEAN

Hvordan påvirker Nammos satsning på LEAN forholdet til leverandører?

- Tas det spesielle hensyn til dette ved produktutviklingsprosjekter og involvering av leverandører i disse?
- Hvilke konsekvenser har LEAN-satsningen fått for arbeidet med Supply Chain Management og Innkjøp?
    - Hvilke koblinger ser du mellom disse fagområdene og LEAN-satsningen?
- Hva heter Nammos LEAN-satsning?

Etter implementeringen av Lean, har dette påvirket innkjøp i dine øyne? Hvordan?

- Har dette påvirket håndtering/fremgangsmetode mot leverandørene?
- Har kontraktene forandret seg nevneverdig pga. lean? Krav, type osv.?

Annet

Det har blitt gjennomført forskningsprosjekt og studentoppgaver hos Nammo før, hvordan har dette gått? Har det medført noen forbedringer/endringer?

A.3 Interview guides, second round

A.3.1 All interviewees

Pre-intervju

- Introdusere oss, og oppgaven
- Be om lov til å ta opp
- Forklar at båndopptaket kun blir brukt til våre studier
- Ønsker en flytende samtale så intervjuobjektet oppfordres til å snakke fritt

Leverandører

- Hvilket forhold har du til Nammo´s leverandører?
- Definer en typisk leverandør som Nammo benytter
    - Større/mindre? Hvordan er det tekniske nivået på leverandørene?
- Hvordan klassifiserer dere leverandørene deres?
- Hvilke personer/roller har dere kontakt med hos leverandørene/er det alltid salgsavdelingen?
    - Hvilken innflytelse/autoritet har disse personene?
    - Fortelle litt detaljer om forholdene til leverandørene
        - lengde på forholdet
        - hvor mange er involvert/har kontakt med leverandør, hvem er det som har kontakt, hvem tilpasser seg hvem?
- Er det noen form for klassifisering innen kvalitet eller leveranse presisjon eller lignende? Hvordan gjøres dette?
    - Hvorfor ikke?

Evaluering

- Hvordan gjennomfører Nammo i praksis målinger og evalueringer av sine leverandører?
        - Skjema? hvordan ser dette ut? Hvem har utviklet dette?
    - Er den noen struktur i forhold til regelmessigheten av målinger/evalueringer?
    - Hvordan gjøres mottakskontrollen spesifikt?
    - Hvordan gjøres andre evalueringstiltak spesifikt
    - Er den noen begrensninger mot å kunne gjøre dette i en større grad? Strukturelle - intern/ekstern? ressursmessig?

- Hvem har hovedansvaret for evaluering av leverandører? Kvalitet eller innkjøp?
    - Settes det opp kryssfunksjonelle grupper for å samarbeide om evaluering?

- Det har blitt snakket om å bli bedre på å føre statistikk over kvalitet, mottak og slike ting relatert til leverandører, kan du si litt om dette?
    - hva er status?
    - Hva er i dine øyne grunnen for å bli bedre på dette?

- Leverandørene må utføre selvevaluering, hva legger dere i dette?
    - Hva brukes dette til?
    - Hvordan har dette fungert? Hvordan er leverandørens egenvurdering i forhold til nammo sin vurdering?
    - Skjedd endringer som følge av innføring av dette?
    - Hvem er ansvarlige for skjemaet og oppfølging av leverandører ifm dette?
    - Kan vi få et kopi av et skjema?
    -

- Det har blitt nevnt et risikoevalueringsprogram som dere holder på å innføre, kan du forklare mer i detalj hva dette er?
    - Når brukes dette?
    - Kun i leverandørutvelgelse av nye leverandører, eller er dette brukt i forbindelse med eksisterende leverandører?

- Blir målinger og evalueringer brukt?
    -
- Utvelgelse av nye leverandører, hva er kriteriene som blir brukt?
    - Hvordan blir data innhentet?

Utvikling

- Hvem er det som tar valget å prøve å utvikle en leverandør?
    - Hva er kriteriene/årsakene til å utvikle?
        - er det en fordeling over hvem som tar seg av problemer? prosessproblemer tar kvalitet, leveranseproblemer tar innkjøp?
    - Hvem har det overordnede ansvaret for prosessen?
    - Hvem er med på prosessen?

- Av utviklingsinitiativ som gjøres idag, hvem har bestemt at det skal være sånn?

- Har det noen gang blitt diskutert en mer proaktiv prosess for å utvikle leverandører?
- Er det noen form for gulerot som frister leverandører som leverer kvalitet?
- Hvordan jobbes det spesifikt i praksis når dere reiser på audits.
- Hvem er ansvarlige for å planlegge/reise på audits.
- Ser dere noe sammenheng mellom det utviklingsarbeidet som gjøres i dag og lean filosofi slik dere har lært gjennom Nammo?

Nammo: Mission, Vision, Strategy

- Har Nammo definert mål, visjon og strategi
- Hva er mål, visjon og strategi basert på? Hva er de grunnlagt i?
    - Har disse hatt en implikasjon på innkjøp sitt arbeid?

Lean

- På hvilken måte opererer Nammo etter lean prinsipper
    - Hvilke verktøy/teknikker anvendes?
    - Hvordan settes rammene for lean arbeid i Nammo?
    - Hvem har det overordnede ansvaret for lean prosessene i Nammo?
- Hva var bakgrunnen/Hva er motivasjonen for å introdusere/implementere lean i Nammo?
    - Hvordan påvirkes innkjøpsarbeidet av lean tenking i Nammo?
    - Hvordan ble dette utført i praksis? Hvordan tenker dere å gjøre dette i praksis?
    - Hvem har vært med på dette?
    - Hvem initierte dette?

Innkjøp

- Hvor mange innkjøpere er det i Nammo?
    - Hvor mange i SMCA?
    - Hvor mange i andre BU's?
- Hvordan fordeles roller og ansvar?

- Foruten kontakt med leverandør, hva gjør innkjøperne

Organisering

- Hvordan er Nammo organisert i praksis?
    - Har omstruktureringen resultert i en endring i ansvar og roller? eller er det bare på papiret?
    - Hvem er ansvarlige for hva?
    - Flat eller Vertikal struktur? Hva mener intervjuobjektet
    - Hvordan spres informasjon/nye tiltak i organisasjonen?
- SCMA?

A.4 literature search chart

Search engine/source	Search word(s)/phrase(s)	Search word(s)/phrase(s) condition(s)	Hits	Relevant articles
Krogh (2015)				Jasti and Kodali (2015) Bhamu and Singh Sangwan (2014) Cox and Chicksand (2005) Lamming (1996) Piercy and Rich (2009) Stratton and Warburton (2003) Warnecke and Hüser (1995)
Skogen (2015)				Araujo et al. (1999) Axelsson and Wynstra (2002) Bryman (2012) Dicken (2011) Kraljic (1983) Li et al. (2012) Spekman (1988) Svahn and Westerlund (2009) van Weele (2010)
Jasti & Kodali (2015)				Waters-Fuller (1995) Zhu and Meredith (1995)
Oria	Supplier development & Literature review	Title contains & Title contains	7	Noshad and Awasthi (2015), Ahmed and Hendry (2012)
Ahmed and Hendry (2012)				Wagner (2006) Krause et al. (2000) Trent and Monczka (1999) Modi & Mabert (2007) Sako (2004)
Noshad and Awashi (2015)				Bedey et al. (2009) Monczka et al. (1998) Hahn et al. (1990) Krause and Ellram (1997b) Monczka and Trecha (1988) Noori (2004) Shokri et al. (2010) Simpson et al. (2002) Sánchez-Rodríguez et al. (2005) Ho et al. (2010)
Oria	Lean supplier evaluation	All fields contain	91	Abdollahi et al. (2015) Tsai (2008) Florent and Zhen (2010) Harris and Streeter (2010)
Tsai (2008)			1	Barla (2003)
Oria	Supplier development & Review	Title (contains) & Title (contains)	27	Krause (1997)
Oria	Supplier development & Critical elements	Title (contains) & Title (contains)	1	Krause and Ellram (1997a)
Oria	Supplier development & Krause	Title (contains) & Author (contains)	12	Krause et al. (2007) Krause et al. (1998)
Oria	Supplier development & Risk	Title (contains) & Title (contains)	7	Talluri et al. (2010) Matook et al. (2009)
IØ3091 - Curriculum				Handfield et al. (2000) Farmer (1997)
Oria	Supplier development & Point of view	Any field (contains) & Any field (contains)	11	Nagati and Rebolledo (2013)
Nagati & Rebelledo (2013)				Anderson and Weitz (1992) Ramsay & Wagner (2009)

Bedey et al. (2009)				Trent et al. (1999) Krause et al. (1998)
Simpson et al. (2002)				Tan et al. (1998) Handfield et al. (1999)
Sánchez-Rodríguez et al. (2005)				Krause (1997) Carr & Pearson (1999)
Krause and Ellram (1997a)				Watts & Hahn (1993) Hahn et al. (1990)
Shokri et al. (2010)				Krause & Ellram (1997) Lo and Yeung (2006)
Waters-Fuller (1995)				Burton (1998)
TIØ4175 - Curriculum				**Cousins et al. (2008)**
Supervisor - Recommended				Dubois and Gadde (2002)
TIØ5225 - Recommended				Yin (2009)
McIvor (1997)				Gadde and Håkansson (1994)
Oria	Just-In-Time purchasing	Title (phrase)	43	Handfield (1993)
Oria	Lean purchasing	Any field (phrase)	20	Harris (2013)
Oria	Purchasing function & Evolution	Any field (phrase) & Any field (contains)	71	McIvor (1997)

Bibliography

Abdollahi, M., Arvan, M., and Razmi, J. (2015). An integrated approach for supplier portfolio selection: Lean or agile? *Expert Systems with Applications*, 42:679–690.

Ahmed, M. and Hendry, L. (2012). Supplier development literature review and key future research areas. *International Journal of Engineering and Technology Innovation*, 2:293–303.

Anderson, E. and Weitz, B. (1992). The use of pledges to build and sustain commitment in distribution channels. *Journal of Marketing Research*, 29:18–34.

Araujo, L., Dubois, A., and Gadde, L.-E. (1999). Managing interfaces with suppliers. *Industrial Marketing Management*, 28:497–506.

Axelsson, B. and Wynstra, F. (2002). *Buying Business Services*. Wiley, Chichester.

Barla, S. B. (2003). A case study of supplier selection for lean supply by using a mathematical model. *Logistics Information Management*, 16:451–459.

Berenyi, L. and Banhegyesi, L. (2015). The evaluation and selection of suppliers - in a lean approach. *European Scientific Journal*, 7:25–38.

Bhamu, J. and Singh Sangwan, K. (2014). Lean manufacturing: literature review and research issues. *International Journal of Operations and Production Management*, 34:876–940.

Bryman, A. (2012). *Social research methods*. Oxford university press, Great Clarendon Street, Oxford OX2 6DP, 4th edition.

Burton, T. T. (1988). Jit/repetitive sourcing strategies: "tying the know" with your suppliers. *Production and Inventory Management Journal*, Fourth quarter:38–42.

Carr, A. S. and Pearson, J. N. (1999). Strategically managed buyer-supplier relationships and performance outcomes. *Journal of Operations Management*, 17:497–519.

Cousins, P., Lamming, R., Lawson, B., and Squire, B. (2008). *Strategic supply management - principles, theories and practice*. Prentice Hall - Financial Times, England, 1st edition.

Cox, A. and Chicksand, D. (2005). The limits of lean management thinking: Multiple retailers and food and farming supply chains. *European Management Journal*, 23:648–662.

Dicken, P. (2011). *Global Shift: Mapping the changing contours of the world economy*. The Guilford Press, 72 Spring Street, New York, NY 10012, 6th edition.

Dubois, A. and Gadde, L.-E. (2002). Systematic combining: an abductive approach to case research. *Journal of Business Research*, 55:553–560.

Farmer, D. (1997). Perspective: Purchasing myopia- revisited. *European Journal of Purchasing and Supply Management*, 3, No. 1:1–8.

Florent, T. M. and Zhen, H. (2010). Study on the supplier evaluation index system of lean supply chain. *International Conference on e-Education, e-Business, e-Management and e-Learning*.

Gadde, L.-E. and Håkansson, H. (1994). The changing role of purchasing: Reconsidering three strategic issues. *European Journal and Supply Management*, 1(1):27–35.

Hahn, C. K., Watts, C. A., and Kim, K. Y. (1990). The supplier development program: A conceptual model. *Journal of Purchasing and Materials Management*, 26:2–7.

Handfield, R. B. (1993). A resource dependence perspective of just-in-time purchasing. *Journal of Operations Management*, 11:289–311.

Handfield, R. B., Krause, D. R., Scannell, T. V., and Monczka, R. M. (2000). Avoid the pitfalls in supplier development. *Sloan Management Review*, 41:37–49.

Handfield, R. B., Ragatz, G. L., Petersen, K. J., and Monczka, R. M. (1999). Involving suppliers in new product development. *California Management Review*, 42:1:59–82.

Harris, C. (2013). A metric to drive lean purchasing. *Industrial Management*, 55:10–14.

Harris, C. and Streeter, C. (2010). A new purchasing philosophy. *Industrial Engineer*, 42/9:43–46.

Ho, W., Xu, X., and Dey, P. K. (2010). Multi-criteria decision making approaches for supplier evaluation and selection: A literature review. *European Journal of Operational Research*, 202:16–24.

Jasti, N. V. K. and Kodali, R. (2015). Lean production: literature review and trends. *International Journal of Production Research*, 53:3:867–885.

Kraljic, P. (1983). Purchasing must become supply management. *Harvard Business Review*, September-October:109–117.

Krause, D. R. (1997). Supplier development: Current practices and outcomes. *International Journal of Purchasing and Materials Management*, Spring:12–19.

Krause, D. R. and Ellram, L. M. (1997a). Critical elements of supplier development: The buying-firm perspective. *European Journal of Purchasing and Supply Management*, 3(1):21–31.

Krause, D. R. and Ellram, L. M. (1997b). Success factors in supplier development. *International Journal of Physical Distribution & Logistics Management*, 27:39–52.

Krause, D. R., Handfield, R. B., and Beverly, B. T. (2007). The relationships between supplier development, commitment, social capital accumulation and performance improvement. *Journal of Operations Management*, 25:528–545.

Krause, D. R., Handfield, R. B., and Scannell, T. V. (1998). An empirical investigation of supplier development: reactive and strategic processes. *Journal of Operations Management*, 17:39–58.

Krause, D. R., Scannell, T. V., and Calantone, R. J. (2000). A structural analysis of the effectiveness of buying firms' strategies to improve supplier performance. *Decision Sciences*, 31(1):33–55.

Lamming, R. (1996). Squaring lean supply with supply chain management. *International Journal of Operations and Production Management*, 16:183–196.

Li, W., Humphreys, P. K., Yeung, A. C., and Cheng, T. (2012). The impact of supplier development on buyer competitive advantage: A path analytic model. *International Journal of Production Economics*, 135:353–366.

Lo, V. H. Y. and Yeung, A. (2006). Managing quality effectively in supply chain: a preliminary study. *Supply Chain Management: An International Journal*, 11/3:208–215.

McIvor, R., Humphreys, P., and McAleer, E. (1997). The evolution of the purchasing function. *Strategic Change*, 6:165–179.

Monczka, R. M. and Trecha, S. J. (1988). Cost-based supplier performance evaluation. *Journal of Purchasing and Materials Management*, Spring:2–7.

Nagati, H. and Rebolledo, C. (2013). Supplier development efforts: The suppliers' point of view. *Industrial Marketing Management*, 42:180–188.

Noori, H. (2004). Collaborative continuous improvement programs in supply chain. *Problems and Perspectives in Management*, 2:228–245.

Noshad, K. and Awasthi, A. (2015). Supplier quality development: A review of literature and industry practices. *International Journal of Production Research*, 53(2):466–487.

Piercy, N. and Rich, N. (2009). The implications of lean operations for sales strategy: from sales-force to marketing-force. *Journal of Strategic Marketing*, 17:237–255.

Sako, M. (2004). Supplier development at honda, nissan and toyota: comparative case studies of organizational capability enhancement. *Industrial and Corporate Change*, 13:281–308.

Sánchez-Rodríguez, C., Hemsworth, D., and Martínez-Lorente, A. R. (2005). The effect of supplier development initiatives on purchasing performance: a structural model. *Supply Chain Management: An International Journal*, 10/4:289–301.

Shokri, A., Nabhani, F., and Hodgson, S. (2010). Supplier development practice: Arising the problems of upstream delivery for a food distribution sme in the uk. *Robotics and Computer-Integrated Manufacturing*, 26:639–646.

Simpson, P. M., Siguaw, J. A., and White, S. C. (2002). Measuring the performance of suppliers: An analysis of evaluation processes. *Journal of Supply Chain Management*, Winter:29–41.

Spekman, R. E. (1988). Strategic supplier selection: Understanding long-term buyer relationships. *Business Horizons*, July-August:75–81.

Stratton, R. and Warburton, R. D. H. (2003). The strategic integration of agile and lean supply. *International Journal of Production Economics*, 85:183–198.

Svahn, S. and Westerlund, M. (2009). Purchasing strategies in supply relationships. *Journal of Business and Industrial Marketing*, 24:173–181.

Tan, K. C., Kannan, V. R., and Handfield, R. B. (1998). Supply chain management: Supplier performance and firm performance. *International Journal of Purchasing and Materials Management*, Summer:2–9.

Trent, R. J. and Monczka, R. M. (1999). Achieving world-class supplier quality. *Total Quality Management*, vol. 10 no. 6:927–938.

Tsai, W. (2008). Fuzzy measures of supplier evaluation under lean concepts. *Journal of the Operational Research Society*, 60:1005–1011.

Van Weele, A. J. (2010). *Purchasing and Supply Chain Management: Analysis, Strategy, Planning and Practice*. Cengage Learning, Hampshire, United Kingdom, 5th edition.

Warnecke, H. J. and Hüser, M. (1995). Lean production. *International Journal of Production Economics*, 41:37–43.

Watts, C. A. and Hahn, C. K. (1993). Supplier development programs: An empirical analysis. *International Journal of Purchasing and Materials Management*, 29(2):10–17.

Yin, R. K. (2009). *Case Study Research: Design and Methods*. Sage Publications, Inc., fourth edition edition.