CHALMERS
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Measuring supply chain performance through KPI identification and evaluation

Master's thesis in "Supply Chain Management" and "Quality and Operations Management"

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Division of Operations Management
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Abstract

Supply chain management has become one of the most discussed topics in business literature and is by many organisations considered a key strategic element. Today, markets have become more dynamic with rapid changes in customer requirements. These rapid changes have increased the importance for companies to ensure that materials and information flow smoothly between the actors in a supply chain.

Being able to measure supply chain performance is important since it leads to a greater understanding of the supply chain and provides important feedback on the improvement progress. In spite of companies' and managers' recognition of the importance of supply chain management, they often lack the ability to develop effective performance measures and metrics. In addition, relatively little literature covering PMSs and the selection of performance measures in the context of supply chain management exists.

The purpose of the thesis is to develop a structured framework for creating and evaluating supply chain performance indicators with the aim of facilitating organisations' efforts when measuring supply chain performance.

The theoretical framework, focusing on relevant aspects when measuring supply chain performance, was formed and used in order to develop a new framework for measuring supply chain performance. To investigate the functionality of the framework it was tested in a case study at Swedish Match. The empirical data builds on eight interviews made with the head of each function within the Global supply chain department at Swedish Match as well as on documents and observations. The data consists of information regarding what measures Swedish Match is currently using, as well as how it categorise, and share these performance measures.

The output after applying the framework at Swedish Match resulted in twenty-seven new measures divided into four different categories, measures taken directly from theory, measures defined by the researchers with inspiration from theory, measures from theory already in use at SM, and measures not suitable for Swedish Match. The result from the case study shows that the framework can be used to develop new performance measures. However, before being properly implemented the success of the measures is uncertain.

Keywords: *supply chain management, supply chain strategy, supply chain performance, performance measures, performance measurement system, key performance indicators.*

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Gothenburg, August 14

Niclas Gamme

Martin Johansson

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Table of Abbreviations

BC	Business Control
BS	Business & Operations Support
BSC	The Balanced Scorecard
COGM	Cost Of Goods Manufactured
COGS	Cost of Goods Sold
CPFR	Collaborative Planning Forecasting and Replenishment
CRP	Continuous Replenishment Programmes
DC	Distribution Centre
E & QA	Engineering & QA
EDLP	Everyday Low Pricing
GF	Gothenburg Factory
GSC	Global Supply Chain
HLP	High-Low Pricing
KF	Kungälv factory
KPI	Key Performance Indicator
LS	Loose Snus
OEE	Overall Equipment Effectiveness
PL	Planning & Logistics
PMS	Performance Measurement System
POA	Performance Of Activity
PS	Portion Snus
PSI	Product Supply & Innovation
PSO	Portion Snus Original
PSW	Portion Snus White
QDE-STEP	Quality, Delivery, Economy, Safety, Technology, Environment, Personnel
SCM	Supply Chain Management
SKU	Stock Keeping Unit
VMI	Vendor Managed Inventory

1. INTRODUCTION

This chapter provides the reader with an introduction, starting with the Background where the topic of the thesis is introduced. The second sections present the Purpose and aim of the thesis. The introduction continues with a Problem analysis where three research questions are presented, and ends with Delimitations.

1.1 Background

Supply chain management (SCM) is a term that was first introduced by consultants in the early 1980's and has since then frequently gained increased attention by both researchers and organisations (Lambert & Cooper, 2000). Today, it has become one of the most discussed topics in business literature (Peng Wong & Yew Wong, 2007) and is considered a key strategic element (Gunasekaran et al., 2001).

The reason for the increased focus in supply chain management is largely due to the complex environment in which companies compete. Markets have become far more dynamic and turbulent with rapid changes in customer requirements (Jespersen & Skjott-Larseen, 2005). The markets have also become more segmented which means that customers have various requirements for products and services. In addition, increased requirements on companies from a market to deliver multiple product varieties and provide customised solutions of both products and services are increasing. Furthermore, global competition has put pressure on companies to become faster, better, and cheaper (Jespersen & Skjott-Larseen, 2005). This implies that companies have begun to use outsourcing as a main strategy since it is costly and difficult to produce the needs solely on their own (Gunasekaran et al., 2001). In turn, this emphasise the importance for companies to build strong relationships with other actors in the chain in order to stay competitive. The increased importance for cooperation and integration among actors results in greater complexity when it comes to management and control of technology (Jespersen & Skjott-Larseen, 2005).

Companies and managers have started to realise the potential benefits with supply chain management, and also that competition now increasingly exists between different supply chains rather than between two companies. In spite of companies' and managers' recognition of supply chain management they often lack the ability to develop effective performance measures and metrics (Gunasekaran et al., 2001). This is supported by Bourne et al. (2003) who state that approximately 70 percent of the attempts to implement performance measurement systems (PMS) fail. Measuring supply chain performance might lead to a greater understanding of the supply chain and helps to test and reveal the viability of a firm's strategies. In addition, Ramaa et al. (2009) state that measuring supply chain performance provides important feedback information, helps to reveal progress, increase employers' motivation and communication, and helps to diagnose problems. The measures that help a company measure their progress on performance objectives in everyday work are often referred to as key performance indicators (KPIs).

In general, an extensive amount of research literature has been addressing the subject of PMSs including descriptions of how they are to be developed as well as highlighting their importance. However, (Chan & Qi, 2003) state that even though plenty of models have been developed for PMSs and that an extensive amount has been written about them, there are still relatively little literature covering PMSs and the selection for performance measures in the context of SCM. Some authors have treated the subject but there is still a need to explore and investigate this orientation further.

Swedish Match is a company that develops, manufactures, markets, and sells quality products with market leading brands in the product areas snus, moist snuff, and other tobacco products such as cigars and chewing tobacco, as well as lights such as matches and lighters (Swedish Match, 2015). The organisation is divided in four different corporate functions and in five different operating units. The corporate functions are: group finance, group business control, legal affairs, and investor relations & corporate sustainability and the five operating units are: the Scandinavian division, US division, Lights international, Lights Latin America, and SMD logistics AB. Within the Scandinavian division the highest hierarchy level is Product Supply & Innovation (PSI) and one of the functions belonging to PSI is the Global supply chain function. One of this function's six main strategic objectives for the 2015 is to evaluate existing KPIs as well as developing new KPIs in order to realise their strategy "exceed our customer's expectations". The new framework developed by the authors, based on research literature for evaluating and creating performance measurements, is presented in section 2.4. This framework is thereafter tested in a single case study at Swedish Match. The framework is then evaluated in the analysis chapter.

1.2 Purpose

Since measuring performance is considered an important element in order to stay competitive many models and approaches have been developed, but relatively few of them have been designed from a supply chain perspective. Even though some models exist there is still room for new approaches to be developed in order to complement existing theories in this particular field of research.

Thereby, the purpose of this master thesis is to develop a structured framework for creating and evaluating supply chain performance indicators with the aim of facilitating organisations efforts when measuring supply chain performance. The framework will aim to help firms in their continuous improvement work by selecting and categorising new performance measures, as well as evaluating existing performance measures.

1.3 Problem analysis

As described in the background, supply chain management has gained more and more attention during the last four decades. At the same time, the demand for being able to measure supply chain performance has increased, implying that the need for finding new ways to measure performance has increased. A first step towards this mission is to obtain an understanding of what drives supply chain performance. Hence, the first research question is:

RQ1 What factors influence supply chain performance?

In order to be able to complement existing research literature with a new framework of how to measure supply chain performance there is also a need to understand and study current ways and approaches of how to measure performance, especially in a supply chain context. Therefore, the second question that needs to be answered is:

RQ2 What current methods exist when measuring performance in a supply chain context?

Selecting and categorising measures is just one important aspect of increasing supply chain performance. Another relevant issue, which also needs to be considered, is how organisations use and take advantage of these measures. Hence, the final research question reads as follow:

RQ3 How should performance measures be managed within organisations in order to improve supply chain performance?

1.4 Delimitations

The master thesis will contain a single case study where the framework developed from research literature on supply chain performance will be applied and evaluated in a specific company context, in this case at the Scandinavian division of Swedish Match. The scope of the single case study will be limited to the Swedish part of the Global Supply Chain function at Swedish Match and the interfaces between their first tier suppliers and their distribution centres respectively. Due to its complexity the raw tobacco purchasing process will be excluded from the case study.

2. THEORETICAL FRAMEWORK

This chapter presents relevant literature regarding concepts within supply chain management and how to measure supply chain performance. The chapter consists of four sections where the first section describes basic supply chain terms, necessary for the reader in order to grasp the content of the rest of this thesis. Further, section two elaborates upon the nature of performance measures and performance measurement systems. In addition, it also presents different PMS approaches in a supply chain context and ends with information regarding some relevant requirements of a PMS. Section three explains elements that drives supply chain performance and presents tables including measures from each driver. Finally, based on findings from previous literature treating the subject, the end of this chapter presents a new framework for measuring supply chain performance.

2.1 Supply chain concepts

This section describes the different supply chain concepts and terminology used in this thesis. Three topics are presented in this section, starting with supply chain management followed by supply chain strategy supply chain collaboration.

2.1.1 Supply chain management

A supply chain comprises all parties involved in fulfilling a customer request and includes different parties such as suppliers, manufacturers, transporters, warehouses, retailers, and end customers (Chopra & Meindl, 2013). One of the most accepted definitions of supply chain management is the one developed by The Global Supply Chain Forum, which reads as follow:

"Supply Chain Management is the integration of key business processes from end user through original suppliers that provides products, services and information that add value for customers and other stakeholders." (Lambert & Cooper, 2000)

Besides the different parties in a chain, different flows are also present, and a supply chain can be illustrated as a chain in which materials, products, information, and financial resources flows. Some of these flows goes in both direction within the chain, and are considered to be bilateral Figure 2-1 (McKeller, 2014). Supply chain management is concerned with handling these types of flows.

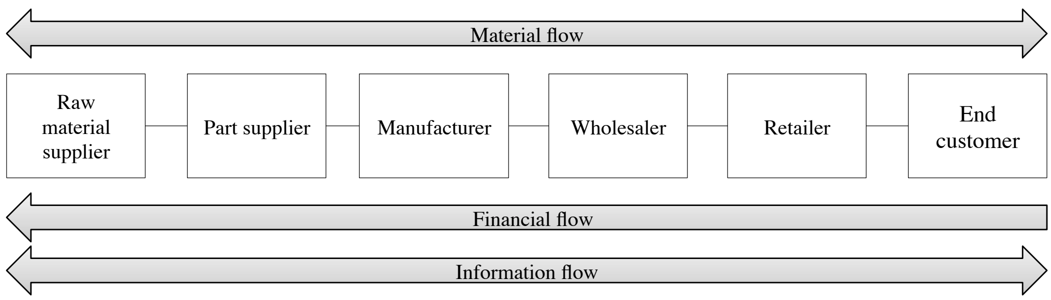

Figure 2-1 Schematic figure of a supply chain.

Even though Figure 2-1 describes the general structure and idea of a supply chain, it is still a simplified picture of reality. Each entity in a chain might have additional suppliers and customers besides the ones included in the particular chain currently in focus. Therefore, a supply chain can be viewed as part of a bigger concept called supply network (McKeller, 2014).

2.1.2 Supply chain strategy

In order to survive in the business world of today and to gain competitive advantage as well as improving company performance, having a competitive, corporate or company strategy is indispensable (Pertusa-Ortega et al., 2010). Nag et al. (2007) define a strategy as: "the major intended and emergent initiatives taken by general managers on behalf of owners, involving utilisation of resources to enhance the performance of firms in their external environments" (Nag et al., 2007). This definition can be supplemented with Slack and Lewis's (2008) description of a strategy as something that should perform the following:
"

- Setting broad objectives that direct an enterprise towards its overall goal.
- Planning the path (in general rather than specific terms) that will achieve these goals.
- Stressing long-term rather than short-term objectives.
- Dealing with the total picture rather than stressing individual activities.
- Being detached from, and above, the confusion and distractions of day-to-day activities "

One part of realising the corporate strategy is to have a supply chain strategy, which is aligned with and supports the vision and goals of the corporate strategy (Schnetzler et al., 2007; Harrison & New, 2002; Presutti & Mawhinney, 2007). Further, Schnetzler et al. (2007) defines a supply chain strategy as a set of supply chain management targets and measures to achieve them. The targets should be focused on improving business success and performance in areas associated with logistic success factors. General supply chain management targets are, meeting customer demands, flexibility, on-time deliveries, cutting costs and lead-time (Schnetzler et al., 2007).

Fisher (1997), states that there are two distinct ways to classify supply chains, physical efficient and market-responsive. The author continues by stating that the supply chain strategy of a company should reflect either one of the classifications. By determining what type of demand the products in a company's portfolio have, it can be decided which one of the classification that suites a company best. When looking at the demand there are several factors to be considered, such as the product life cycle, demand predictability, product variety, standard lead-times to market and how much of the orders that should be filled from stock (Fisher, 1997). Fisher (1997) continues by stating that by classifying the products themselves (by their probable demand), as either primarily functional or primarily innovative one can determine what type of supply chain that is most likely to fit a company.

Primarily, functional products have a long product life cycle and a stable and predictable demand. This predictability makes products easy to copy and due to competition it makes the margins low. Primarily innovative products on the other hand usually have higher profit margins due to the newness of the product. However, this also means that the lifecycle of innovative products is shorter and forces companies to introduce new products regularly, which makes the demand more difficult to predict (Fisher, 1997). In Table 2-1 different product attributes and how the two product types relate to each attribute are listed.

Table 2-1 Functional versus Innovative products: difference in demand (Fisher, 1997)

Aspects of demand	**Functional (predictable demand)**	**Innovative (Unpredictable demand)**
Product life cycle	more than 2 years	3 months to 1 year
Contribution margin*	5% to 20%	20% to 60%
Product variety	low (10 to 20 variants per category)	high (often millions of variants per category)
Average margin of error in the forecast at the time production is committed	0,1	40% to 100%
Average stock-out rate	1% to 2%	10% to 40%
Average forced and-of-season markdown as percentage of full price	0	10% to 25%
Lead-time required for made-to-order products	6 months to 1 year	1 day to 2 weeks
* The contribution margin equals price minus variable cost divided by price and is expressed as a percentage.		

Because of the different nature of the two product types, the requirements put on a supply chain differ. To understand why, Fischer (1997) describes two functions of a supply chain. The 'physical' function which includes all conversions of materials and transportations and the 'market mediation' function which is the ability to ensure that the product variation is what the customer demands. There are separate costs connected to both functions and according to Fisher (1997) the functions can be connected to the product types. Functional products with low variation and easily planned demand makes it possible for companies to focus almost exclusively on the costs of the physical functions, such as minimising inventory and production costs, which goes well with the low margins of such products. Innovative products on the other hand, with fluctuating demand and high variation in products, make it more important to focus on the market mediation costs. The higher margins on such products make it worth sacrificing physical costs in order to be able to supply products according to the customer needs (Fisher, 1997). In Table 2-2 the two different types of supply chain strategies according to Fisher are presented.

Table 2-2 Physically efficient versus Market-Responsive Supply Chains (Fisher , 1997).

	Physically Efficient process	**Market-Responsive Process**
Primary purpose	Supply predictable demand efficiently at the lowest possible cost	Respond quickly to unpredictable demand in order to minimize stock outs, forced markdowns and obsolete inventory
Manufacturing focus	Maintain high average utilization rate	Deploy excess buffer capacity
Inventory strategy	Generate high turn and minimize inventory throughout the chain	Deploy significant buffer stocks of parts or finished goods
Lead-time focus	Shorten lead-times as long as it doesn't increase cost	Invest aggressively in ways to reduce lead-time
Approach to choosing suppliers	Select primarily for cost and quality	Select primarily for speed, flexibility and quality
Product-design strategy	Maximize cost	Use modular design in order to postpone product differentiation for as long as possible

However, Fisher's model has been questioned by several authors, such as Birhanu et al. (2014), Wright (2013) and Selldin and Olhager (2007). Even though Fisher's model does not work in all cases it is in consensus among the authors Birhanu et al. (2014), Wright (2013) and Selldin and Olhager (2007) that it is a good way of classifying a supply chain at a higher level.

As previously mentioned, a supply chain strategy should reflect the corporate strategy (Schnetzler et al., 2007; Harrison & New, 2002). According to Birhanu et al. (2014), creating and working according to a correct strategy is crucial to the performance of a company in their competitive market. One of the main concerns in a supply chain is the ability to handle uncertainty. Uncertainty can be divided into three classes, i.e. demand, manufacturing, and supply uncertainties, where demand uncertainty refers to the issue of being able to properly forecast customer demand. Supply uncertainties include the purchase of materials and manufacturing uncertainties involves the ability to handle new technology (Birhanu et al., 2014).

According to Chopra and Meindl (2013), the different customer needs are changing and can be elaborated upon along six attributes depict in Table 2-3.

Table 2-3 Attributes affecting overall implied demand uncertainty (Chopra and Meindl, 2013).

Attributes
The quantity of the product needed in each lot
The response time that customers are willing to tolerate
The variety of products needed
The service level required
The price of the product
The desired rate of innovation in the product

These different attributes can be merged into one universal metric, labelled implied demand uncertainty (Hines, 2004). While demand uncertainty describes the customer demand for a specific product, implied demand uncertainty is the uncertainty affecting the demand a specific supply chain seeks to satisfy (Chopra & Meindl, 2013).

According to Lee (2002) and Fisher (1997), products with high implied demand uncertainty tend to have high margins, since the product is less mature and is not exposed to competition. Increased implied demand uncertainty also leads to an increased difficulty to match supply with demand, resulting in either oversupply or a stock out situations. With low demand uncertainty, forecasting is easier to manage and forecasts will become more accurate (Lee, 2002; Fisher, 1997).

Another important issue when trying to link a corporate strategy and a supply chain strategy is to understand the supply chain capabilities required (Chopra & Meindl, 2013). This step involves finding a way to best meet demand with the given uncertainty previously presented. Chopra and Meindl (2013) state that this can be done by characterising a supply chain in terms of its degree of responsiveness and efficiency, in accordance with Fisher's (1997) approach. Pure responsiveness, the first extreme category in this case, refers to the ability of a supply chain to meet short lead-times, handle a large variety of products, meet a high service level, respond to wide ranges of quantities, and handle supply uncertainty. These capabilities are all important when trying to manage a situation where the implied demand uncertainty is high. Supply chain efficiency refers to the cost that incurs for producing and delivering products. Chopra and Meindl (2013) state that for every effort to become more responsive, additional costs will be added. This implies that there exists a trade-off, where firms need to decide what to prioritise. They continued by stating that supply chains in the responsiveness and efficiency spectrum ranges from those only focusing on being responsive, to those only focusing on producing and delivering at lowest possible cost.

The degree of responsiveness in the supply chain needs to correlate with the implied demand uncertainty. Figure 2-2 depicts the relation between these factors, and when studying the figure it can be seen that high implied uncertainty is linked with a responsive supply chain and low implied uncertainty is linked with an efficient supply chain. Note that the scope of strategic fit in Figure 2-2 represents the different degrees of responsiveness along with the degree of implied uncertainty.

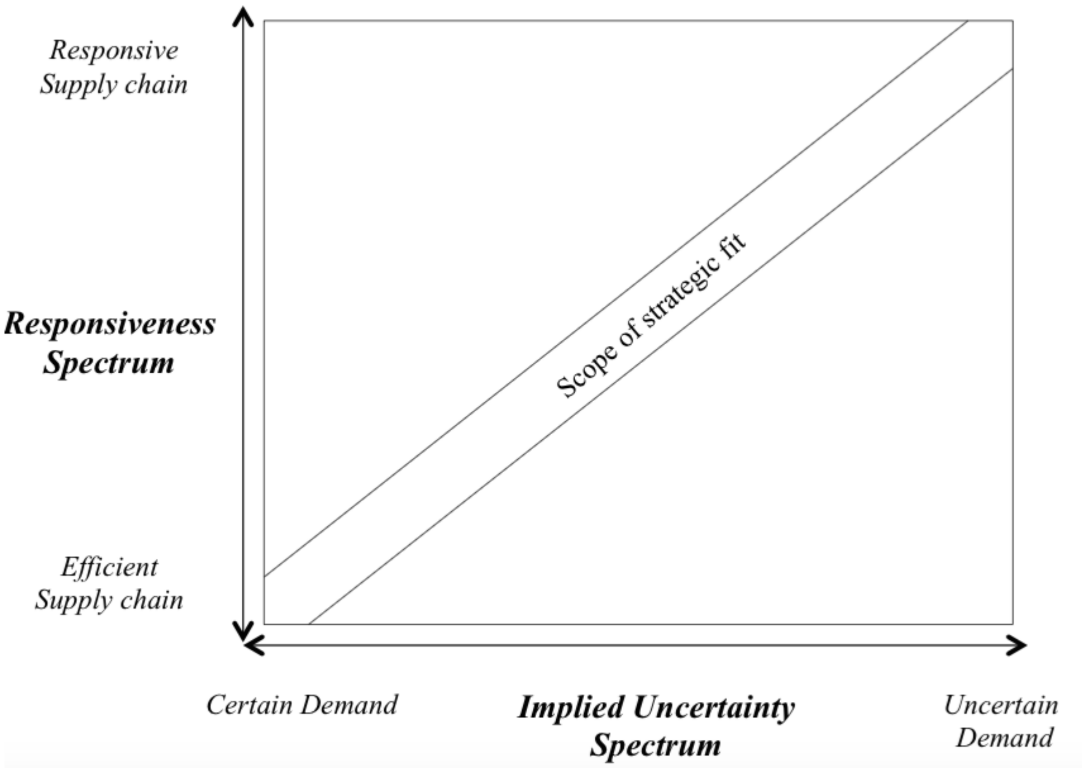

Figure 2-2 Relationship between responsiveness and efficiency and implied demand uncertainty. Adapted from Chopra and Meindl (2013).

2.1.3 Supply chain Collaboration

Supply chain collaboration is a relatively new concept in research literature and the most well-known form, collaborative planning forecasting and replenishment (CPFR), emerged in the mid 1990's. However, it has been suggested that less advanced forms of collaboration was used earlier on in the industry, such as vendor managed inventory (VMI) and continuous replenishment programmes (CRP) (Barratt, 2004). The different concepts of collaboration have been implemented successfully in many different industries by various companies. Despite these success stories quite few companies within these industries had implemented these types of collaboration in the beginning of the 21st-century. A reason for this could be that the practices of collaboration are not as well defined as one would desire (Holweg et al., 2005).

According to Kumar and Nath Banerjee (2014), supply chain collaboration is one of the most important factors for a supply chain in regard to competitiveness, and there are many benefits to gain from collaboration within a supply chain. Accordingly, Fisher (1997) states that a study showed that approximately 30 billion US-dollars was annually wasted in the food industry due to poor supply chain coordination. However, coordination as well as cooperation are only parts of collaboration, since these two refers to transactions and information sharing while collaboration refers to a long lasting relationship with common strategic goals and targets (Kumar & Nath Banerjee, 2014). Another term that is often confused with supply chain collaboration is supply chain integration, probably because both terms describes a close coupling between at least two actors in a supply chain. Although the two are closely related they should not be used interchangeably, since integration refers to ownership/control of resembling processes that used to be managed separately, while collaboration refers to a joint responsibility of similar processes through relationships between different actors in the supply chain. This means that it is not controlled by contracts, but rather through a relationship with mutual gain between two actors (Cao & Zhang, 2011).

Even though supply chain collaboration can be used at all levels and in all processes across a supply chain, probably the most common area of collaboration is planning, replenishment and forecasting, where a transparent demand pattern and visibility throughout the supply chain is key, in order to avoid stock-outs and high inventories. Many authors have called visibility through collaboration important in order to avoid phenomena such as the "Bullwhip effect" (Holweg et al., 2005). In order to achieve transparent demand patterns through collaboration, information sharing is of outmost importance. To achieve effective information sharing companies must be willing to share tactical and strategic data, which over time will enable firms to share risks and capabilities in order to achieve customer satisfaction. However, a firm base of trust has to be created in order for the relationship to work properly (Cao & Zhang, 2011). According to Barratt (2004), the first step in order to enable external supply chain collaboration between two actors is to create a culture with internal collaboration between different functions within the separate firms. The author also emphasises that collaboration should not be based on technology; it can however be an enabler in information sharing. In summary, supply collaboration can contribute to improved visibility, higher service levels, customer satisfaction, reduced cycle times, and a greater ability to cope with uncertainties in demand (Kumar & Nath Banerjee, 2014).

2.2 Concept of measuring performance

The importance of measuring performance in any business is a widely spread belief. This chapter explains what performance measures are and how they help companies in achieving their goals. It also describes the structure and purpose of a performance measurement system and provides the reader with some examples of existing PMS.

2.2.1 Performance measurements

To fully understand what performance measures are, the first step is to know what performance is. According to Lebas (1995), performance can be viewed as being subjective and it depends on the targets and goals that each firm set for themselves. In other words, performance is the ability to meet certain criteria's, the time it takes, and the path used to get there. Performance measures should be indicators of how well this is being done. Neely et al. (2005), defines performance measurement as: "Performance measurement can be defined as the process of quantifying the efficiency and effectiveness of action", and performance measure as, "A performance measure can be defined as a metric used to quantify the efficiency and/or effectiveness of an action" (Neely et al., 2005).

Performance measures are created from a single or several indicators of a process. The measures can be a single indicator, a sum of indicators or a ratio of them depending on the information wanted from the measure. Further, measures can be of a 'single level' nature where they only represent a local part of a larger system or a company. They can also be of an 'aggregated level', based on local measures and represent an aspect of an entire system or an entire company (Franceschini et al., 2007). Apart from quantifiable measures with numeric values, there are also qualitative measures. The qualitative measures are more complicated to use, since they cannot be directly represented numerically. Typical qualitative measures are customer satisfaction and information flow i.e. measures that cannot be measured, but has to be expressed in other ways (Beamon, 1999). These measures are better described as average, good, and excellent, which means that measuring them includes some kind of evaluation. One common way of doing this is by using likert scales to register opinions and feelings. A likert scale is based on a number of options rating an opinion or feeling to a degree of compliance with a statement (Tonchia & Quagini, 2010).

2.2.2 Performance Measurement systems

A performance measurement system offers the necessary information for the monitor, control, evaluation, and feedback function for operations management. Furthermore, it might also act as a motivation driver and a driver for continuous improvement and help achieve strategic objectives (Olsen et al., 2007). In addition, Tonchia and Quagini (2010) present a bullet list of seven components describing the scope and purpose of a performance measurement system:

- Translation and verification of corporate strategic plans and support for intervention/improvement programmes.
- Comparison with the performance of its best competitors (benchmarking)
- Control/monitoring of operational activities
- Coordination of activities
- Evaluation of human resources
- Involvement and motivation of human resources
- Individual and organisational learning ("learning-by measure" and "learning by error")

Neely et al. (2005) defines a performance measurement system as 'the set of metrics used to quantify both the efficiency and effectiveness of actions´. Neely et al. (2005) also state that a performance measurement system can be viewed and studied at three different levels. Tonchia and Quagini (2010) have a similar approach of explaining a PMS and label the corresponding three layers elements, architecture, and interfaces.

In general, all performance measurement systems consist of a number of individual performance measures as those described in section 2.2.1 (Neely et al., 2005). These are occasionally called the elements of a PMS and are initially indicators and become measurements only when they have been assigned a value (Tonchia & Quagini, 2010). Important to consider at this level is what measures that are being used, why they are used, what benefit the measures provide, and finally the cost of measuring each specific measure (Neely et al., 2005). The individual performance measures are the first level in a performance measurement system.

The second level can be described as the stage where the PMS is studied as an entity and Tonchia and Quagini (2010) describe this as the architecture of a PMS. The authors state that there are three architectural features, which need to be discussed. The first feature, vertical, is concerned with dividing the indicators in accordance to where they fit in the organisation i.e. if they are of a strategic, tactical, or operational nature. It also includes determining how the indicators relate to each other. The second feature is concerned with defining what indicators that are suitable for the different organisational units and how these are shared and compared between the different functions. The last feature defines what indicators are actually able to measure and monitor organisational processes. According to Neely (2005), this level should also consider how the performance measures relate to each other and how well they cover the improvement objectives, as well as business objectives. The importance of covering internal, external, financial, and non-financial aspects is also included at this level.

A PMS should not be viewed in isolation, but has to be put in a broader context along with other systems within a company such as the ERP system etc. This is because they sometimes share the same input data and also due to the fact that a PMS sometimes provide outputs for other systems (Tonchia & Quagini, 2010). According to Neely (2005), the integration of a PMS into the organisation is a part of the third level and the environment surrounding the PMS is taken into consideration. The PMS has to be synchronised with the goals and strategy, as well as being able to function within the organisational structure. At an external level a PMS should incorporate customer satisfaction and competitor performance. A typical way of measuring competitor performance is benchmarking, which can be done both against competitors and other companies in other similar industries.

2.2.3 Performance measurement systems in a supply chain context

This section presents four approaches describing how a PMS can be structured and how different measures can be categorised.

Approach 1 - The Resource, Output, and Flexibility approach

Beamon (1999) states that it is crucial to be aware of the complexity of a supply chain when creating a PMS. In the article, Beamon (1999) suggests that a supply chain measurement system must focus on three different types of measures, in order to be sufficient. All three of the measures focus on different crucial parts and goals of a supply chain. Table 2.4 shows the three measures and their focus.

Table 2-4 Key elements related to strategic goals (Beamon, 1999)

Performance measure Type	Goal	Purpose
Resources	High level of efficiency	Efficient resources management is critical to profitability
Output	High level of customer service	Without acceptable output, customers will turn to other supply chains
Flexibility	Ability to respond to a changing environment	In an uncertain environment, supply chains must be able to respond to change

Resource measures are usually connected to efficiency measures, i.e. to what degree the resources are utilised in the supply chain, and are often a quantified minimum requirement of the resources needed. The output measures are usually quantifiable short-term measures that show how well a company did, but can also be of a qualitative nature such as customer satisfaction. The output measures have to reflect the strategic goals, both organisational and customer requirement goals. Flexibility can be used as a measure of how well a company is able cope with fluctuation in demand and deliveries from suppliers, manufacturers and customers, and is vital for the success of a supply chain in a modern market (Beamon, 1999). To be able to measure flexibility accurately one need to be aware of that it is a measure of potential performance, which has to be explained in the form of other measures such as volume and delivery. The measures all affect each other and it is important to have a balance between them in order to achieve the set goals of a company.

Approach 2 - Performance of activity

Chan and Qi (2003) argue that some of the problems relating to PMSs in a supply chain are the lack of strategy focus and the large amount of financial measures. The authors continues by explaining the importance of looking at the entire supply chain, since not doing so might lead to local optimisation instead of optimisation of the whole chain. Chan and Qi (2003) suggest that a process-based approach should be used to analyse the supply chain in order to map the structures and relationships between the different actors in the network. In the process based approach the supply chain is viewed as one entity, which is divided into core-processes, which in turn comprises of several sub-processes, which is a set of activities. A seven-step method is proposed when breaking down and analysing the processes to be measured. The core processes, sub-processes, activities and the measures they contain are what create the framework for the PMS. In order to help managers get a collected and easily managed view of what to measure Chan and Qi (2003) proposes the ‘Performance of activity’ (POA) concept and as a visual aide they use the ‘metrics board’. Each metric represents one dimension of activity or process performance. The metrics are listed in Table 2-5. The metrics can be inputs and outcomes, as well as tangible and intangible. The purpose of the metrics board is to help management categorise existing measures, as well as to work as a reference when creating new measures. Chan and Qi (2003) emphasises that not all measures have to be used on all processes, the choice of measurements should be based on the actual needs.

Table 2-5 The POA Metrics board (Chan & Qi, 2003).

Performance metrics		Description
1	Cost	The financial expense to carry out one event or activity
2	Time	The time between the beginning and completion of ne specific event or activity
3	Capacity	The ability of one specific activity to fulfil a task or perform a required function
4	Capability	A talent or ability of one activity to be used, treated, or developed for the specific purposes and required functions
	Effectiveness	The ability of one specific event or activity to achieve an intended or desired effect in performing the functions or taking the responsibilities
	Reliability	The ability to perform a required function under stated conditions for a stated period time.
	Availability	The ability to bring about effective or beneficial results or the degree to which one specific functional activity is ready when needed
	Flexibility	The ability of one specific Activity to adapt to the varying functional requirements or respond to the changes
5	Productivity	The rate at which one specific event or activity adds value at the cost of resources
6	Utilisation	The utilising rate of the resources to carry out one specific activity
7	Outcome	The results or value added of one specific activity and event

Approach 3 - A balanced- and Strategic, tactical, and operational approach
Gunasekaran et al. (2001) highlights the fact that firms lack insight regarding how to develop effective performance measures and metrics. They continue by stating that performance measures and metrics are crucial elements in order to successfully test and reveal the viability of strategies, which is considered important when striving towards finding clear directions for improvements and when trying to realise company goals.

Gunasekaran et al. (2001) especially put emphasis on two aspects from which measures and metrics need to be studied. The first aspect is focusing on the importance for managers and researcher to put equal emphasis on financial and non-financial measures instead of concentrating on only either of the two (Gunasekaran et al., 2001). This dual focus increases the possibility to present a clear picture of organisational performance. Using this balanced approach also include the importance of understanding that, while financial measures might be suitable for strategic decisions, non-financial measures might be more suitable when measuring and controlling day-to-day manufacturing and distribution operations (Gunasekaran et al., 2001). The second aspects speaks about the fact that there is a lack of clear distinction between metrics at strategic, tactical and operational levels and states that it would be preferable to sort and place different measures at an appropriate hierarchical level (Gunasekaran et al., 2001). With this point of departure, different measures are discussed, derived and elaborated upon along the four links plan, source, make/assemble, and deliver which is the four pillars in the Supply Chain Operations Reference model (SCOR-model) developed by the Supply Chain Council. The different measures are placed in the respective link in accordance to where they fit in the model.

Approach 4 - The balanced scorecard approach

The balanced scorecard framework (BSC) was first developed by Kaplan and Norton (1996). Performance measures are developed across four balanced perspectives, where financial measures constitute just one of the four perspectives. The other three perspectives are customers, internal business processes, and learning and growth. Thereby, companies are provided with the opportunity to measure financial results as well as monitoring progress in building the capabilities and obtain the intangible assets needed for future growth (Kaplan & Norton, 1996). The four different perspectives in a BSC can be described with one question respectively: "How do we look to shareholders? ", "How do customers see us? ", "What business processes must we excel at?", and "Can we continue to improve and create customer value?", (Ghia et al., 2009. Figure 2-3 shows the connection between the different perspectives.

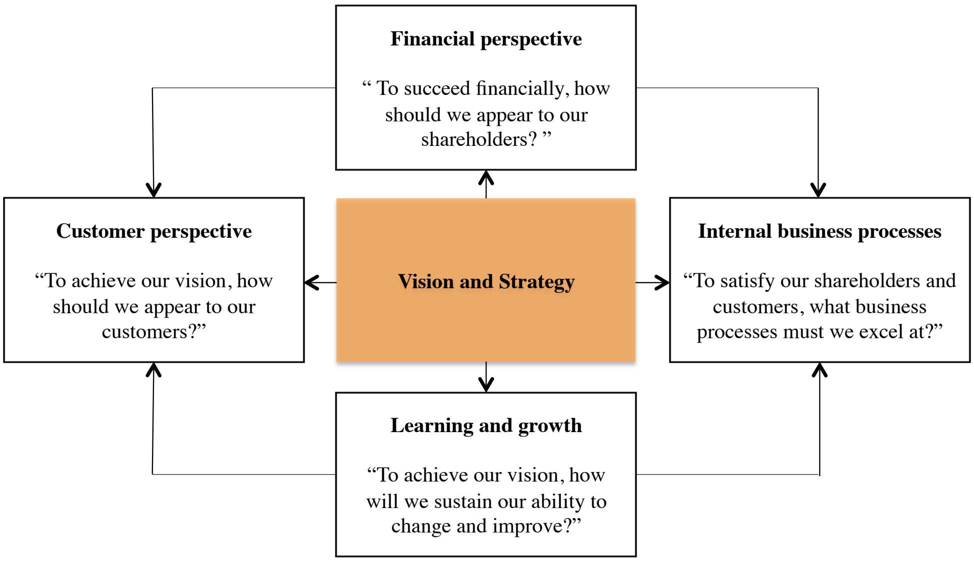

Figure 2-3 Elements of the balanced scorecard. Adapted from Kaplan and Norton (1996).

There has been several frameworks and methods developed for using BSC when measuring the performance of a supply chain. Since the BSC was created to help managing large- and medium-sized companies some attention has to be made to the different perspective in a supply chain (Antônio et al., 2015). Antônio et al. (2015), continues to explain that the adoption and use of the BSC would be simplified if all of the entities in the supply chain used the same metrics. However most companies in a supply chain have operations that differ from each other and therefore a consensus in metrics used might be difficult to achieve. Chia et al. (2009) state that the use of BSC in a supply chain means that the different entities must share their measures to create a holistic view of the supply chain in order to achieve strategic goals and improve future results.

2.2.4 Verification and characteristics

This section consists of general guidelines regarding requirements of a PMS and individual performance measures. Neely et al. (2000) state that there are some rules and guidelines that should be considered when creating a performance measurement system. A few points that needs to be considered in order for the system and the measures within it to be effective and work properly are listed in Table 2-6. Neely et al. (2000) has put together the list from the views of several different researchers and it can be used as a reminder when creating and updating a performance measurement system.

Table 2-6 List of recommended Characteristics for a PMS (Neely et al., 2000).

Characteristics design of PMS	**Characteristics measures**
Performance measures should be derived from the company's strategy.	Performance measures should enable/facilitate benchmarking.
The purpose of each performance measure must be made explicit.	Ratio based performance measures are preferable to absolute numbers.
Data collection and methods of calculating the level of performance must be made clear.	Performance criteria should be directly under the control of the evaluated organizational unit.
Everyone (customer, employees and managers) should be involved in the selection of the measures.	Objective performance criteria are preferable to subjective ones.
The performance measures that are selected should take account of the organisation.	Non-financial measures should be adopted.
The process should be easily revisitable - measures should change as circumstances change.	Performance measures should be simple and easy to use.
	Performance measures should provide fast feedback.
	Performance measures should stimulate continuous improvement rather than just monitor.

In addition, Beamon (1999) states that there are a number of key factors that can be found in performance measurement systems that are successful. The factors are listed in Table 2-7 along with some explanations. Beamon (1999) also states that there are four questions that always should be asked: ”What to measure? How are multiple individual measures integrated into a measurement system? How often to measure? How and when are measures re-evaluated?”

Table 2-7 Characteristics needed for a successful PMS (Beamon, 1997).

Characteristic	**Description**
Inclusiveness	Measurement of all pertinent aspects
Universality	Allow for comparison under various operating conditions
Measurability	Data required are measurable
Consistency	Measures consistent with organization goals

In the previous section some examples of existing performance measurement systems were described. Even though not explicitly expressed as requirements some relevant points from the previous section can be used in order to validate a PMS. For example, since both approach three and four are highlighting the importance of measures to be both financial and non-financial it can be considered an important requirement, even though not stated in a typical requirements list. Table 2-8 consist of the requirements that will be used in the new framework model explained in section 2.4. Even though Table 2-6 seems to cover most of the relevant requirements, two additional requirements are added. The first added requirement is the characteristics suggested by Beamon (1999). The second requirement included in the list is that measures should be represented throughout the whole organisation i.e. on a strategic, tactical, and operational level (Gunasekaran et al., 2001). In Table 2-8 the characteristics suggested by the authors are added to Neely’s existing list of characteristics.

Table 2-8 Extended Characteristics criteria's for a PMS, with added characteristics from the authors.

Characteristics design of PMS		**Characteristics measures**	
1.	Performance measures should be derived from the company's strategy.	1.	Performance measures should enable/facilitate benchmarking.
2.	The purpose of each performance measure must be made explicit.	2.	Ratio based performance measures are preferable to absolute numbers.
3.	Data collection and methods of calculating the level of performance must be made clear.	3.	Performance criteria should be directly under the control of the evaluated organizational unit.
4.	Everyone (customer, employees and managers) should be involved in the selection of the measures.	4.	Objective performance criteria are preferable to subjective ones.
5.	The performance measures that are selected should take account of the organisation.	5.	Non-financial measures should be adopted.
6.	The process should be easily revisitable - measures should change as circumstances change.	6.	Performance measures should be simple and easy to use.
7.	The performance measures selected should measure all pertinent aspects*	7.	Performance measures should provide fast feedback.
8.	The performance measures selected should allow for comparison under various operating conditions*	8.	Performance measures should stimulate continuous improvement rather than just monitor.
9.	All the data required should be measurable*		
10.	The performance measures selected should be consistent with organisational goals*		
11.	The performance measures included should cover strategic, tactical, and operational levels of the organisation*		

2.3 Elements driving supply chain performance

This section presents and elaborates upon different elements that drive supply chain performance. It will be based on the work of Hugos (2011) as well as Chopra and Meindl (2013) which both respectively define a set of drivers that can be balanced in different ways to achieve proper balance between responsiveness and efficiency. The classification of the drivers from the respective author is similar but differ in some ways. The next paragraph presents the two different ways to categorise the drivers.

Chopra and Meindl (2013) are using six different drivers, which will affect the level of responsiveness, and efficiency while Hugos (2011) is using five. Depending on how managers make decisions along these drivers they will contribute to a certain degree of responsiveness and efficiency. The two authors both have inventory, transportation, and information as common drivers. Chopra and Meindl (2013), defines facilities as one driver. Here, decisions regarding location, capacity, and flexibility of facilities are taken. Hugos (2011) is also addressing these types of decision factors but does this with two separate drivers, where the first one, the production driver, include decisions regarding plant capacity, workload balancing, quality control and equipment maintenance. The second of the two, the location driver, is concerned with taking decisions regarding where facilities for inventory and production should be located. Chopra and Meindl's (2013) fifth driver is sourcing and include decisions such as who will perform a certain supply chain activity and the sixth driver is pricing, which include taking decision regarding how much a company should charge for the products or services that they provide in the supply chain.

2.3.1 Facilities

Chopra and Meindl (2013), defines the facility driver as the physical locations where a product is stored, assembled or fabricated. According to Vokurka and Davis (2004) and Melo et al. (2009), one of the major decisions that has to be made in every supply chain is which products, processes and customer markets that should be connected to each facility, as well as where the facilities should be located. When it comes to deciding the location of a facility, factors such as distance to customer, time and costs has to be considered (Melo et al., 2009). It is important that the facility location strategy is based on information regarding what products, processes, customers, and markets that are connected to each facility (Vokurka & Davis, 2004).

The overall decision that has to be made in regard to any facility is the degree of efficiency versus the degree of responsiveness (Chopra & Meindl, 2013), which has to match the capabilities wanted in the rest of the supply chain, in order for the supply chain to be competitive (Squire et al., 2009). To gain a customer perspective of all the operations performed at the facilities, five performance objectives can be used; quality, speed, dependability, flexibility and cost (Slack & Lewis, 2008). Quality refers to the quality perceived by the customer as well as the conformance quality in production. Speed is basically the different lead-times throughout the processes, for example the time it takes for raw material to be transformed into a final product. The next performance objective is Dependability, which is the ability to deliver something on time, or when it is wanted. The ability to change the output of a process is seen as flexibility and can be divided into range and response flexibility, where range refers to the ability to handle the product variety and volume, and response flexibility is the ability to quickly change the manufacturing setup. The final performance objective is cost, which refers to all the costs associated with delivering an order. Important to remember is that each facility might need to have different focuses on their performance objectives (Slack & Lewis, 2008).

Capacity planning is one of the most important strategic decisions that has to be made in any production facility or warehouse and it can in some way affect all of the performance objectives mentioned above. Having a fully utilised capacity is the most efficient way to operate a facility, however this will leave the facility vulnerable to unplanned stops and uncertainties in demands (Jack Hammesfahr et al., 1993). Hence, having a high level of capacity utilisation will affect the responsiveness of a facility negatively. With a low degree of utilisation of a production line, sudden changes in demand can be managed by increasing the utilisation, high responsiveness and low efficiency (Jack Hammesfahr et al., 1993; Yang et al., 2014). Yang et al. (2014) state that the effects of this trade-off can be reduced by technical investments to create a facility that has flexible production capacity. The flexible capacity helps creates a possibility to postpone production planning, which makes it easier to forecast the demand, thus eliminating the problem of uncertainty in demand. Another way to create flexibility according to Thatte (2013), is by using modularity in products and production. By breaking down processes or products into smaller independent pieces, variation in products can be dealt with by changing small parts of the process. According to Cao and Zhang (2011), collaboration is an important factor when planning for capacity. By combining resources from different facilities in a supply chain one can achieve strategic advantages in regard to efficiency and responsiveness. Planning and forecasting can be used to achieve a higher degree of utilisation of capabilities as well as fast customer response time.

A widely used tool for measuring effectiveness in manufacturing firms is overall equipment effectiveness (OEE). The tool created by Nakajima in the 1980's is a quantitative approach to measuring productivity (Charaf & Ding, 2015; Muchiri & Pintelon, 2008). The tool is designed to help companies realise possible improvement points to increase the productivity of their equipment, more specifically down time losses, speed losses, and quality losses. There are many different definitions, but the authors has chosen the one described below, which consists of three main parts, availability rate (A), performance efficiency (P), and quality rate (Q). The three main components are displayed in Table 2-9 along with their respective definitions. These are calculated as percentages and multiplied with each other to form:

$$OEE = A * P * Q$$ (Muchiri & Pintelon, 2008).

Table 2-9 Explanations and definitions of the different formulas used to calculate OEE (Muchiri & Pintelon, 2008).

OEE components	**Definition**
Availability rate (A)	(Operating time / Loading time)*100
Operating time	*Loading time-Down time*
Performance efficiency (P)	(Theoretical cycle time * Actual output) / Operating time
Quality rate (Q)	((Total production-Defect amount) / Total production)* 100

In financial terms, the facility related metrics impacts cost of goods sold, the assets in property plant and equipment (Chopra & Meindl, 2013). In Table 2-10 relevant facility measures such as OEE and many others are presented. The measures include internal measures, as well as measures that relates to the customer interface. Explanations and definitions of the respective measurements are not included in the table but can be found in appendix A, and some of them will also be further elaborated upon in the analysis chapter. The measures presented in Table 2-10 are gathered from the work of Chopra and Meindl (2013), Bragg (2011), Muchiri and Pintelon (2008) and Huang and Keskar (2007).

Table 2-10 Facility measures

Facility measures	
Percentage of new Parts used in New products	Product variety
Percentage of existing parts reused in new products	Volume contribution of top 20 percent SKU's and customers
Put-away cycle time	Average production batch size
Scrap percentage	Production service level
Average Picking time	Fill Rate
Picking accuracy for assembled products	Scrap expenses
Order lines shipped per labour hour	In process failure rate
Dock door Utilization	Yields during manufacturing
Percentage of Warehouse stock locations Utilized	% of errors during release of finished product
Square footage of Warehouse storage space	Incoming material quality control
Storage density percentage	% of orders scheduled to customer request date
Inventory per square foot of storage space	Order fulfilment lead-time
Average pallet inventory per SKU	Return product velocity
Capacity	Average release cycle of changes
Utilisation	Total build cycle time
Processing/setup/down/idle time	Upside order flexibility
Production cost per unit	Downside order flexibility
Quality losses	Capacity utilisation
Theoretical flow/cycle time	Average days per engineering change
Actual average flow/cycle time	Published delivery cycle time
Flow time efficiency	Package cycle time
Quarantine / hold-time	

2.3.2 Inventory

Inventory is one factor that drives supply chain performance and most companies have inventory tied to their business in one way or another (Müller, 2011). Inventory exists within a company in different types and at different locations. Greasly (2008) categorises inventory by location as, raw materials, work in progress, supplies used in operations, and finished goods. Raw materials are goods received from suppliers and used to manufacture parts or completed goods (Müller, 2011). Work-in-progress is inventory within the operation process and serves to decouple manufacturing stages and to provide flexibility in production scheduling (Greasley, 2008). Some ways to minimise work-in-progress is to eliminate obsolete stock, reduce the number of products, or improve the operation processes. Finished goods are goods ready to be shipped out to customers (Müller, 2011) and the main purpose of this inventory type is to make sure that products and items are available to customers and also to prevent that changes in production output causes disruption (Greasley, 2008). It can be minimised by for example improving demand forecasts.

Inventory can be classified not only by where it is located but also by its type. Researchers mention different types but the most common are described below. Cycle inventory is defined as the amount of inventory required to meet demand for a certain part or product between two purchasing events (Hugos, 2011). Not seldom, purchasing managers prefer to order large lots in order to gain economies of scale, but this however comes to a greater handling cost (Hugos, 2011). Handling costs are cost associated with storing, handling and insuring the goods. One needs to make decision regarding if goods should be purchased once in a large lot or multiple times in small lots within a defined time window. Another type of inventory is safety inventory, sometimes referred to as buffer inventory and the purpose of this stock is to compensate for demand and supply uncertainties (Müller, 2011). It also decouples different operations from each other so that they can operate independent, and is therefore also called uncoupling inventory. Having this type of inventory might lead to increased manufacturing flexibility (Law, 2009). Managers need to make decisions whether to prioritise having some extra inventory and the cost that it incurs, or having less inventory and perhaps facing the risking of being out of stock and thereby losing potential sales (Hugos, 2011). Seasonal inventory is referred to as the inventory that a company builds up based on predictable changes in demand that occurs during a certain period (Hugos, 2011). If a certain company has a product that has seasonal demand and in addition a fixed manufacturing rate which is costly to change, then the company would preferably try to manufacture products at a steady rate and build up inventory for periods when demand is lower (Hugos, 2011). This type of inventory related to foreseeing future demand and adapting the inventory levels is sometimes also called anticipation inventory (Law, 2009; Müller, 2011; Greasley, 2008). Another type of inventory is called transit inventory and refers to inventory en route from one location to another (Müller, 2011). The common meaning of this type of inventory is not goods or materials moving within a production facility but rather goods flowing in the distribution channel, either towards the focal company from the supplier or from the focal company to the customer (Müller, 2011). This type of inventory does not only help to understand the physical flow but also to understand how inventory in transit is registered and when it shows up in the receiving company's records. Either the ownership of the goods are signed to the receiving company at the same time as the goods leave the supplier and could then be added to the receiving company’s inventory records or the goods are registered in the records when the goods arrive at the receiving company (Müller, 2011).

Inventory exists within a company or supply chain for different reasons. Inventory sometimes acts like a safety precaution against fluctuations in demand and when it is difficult to establish how much material that will be needed at a given time (Müller, 2011). Another reason is the fact that incoming deliveries from suppliers occasionally are unstable, which could lead to lost sales if the inventory does not work as a safeguard (Müller, 2011). Furthermore, inventory also exists because of quantity discounts which might lead to companies sometimes ordering larger quantities than needed in order to get a favourable price (Müller, 2011).

An important inventory task in supply chain management is to manage inventory in a way that best serve the company strategy and supply chain strategy in terms of responsiveness and efficiency. In general, high levels of inventory make a company responsive but at the same time lead to cost increases (Chopra & Meindl, 2013). Just as the facility related measures, inventory affects cost of goods sold but also the cash-to-cash cycle and the assets held by the supply chain.

In Table 2-11, a set of relevant inventory measurements are listed and when studying this list it is important to bear in mind that all of these measurements might not always be relevant or of interest to all companies, but should rather be selected selectively depending on the nature of the company as well as the environment the company operates in. The nature of the measures ranges from pure operational to pure financial measurements. Explanations and definitions of the respective measurements are not included in the table but can be found in appendix A and some of them will also be further elaborated upon in the analysis chapter. The measurements presented in Table 2-11 are gathered from the work of Chopra and Meindl (2013), Bragg (2011), Hofman (2004), and Müller (2011).

Table 2-11 Inventory measures

Inventory measures
Cash-to cash cycle time
Average inventory
Inventory turns
Average replenishment batch size
Average safety inventory
Seasonal inventory
Fill rate
Fraction of time out of stock
Obsolete inventory
Raw material content
Bill of material content
Economic order quantity
Distribution turnover
Warehouse order cycle time
Inventory availability
Inventory accuracy
Inventory turnover
Average backorder length
Storage cost per item
Obsolete inventory percentage
Percentage of inventory > x days old
Percentage of returnable inventory

2.3.3 Sourcing

When it comes to sourcing, there are several different point of views of what the term really encompasses and there is no consensus in terms of its definition. According to Van Weele (2005) sourcing, is defined as the activity of developing the most appropriate supplier strategy for a certain commodity or product category, where sourcing strategy refers to how many suppliers that should be considered for each commodity, what kind of relationship to strive for, and what type of contract to negotiate for. It is also described as finding, selecting, and managing the best thinkable source of supply on a worldwide basis. The author continues by stating that sourcing is a part of a broader term, procurement, which includes all activities needed in order to get a product from a supplier to the customer. In total, procurement consists of the purchasing function (specification determination, supplier selection, contracting, ordering, expediting, follow-up and evaluation), stores, traffic and transportation, incoming inspection, and quality control and assurance. Worth noticing is that transportation is included in procurement but is later mentioned as a separate driver in this chapter. Thereby, they are related to each other and should preferably be studied simultaneously.

Chopra and Meindl (2013) define sourcing as a set of business processes needed to purchase goods and services. They also mention three key decisions, which need to be considered with regards to sourcing i.e. if a company should outsource or insource tasks, supplier selection, and procurement. They continue by stating that in terms of responsiveness and efficiency managers need to take decisions if tasks should be performed by a responsive or efficient source and if the source should be internal to the company or a third party.

Supplier selection is mainly viewed at from two different perspectives in academic research, a philosophical approach with a more qualitative view and a more quantitative approach where researchers view it as an optimisation problem. To insure that the selection is mathematically optimised as well as fits with the company strategy, the two approaches have to be merged or used together (Huang & Keskar, 2007). Regardless of which approach that is used ,the buyer has to identify which product criteria that has to be fulfilled by the supplier as well as which strategic criteria's that has to be fulfilled by the supplier itself in regard to responsiveness and efficiency (Oly Ndubisi et al., 2005; Huang & Keskar, 2007; Wu et al., 2013). However, many researches view the quality criteria as the most important criteria for any supplier selection (Wu et al., 2013). In financial terms, sourcing measures impact cost of goods sold and accounts payable, as well as inventory and inbound transportation costs.

Performance measures regarding sourcing is presented in Table 2-12 and are further described in appendix A. The measures are collected from the work of Chopra and Meindl (2013), Bragg (2011), Kasilingam (1998) and Huang and Keskar (2007)

Table 2-12 Sourcing measures

Sourcing measures
Days payable outstanding
Average purchase price
Range of purchase price
Average purchase price
Average purchase quantity
Supply quality
Supply lead-time
Fraction of on-time deliveries
Supplier reliability
Delivery reliability
Order received complete
Orders received on time to commit date
Orders received on time to required date
Oder received defect free
Customer returns/ returned products to supplier
Supplier's corrective action responsiveness
Availability of products
Flexibility in schedules
Percentage of demand met
Percentage of purchase orders released with full lead-time

2.3.4 Information

The importance of information sharing between units in supply chains has proven to be very important. More and more companies extend their coordination and cooperation in order to better being able to meet increases in customer demand uncertainty. By doing so they can increase both the efficiency and the responsiveness of the supply chain (Fiala, 2005; Fawcett et al., 2007). However, according to Fawcett et al. (2007), many companies put far too much emphasis on the technology needed. Implementing advanced and costly information technology does not create the necessary connection between two companies on its own. There is also a need for a more hands on behavioural change in the mentality of sharing information with other companies, in order for the sharing to be really effective. Then, the technology will become a tool for realising the information sharing rather than the actual information sharing itself (Fawcett et al., 2007). Further, the quality of the information is of equal importance. The occurrence of information sharing, the amount of information shared and the quality of the information will have a major impact on how well the collaboration will work. The willingness to share possibly sensitive information is crucial to the effectiveness of collaboration (Prajogo & Olhager, 2012).

One area where collaboration through information sharing for integration in supply chains is of major importance is planning and forecasting. All business areas are in some way in need of forecasting and planning, and collaboration is often used to improve this in supply chains (Nakano, 2009; Helms et al., 2000). The first step to create a system where planning and forecasting can be done collaboratively is for each firm in the supply chain to create an internal system which proficiently can forecast the demand of parts and inputs it takes to meet the demand. Only then can an accurate collaborative planning and forecasting system be implemented with partners in the supply chain. Effective collaboration is dependent on information being shared at the right time and that the information is accurate and detailed (Ahumada & Villalobos, 2004).

High demand uncertainty will create great difficulties when planning and forecasting and these difficulties are sometimes the root to a phenomenon referred to as the Bullwhip effect (Holweg et al., 2005). It has been shown that information sharing can reduce the effects of the Bullwhip effect. This is mainly because of the joint planning and forecasting, that leads to lower demand uncertainty and a higher degree of trust between the actors in a supply chain (Kumar & Nath Banerjee, 2014). In Table 2-13, a set of relevant information measurements is listed. Explanations and definitions of the respective measurements are not included in the table but can be found in appendix A and some of them will also be further elaborated upon in the analysis chapter. The measurements presented in Table 2-13 are gathered from Chopra and Meindl (2013)

Table 2-13 Information measures

Information measures
Forecast horizon
Frequency of update
Forecast error
Seasonal factors
Variance from plan
Ratio of demand variability to order variability

2.3.5 Pricing

Another element that drives supply chain performance is pricing. According to Brinckerhoff (1992) there are especially four important factors to consider when setting prices. Firstly, the fixed costs needs to be determined and decisions regarding how fast to recover for them must be taken. Fixed costs are costs that do not vary depending on the sales quantity and comprise costs such as administration salaries, rent, legal fees, marketing expenses etc. Secondly, the variable cost for manufacturing a product or providing a service needs to be determined, and unlike fixed costs these costs varies depending on the amount of products and services sold. Examples of variable costs are cost of parts, labour for assembly, and shipping. The third factor to determine is the level of profit, in percentage, a company should make for each unit of sale. The result of adding the fixed cost and the variable cost per item and then subtracting this from the revenue stemming from that unit is the net profit. The profit margin is then calculated by dividing the net profit with the unit revenue. The last factor to consider is the existing competition on the market that a company operates in. Even though price might be one important element to consider, it is not only the price that determines if a company is attractive on the market and a company does not always need to beat the competition in terms of price. Even so, it is necessary to keep track of the general price guidelines on the market, since they provide a company with a good indication if the price set by a company is reasonable. In addition, Chopra and Meindl (2013) highlights two important areas related to pricing in which decisions need to be taken. These are if everyday low pricing or high-low pricing should be applied and if a company should set a fixed price or use menu pricing.

Two basic pricing strategies are everyday low pricing (EDLP) and high-low pricing (HLP). EDLP is based on keeping stable low prices over time. The idea is that constant low prices will create a stable demand of products, which in turn will reduce the need for promotions and simplify forecasting. The stable forecasting will help manufacturers and suppliers to produce products more efficiently (Kahn & Easton, 2002). When using HLP however the base price for a product is set higher than with EDLP, and discounts are used to promote and sell big quantities for certain periods in time (Kaufmann et al., 1994). These peaks in demands might force the actors providing the products to be flexible in their capacity, hence increasing the unit price. However, HLP can also be used to smoothen demand over time, while EDLP used for products with unstable demand will increase the demand uncertainty. The choice of pricing strategy will affect the entire supply chain (Kahn & Easton, 2002).

To gain competitive advantages on a market other attributes than price might be important to consider. For example, short lead-times might be of high importance for a certain customer segment, while price is the most important for another. Price and lead-time correlate with each other and impact performance in terms of responsiveness and efficiency. If a company pursues short lead-times, it will most likely need to increase their price in order to cover for the costs incurred for requiring extra capacity or personnel (Huang et al., 2013). Contrariwise, if longer lead-times are pursued, this will probably lead to lower prices. This means that short lead-times might be hard to combine with a low price (Huang et al., 2013). Therefore many companies have solved this problem by offering the same product with different pricing depending on the customer's desire for fast deliveries. By charging extra for the speedy delivery the time sensitive customers are being satisfied, while the price aware customers can enjoy their low price (Boyaci & Ray, 2003). The impact of the pricing measures is connected to revenues, but might also affect the production cost and inventories. Performance measures regarding pricing are presented in Table 2-14 and are further described in appendix A. The measures are collected from the work of Chopra and Meindl (2013) and Lapinskaite and Kuckailyte (2014).

Table 2-14 Pricing measures

Pricing measures
Profit margin
Days sales outstanding
Incremental fixed cost per order
Incremental variable cost per order
Average sale price
Average order size
Range of sales price
Range of periodic sales
Cost Of Goods Sold (COGS)

2.3.6 Transportation

The sixth and final element that drives supply chain performance is transportation (Chopra & Meindl, 2013). Together with inventory costs, transportation costs stands for approximately 60 percent of the total logistical costs, which makes it an important cost-component to keep track of (Ahumada & Villalobos, 2004). Transportation has different roles in a supply chain i.e. it provides a linkage between production, storage, and consumption (Kasilingam, 1998). Excellent execution concerning transportation is a vital component in overall logistics and supply chain success (Tracey, 2004).

There are several transportation related decisions that managers need to consider such as cost for transporting goods, physical network design, mode and carrier assignment, service negotiations, and information support systems (Tracey, 2004). In the network design one needs to consider whether a shipment from a supplier should be directly shipped to the point of demand or should go through one or several consolidation points first. In terms of transportation modes, one needs to decide what mode to use in accordance with the company and supply chain strategy. A company can choose between different modes such as rail, air, sea, pipeline, and truck and all modes have different characteristics in terms of space, speed, cost of shipping and flexibility (Chopra & Meindl, 2013). For example, transporting goods by air is an expensive alternative and leads to increases in transportation costs. However, it allows a company to ship products fast to customers and end-consumers and contribute to a higher degree of responsiveness and customer satisfaction.

From a single company perspective transportation can be divided into inbound transportation and outbound transportation. Inbound transportation links the company with its suppliers and can be seen as an important component since it affects the performance of other functions such as production and distribution by providing the right material at the right location and on time. The fact that inbound freight accounts for 10 percent of the total material costs (Tracey, 2004) makes it a relevant parameter to keep track of. The quality output from inbound transportation can be seen as delivering undamaged materials, in time, and with timely and correct information (Tracey, 2004). With increasing inbound transportation performance, one can also most likely expect increased product quality and lower manufacturing costs in terms of lower rework costs and less work-in-progress inventory. Outbound transportation links the company with its customers and is responsible for delivering finished goods to the next entity in the chain (customer or end-consumers) (Tracey, 2004). Thereby, outbound transportation interacts 'face-to-face' with the customers in many transactions and greatly affects how the customers perceive the manufacturing company. With this said, it can be found that outbound transportation directly can be linked to the overall customer satisfaction (Tracey, 2004). According to Chopra and Meindl (2013) inbound transportation decisions affect the costs of goods sold, while outbound transportation costs affects the selling, general, and administrative costs. In Table 2-15, a set of relevant transportation measures are listed. Explanations and definitions of the respective measures are not included in the table but can be found in appendix A and some of them will also be further elaborated upon in the analysis chapter. The measures presented in Table 2-15 are gathered from the work of Chopra and Meindl (2013), Bragg (2011) and (Kasilingam, 1998).

Table 2-15 Transportation measures

Transportation measures
Percentage of demand met
Percentage of good parts
Delivery reliability
Transit time
Transit time variability
Transportation cost per unit
Damage free shipments
Perfect shipments
Equipment utilisation
On time arrival and departure
Average inbound transportation costs
Average incoming shipment size
Average inbound transportation costs per shipment
Average outbound transportation cost
Average outbound shipment size
Average outbound transportation cost per shipment
Fraction transported by mode
Shipping accuracy
Percentage of products damaged in transit

2.4 A new framework for measuring supply chain performance

With the aim of contributing to existing research literature treating the subject regarding how to measure supply chain performance this chapter presents a framework of how to select, categorise and evaluate performance measures in a structured way by following the steps in the model depicted in Figure 2-4.

The framework is based on the idea that all aspects regarding business activities in a company should reflect the vision and goals of the corporate strategy, only then can the strategic goals be achieved. Consequently, the first step in the framework is to evaluate the existing company strategy, sometimes referred to as the competitive strategy. This can be done studying the general guidelines presented in section 2.1.2. This should then be compared with the current situation at the investigated firm. Besides fulfilling the general guidelines, a strategy should be able to be broken down further in the organisation hierarchy to other divisions or functions. Therefore, this step should also study whether or not this is the case.

As stated in section 2.1.2 one part of realising the corporate strategy is to have a supply chain strategy, which is aligned with and supports the vision and goals of the corporate strategy (Schnetzler et al., 2007; Harrison & New, 2002;Presutti & Mawhinney, 2007). The next step, step two, in the framework model is therefore to evaluate the existing supply chain strategy of the company. This can be done in different ways and a strategy can be analysed from several different angels and perspectives. However, this framework aims at determining what type of supply chain strategy that best suits the company by looking at the features of the product in line with the approach of Fisher (1997) as well as looking at the implied demand uncertainty by following the approach of Chopra and Meindl (2013). The output from this step aims at defining what type of supply chain strategy the company should pursue in terms of the degree of responsiveness and efficiency.

Step three is concerned with selecting relevant performance measures that supports the supply chain strategy selected in the previous step. This step uses the six different elements that drive supply chain performance discussed in section 2.3, along with different individual measures (Table 2-10; Table 2-11; Table 2-12; Table 2-13; Table 2-14; Table 2-15). The measures can be used to obtain a certain degree of responsiveness and efficiency that correlates with the supply chain strategy. As stated in section 2.2 there are several different ways in which performance measures can be categorised in a PMS. However, using these six elements that drives supply chain performance (Chopra & Meindl, 2013) has not been tested before and provide this research area with a new perspective. The output from this step consists of a table of selected measures considered to be useful when striving to achieve the strategy and goals according to the findings in step 2.

Since step three provides a company with a set of categories of measures and also specific individual measures the next step, step four, is concerned with investigating what type of performance measures that are currently being used at the investigated company and if they support the strategy. It also includes investigating to what extent the current measures are sufficient in this quest or if additional measures might be needed to complement the existing measures. In addition, other factors will also be investigated such as how the performance measures are shared within the organisation (between different functions or departments) and between their first tier suppliers and customers. The frequency of information sharing and the quantity of measures being shared will also be investigated. This is done in order to get a clear picture of how the company manages and handles their performance measures and also to provide a more holistic approach, since selecting and evaluating measures is just one aspect of improving supply chain performance. The output from this step consists of lists of performance measures currently used in the company, as well as indicators that reveal how the company manages their measures. Important to consider at this step is that most of the measures in each driver are measures that in some way affect performance and might be of importance in general. However, the selection process in order to be effective aims at highlighting measures that are relevant to the given output in step 2

Step five is the activity where the two different lists of performance measures from step three and four respectively is compared. In this step, the different individual performance measures are viewed together and compared with the aim of creating a list, which is as comprehensive and complete as possible. This means that some measures from step three might be added to complement the lists of measures (from step four) currently used by the company. It might also be the case that some of the measures in the list generated from step four are removed, since they are no longer relevant and considered out-dated, and should instead be replaced by measures from the list in step three. In addition, some measures from step three might also be excluded. The output from this step consists of a set of new measures, that should be added to the existing PMS, as well as reflections on the relevance of existing measures.

The final step includes a verification of the comprehensive list in order to ensure that they cover all pertinent aspects of measuring performance. This is done by incorporating the different models described in section 2.2.3. This includes verifying that the performance measures fulfil the requirements presented in section 2.2.4. The output from this step is a final list of suitable performance measures, key performance indicators, that could help the company measure their supply chain performance.

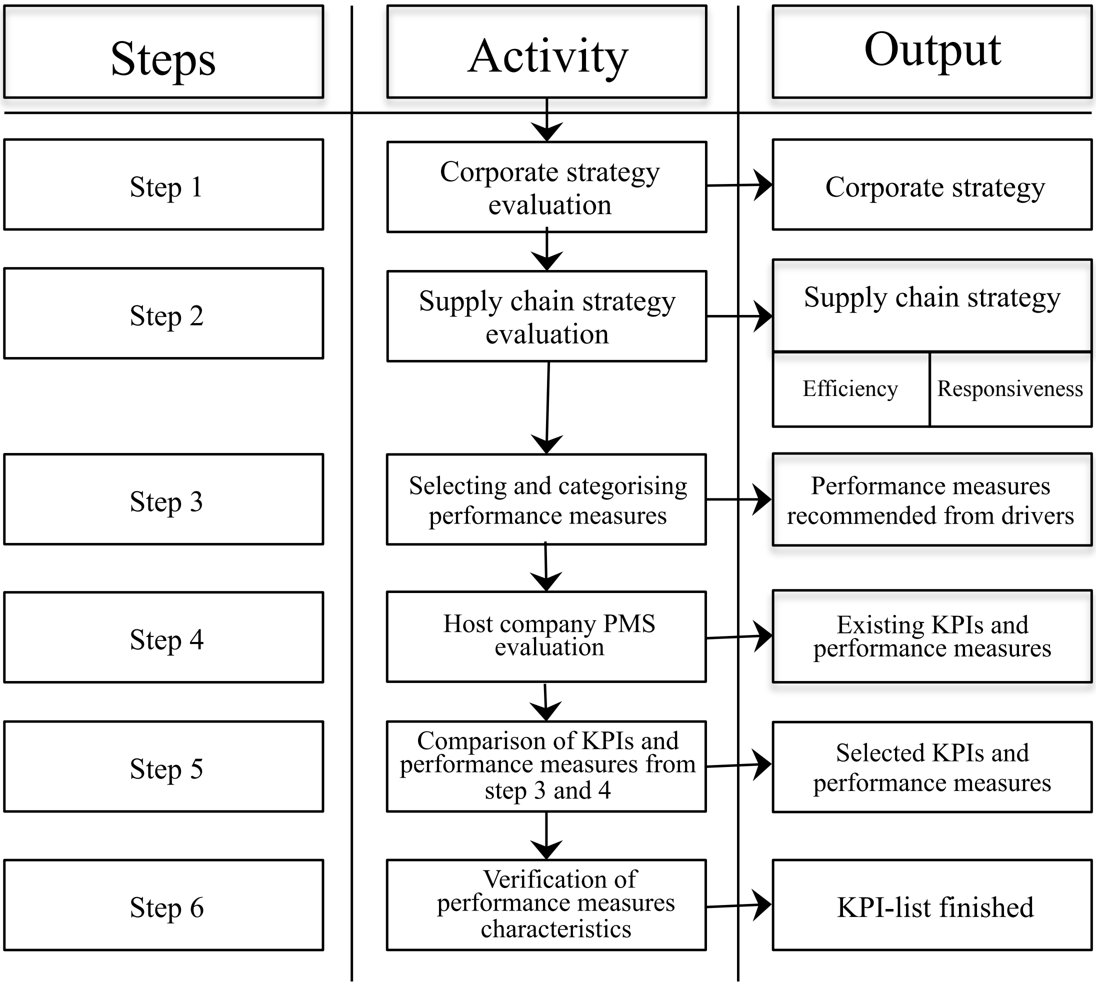

Figure 2-4 Framework for evaluating and identifying performance measures developed by the authors

3. METHODOLOGY

This chapter presents the selected research strategy for this thesis. It also describes the research process, such as how data was collected, how literature were obtained and studied, and analysed. In addition, some reflections upon the research quality of the thesis are presented.

3.1 Research strategy

Research strategies describe different ways of conducting research, and depending on the characteristics of the research project being conducted different strategies are more appropriate than others. One of the most common ways of separating different strategies is the distinction between quantitative research and qualitative research. Even though the two approaches represent different ways of approaching business research, both of them might contain traces of the other (Bryman & Bell, 2011). The distinction does serve a purpose in creating clear definitions on how the different approaches are structured. However, it is important to remember that quantitative and qualitative methods sometimes can be used to analyse each other.

When using a quantitative method, the research strategy is mainly based on quantification in regard to the collection and the analysis of data. It is normally connected to a deductive approach where the quantified data is used to reject or confirm a theory formulated on beforehand. The epistemology positivism, where the social reality in the surroundings are considered to have no effect on the results, is often connected to a deductive approach (Bryman & Bell, 2011). A qualitative strategy focuses more on words rather than numbers and the epistemological views of natural science and positivism have been replaced by a belief that social realities is changing constantly in regard to the individual. These changes in the social reality are affecting the area that is being researched. In qualitative research an inductive approach is usually used, where observations and findings are used to create a theory, rather than using numbers to confirm an existing theory (Bryman & Bell, 2011).

The most common form of research conducted in the area of supply chain management is the quantitative approach and traditionally it has been done with surveys, creating a broad quantitative basis for the testing of a theory (Golicic et al., 2005). However, Golicic et al. (2005) stresses the need for a more balanced approach between qualitative and quantitative research in the field. In light of this and because the aim of the thesis is to create a new framework for creating supply chain performance indicators, a qualitative and inductive approach was chosen to be the most suitable one. Because the chosen research approach was inductive to its nature, a qualitative and narrative literature review was used to analyse existing theory in the fields of ‘supply chain performance’ and ‘measuring performance’. The data found in the literature review was organised and analysed in order to create an understanding of the subject, which enabled the researchers to construct a theory and a framework to support that theory. To validate the practical functionality of the framework, a case study was conducted at Swedish Match (SM) and more specifically at the Global Supply Chain (GSC) function.

According to Seuring (2005), case studies is a good way of getting basic comprehension of new fields of research and one of its strengths is to identify issues in conceptual development. The author also states that there is a need for more case studies in supply chain management research. Therefor a case study was conducted in order to validate the framework developed from the literature review and to get a better understanding of the implications emerging when put in the context of an organisation.

3.2 Research Process

In this chapter the different parts of the research process will be presented and described in detail. It will be explained how the different parts contribute to the project and how they were performed.

3.2.1 Literature review

To create an understanding of the topic and to identify a gap in existing research, the first step in this thesis was to perform a literature review, the data for the review was collected from various academic databases online. According to Seuring et al. (2005), a literature review is the foundation of any research since it creates a basic understanding of the concepts and content of the field being research. The authors continue to state that there are three main types of analysis that can be conducted within a literature review, qualitative, quantitative, and structural analysis. Even though they are different in their nature, they can and are often used in combination with each other. It is also important to remember that the data used in a literature review is secondary data, which means that the researcher needs to be critical about the information. The data could have been collected for a different purpose and the authors might be bias, therefore it is important to consider the source of the data presented and the background of the author (Ghauri & Grønhaug, 2010).

For the literature review conducted in this study, a narrative review was used. A narrative review is suitable when the research is inductive and qualitative to its nature (Bryman & Bell, 2011). The aim of the literature review, as stated above, was to create a broad understanding of the topic and to identify a gap in existing literature, which according to Bryman & Bell (2011), makes a narrative approach suitable, rather than a systematic review where the procedures are very explicit and the scope is narrowly specified from the beginning, making it more suitable for a deep analysis of a more defined subject.

To get a grasp of the literature available on the subject, the literature review started with an explorative phase, where keywords and key phrases were used to gather journal articles and books from online bibliographic databases, such as Emerald, Proquest and ScienceDirect. These databases were accessed through the Chalmers University of Technology's online library. Once a basic understanding of the subject and a scope was established, references and 'cited by' functions where used to deepen the review and create an understanding of which of the authors researching the area was cited the most as well as what theories and frameworks that have been validated or questioned. These articles were then used to create new keywords and key phrases that were used to perform new narrower search for literature. Keywords used are presented in Figure 3-1.

Keywords used in literature search
Supply chain management, supply chain performance, performance measurement, performance measurement system.

Figure 3-1 Keywords used in literature study.

The observations and findings from the literature review were then used to create the theoretical framework for the thesis and the eventually the framework presented in section 2.4. The framework is based on well-established theories and approaches and was created to fill a gap in existing research.

3.2.2 Case study

In order to test the model and to further increase the validity of the model, a single case study was conducted at the GSC function, at SM. According to Yin (2014), a case study is suitable when trying to understand how a phenomenon works in a real-life setting. Performing a case study will help the researcher understand how social factors and a specific context will affect the outcome of a phenomenon, by allowing the researcher to perform an in depth study in a contemporary setting. When conducting a case study it is important to stay non-bias through out the research project, in order to get good and fair results. It is also important to stay adaptive and to be well prepared, since conditions might change over time. It is also important to ask objective questions and to be a good listener (Yin, 2014).

The main objective of the case study was to investigate if the framework developed could be applied to the specific contemporary context of SM. According to Bryman & Bell (2011), the results from a case study are rarely generalizable. Therefore the aim of the case study was not to prove a general applicability of the framework, but to test if the general framework created from existing research can be applied in a specific company context, such as SM. The case study at SM consisted of data collection and the framework was applied on the data collected by the researchers.

3.2.3 Data collection

According to Phillips et al. (2008) there are numerous types of different methods for gathering qualitative data such as interviews, focus groups and observations. For this thesis, interviews and observations were the selected methods for obtaining the qualitative data.

Interviews are considered a useful method and might deliver data that is not available or found in performance records. It might also be useful when data is difficult to gain from written responses or observations (Phillips et al., 2008). There are three common types of interview methods i.e. structured interviews, semi-structured interviews and unstructured interviews (Wilson, 2013). In this thesis, semi-structured interviews were chosen and considered to be the most suitable method. This is because semi-structured interviews provide a sufficient base with specific questions as a starting point, which help the interviewer to stick to the main topic, but at the same time offer the interviewee with an opportunity to clarify different topics and raise additional issues in a more open way. They also provide the opportunity for discovering previously unknown issues (Wilson, 2013).

In order to gain information regarding how SM are currently measuring their supply chain performance and how they handle their performance measures, seven interviews were conducted with the head of the respective function within the GSC function at SM. Before the interviews were carried out some preparations were made in order to be able to execute the interviews in an accurately manner. Firstly, the design of the interview form was developed with questions structured in accordance with the structure of the framework developed by the researchers, presented in section 2.4. However, it was also supplemented with some additional questions in order to gain some general information about the company and the respective functions. The interview form was structured in six sections where the first part contained questions concerning the interviewee in order to get an understanding of his or hers professional background and experience. The second section of questions was concerning the work and development of the supply chain strategy as well as the different activities and responsibilities dedicated at the respective function. The third section included questions regarding what measures SM is using today. The fourth and fifth section respectively comprised questions regarding how performance measures are shared within the organisation and between other actors in the supply chain as well as potential areas of improvement. The final section consisted of more in depth questions relevant to the specific function. When the design of the interview form was finished it was sent out to the interviewees in advance in order to ascertain that the interviewee had time to prepare and process the questions. The interview form was written and conducted in Swedish in order for the interviewees to feel as comfortable as possible. The interview form as it was sent out to the interviewees can be found in appendix B.

Observations are also considered as a useful data collection method. It might be used when trying to understand the groups or individuals behaviour and how they approach different issues (Phillips et al., 2008). Observations were carried out three times during the data collection process. The first observation session was made when visiting one of the daily morning meetings held by the production manager at the Gothenburg factory. The second observation session took place in a conference room at SM where the researchers had the opportunity to take part of a management meeting with all managers from the GSC function when discussing KPIs and other strategic issues. The third observation session took place during a tour in the Gothenburg factory, where the researcher were provided with the opportunity to study the flow and the processes in the factory.

Besides the qualitative data obtained through interviews and observations some additional qualitative data, in the form of Microsoft Excel sheets, were received from each function. These documents are called roadmaps and each function has their own roadmap that consists of issues related to their activities and processes, but they are all derived from the overall goals in line with GSC strategy. These roadmaps are broken down in more quantitative measures and specific KPIs that were also received from the interviewees.

3.3 Data Analysis

Since the aim of the case study was to test the created framework, the data collection and the analysis was based and planned in regards to the different steps in the framework. According to Yin (2014), this is one of four general strategies that can be used when analysing data from a case study, and this particular strategy is by Yin (2014) referred to as “Relying on theoretical propositions”. When using this strategy the researcher used the theoretical propositions and the research questions as guiding points when conducting the analysis. Since the case is built to investigate these propositions and questions, the data collection plan is often shaped around them and the analytic priorities are formed after them and guides the analysis during the research project. According to Ghauri and Grønhaug (2010), the main objective of data analysis is to create an understanding and bring order in the collected data. Even though it is difficult to specify one approach to qualitative data analysis that is general, there are some guidelines that can be useful. For example, qualitative data analysis can be divided into three components, 'data reduction', data display, and 'conclusion drawing or verification' (Ghauri & Grønhaug, 2010).

Data reduction is important since the amount of data collected in a case study is usually comprehensive (Ghauri & Grønhaug, 2010). The first step when analysing the collected data from the case study was therefore to transcribe the recorded interviews and extracting the relevant data. The information from each interviewee was then categorised to ensure that the information needed for each step in the framework had been obtain from each function. If information was missing at this stage further inquires were made to the interviewee to obtain additional information and to ensure that all of the information needed in later stages was collected. Since one person from each function was interviewed the different functions could then be compared with the help from the categorisation. The categories made it possible for the researchers to ensure that the same information was received from each function as well as function specific information. To decrease the risk of bias results several employees were consulted on certain subjects.

A part from the information obtained during the interviews, documents containing KPI-lists, measures, and roadmaps were received from the different functions. This information was also categorised and reviewed in order to make sure that all of the information needed had been obtained. In order to be able to analyse the data, tables with the information needed was created, which are displayed in section 4. The tables were then used to compare the different measures between the functions to make sure that the same data had been received from each function. The different sets of data was then compared to each other along with information received during observations in order to receive a full picture of the current situation and future challenges. The data obtained from documents was also compared with the information received during interviews and observations made by the researchers to further increase the reliability. This is called triangulation and is according to Bryman and Bell (2011), a good way to increase the credibility of the information.

The categorised and reviewed data was then used to perform the steps in the framework. Throughout the use of the framework the collected data, the theory from the theoretical framework, and observations from the researchers were used together when analysing the current state at SM and when selecting new performance measures. In order to ensure that no mistakes were made, the results were reviewed after each step and the final result discussed.

3.4 Research Quality verification

When evaluating business research three main criteria are used, Reliability, Validity and Replication (Bryman & Bell, 2011). Replication is necessary in order for other researchers to be able to replicate the findings from a previous study. Since replication is relatively rare (Bryman & Bell, 2011) this criteria will not be treated further in this section. Instead, the rest of this chapter discuss the first two criteria's, Reliability and Validation.

3.4.1 Validity

According to Yin (2014), validity can be divided into three categories, internal, external and construct validity. The rest of this section elaborates further on the first two categories, internal and external validity.

Internal validity address the issues whether or not a conclusion related to a causal relationship between two or more variables holds (Bryman & Bell, 2011) i.e. if a certain factor *x* really is the factor that led to the event *y*, or if there is another factor *z* that is actually causing the event *y* (Yin, 2014). As mentioned in the previous section, using multiple sources of data in a study, triangulation, can be used to increase the internal validity. In this thesis interviews from several different functions and individuals at SM were conducted. In addition, observations and data sheets were used to complement the information obtained from the interviews.

External validity is concerned with the issue if the findings of a study apply to other contexts (Bryman & Bell, 2011). According to Bryman and Bell (2011) external validity is generally a bigger issue than internal validity when performing qualitative research, since this type of research often make use of small samples or case studies. Since a case study was used in this thesis the external validity reduces, and the fact that the findings are generalizable can be questioned. In order to increase the external validity Bryman and Bell (2011) state that the 'thick description' can be applied, which means that the specific context and environment in which the case study were made are described in detailed. Therefore, the researchers made use of this concept in this study.

3.4.2 Reliability

A study is reliable when errors are minimized and biases avoided. This means that if two different researchers follow the same procedures, they will arrive at the same findings and conclusions (Yin, 2014). For a study to be reliable the procedures of a study has to be well documented and possible to perform later in time. Only then can another researcher replicate the procedures in a new case. When a second researcher is able to perform a study and arrive at the same findings and conclusions it is referred to as external reliability. Internal reliability concerns the extent to which several researchers can draw the same conclusions from a situation, in a study (Bryman & Bell, 2011). Internal reliability can also be seen as a parallel to dependability in qualitative research. Dependability is achieved when all of the procedures and data collected is adequately described and presented, enabling the study to be reviewed thoroughly.

To increase the reliability of the research the researchers have been careful through out the project to avoid biases and to stay objective. Both researchers have reviewed all the data collected and all decisions and analysis has been agreed upon. To ensure that no mistakes were made or angles missed in the research process, the supervisors at SM and at Chalmers have been consulted continuously during the project.

One of the issues with the reliability in qualitative research is the lack of standardisation of semi-structured and un-structured interviews. Due to the open questions and the flexibility in the interview guides it is difficult to perform interviews with exactly the same result (Bryman & Bell, 2011). Another issue of reliability when conducting interviews is the risk of anchoring, which is when the interviewer unknowingly projects his or her opinions on the interviewee. Anchoring can have big effects on the information received (Bryman & Bell, 2011).

In order to increase the reliability of the information received from the interviews several methods were used and one of them was to recorded the interview session. The advantages of recorded interviews are many, the answers from the interviewees can be revisited for further analysis and allows the interviewers to discuss answers that are unclear and also allows the data to be reused (Bryman & Bell, 2011). In addition to the recorded interviews both researchers were present at all interview sessions and the answers received were reviewed and analysed by both researchers. Since there were more than one researcher present at all interviews and during the analysis, the risk of any answers being perceived in the wrong way and the risk of anchoring is reduced, since the researchers can remind each other of staying objective.

4. EMPIRICAL STUDY

The first section of this chapter provides the reader with basic information about the organisation, including a description of its product areas along with the overall corporate strategy. It also describes the corporate structure together with some basic additional information. Section two provides a slightly more in depth description of one of the functions, GSC, which is a function within Product Innovation & Supply (PSI). In turn, PSI is a part of the Scandinavian division, which is one of the five operating units depict in Figure 4-1. Section three presents information obtained from conducted interviews, published documents and observations at SM.

4.1 Corporate Background

SM is a global company that develops, manufactures, markets, and sells quality products with market leading brands in the product areas snus, moist snuff, and other tobacco products (cigars and chewing tobacco) and lights such as matches and lighters (Swedish match, 2015). ‘A world without cigarettes’ is the vision of SM and their long term strategy is to create shareholder value by offering tobacco consumers enjoyable products of superior quality in a responsible way. In the snus and moist snuff area this is to be achieved through the strategy reading: “In Scandinavia, we will defend and develop our strong market positions and lead the development of the Snus category.” (Swedish match, 2015). In line with the business model, SM continuously try to connect the right people to their business, work with their strategy and structure, with the aim to rapidly meet changing markets requirements by being flexible and innovative.

The average number of employees in the SM group during 2014 was 4395, and the net sales for 2014 were 13 305 million SEK. The headquarter is located in Stockholm, Sweden and the production facilities are situated in Brazil, the Dominican Republic, the Netherlands, the Philippines, Sweden, and the United States. The organization is divided in four different corporate functions and in five different operating units (Figure 4-1). The corporate functions are: group finance, group business control, legal affairs, and investor relations & corporate sustainability and the five operating units are: the Scandinavian division, US division, lights international, light Latin America, and SMD logistics AB.

One of the functions within the Scandinavian division is PSI, which is responsible for the supply of the group’s smoke free products, including new product development and product portfolio development. In addition they are responsible for sales and marketing in Sweden and Norway. They are market leaders with market shares of 69 percent in Sweden and 58 percent in Norway.

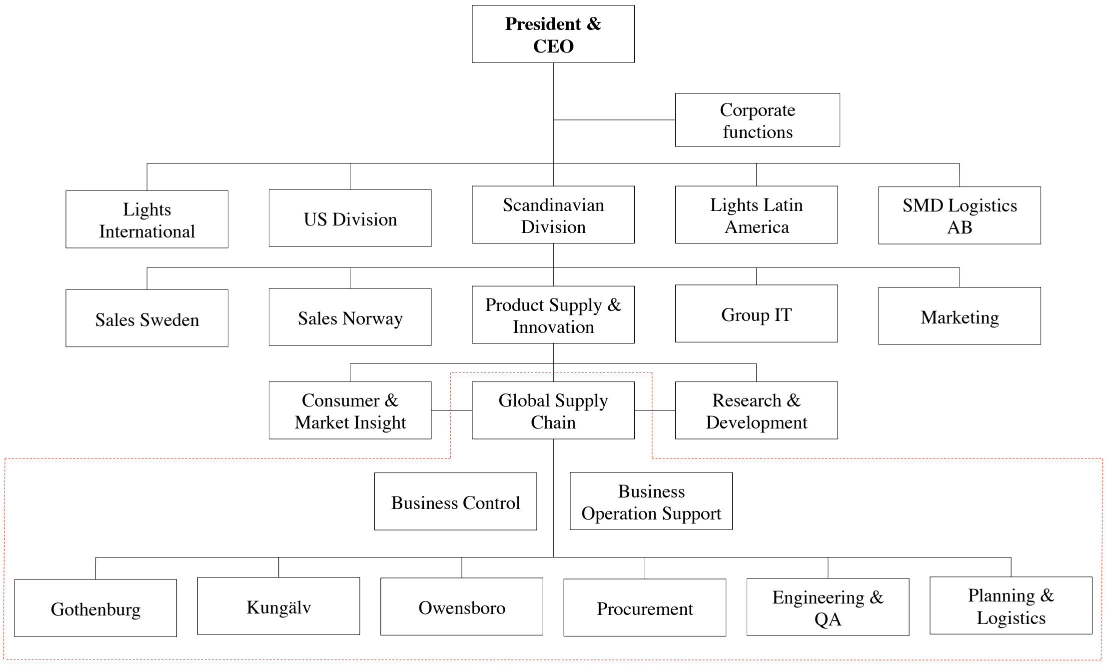

Figure 4-1 A simplified picture of the organisational structure of Swedish Match.

4.2 Global supply chain function

PSI has three sub-functions, one of which is the GSC function (Figure 4-1). The vision of the function is: "We shall exceed our shareholders expectations" and in order to manage this they have a mission which reads as follows: "We shall secure future market- and customer demands, by continuously deliver uncompromising quality with the right service level at a competitive cost (QDE-step)". In turn, the mission is broken down into different focus areas that are to be undertaken over a three year period. In 2014, six new focus areas were decided for the period 2015-2017. The mission and the focus areas are composed and revised by the GSC management team during annual strategy meetings. The meetings takes place twice a year and stems from the strategic focus areas from the PSI function as well as from strategic dialogues with the Scandinavian division. They also discuss the strategy outline on a more long term basis.

In order to communicate the focus areas throughout the entire organisation, the head for each function, together with their own team, breaks down the focus areas further into roadmaps, which in turn are broken down into specific KPI lists. The breakdown of the overall corporate strategy throughout the organisation is depicted in Figure 4-2.

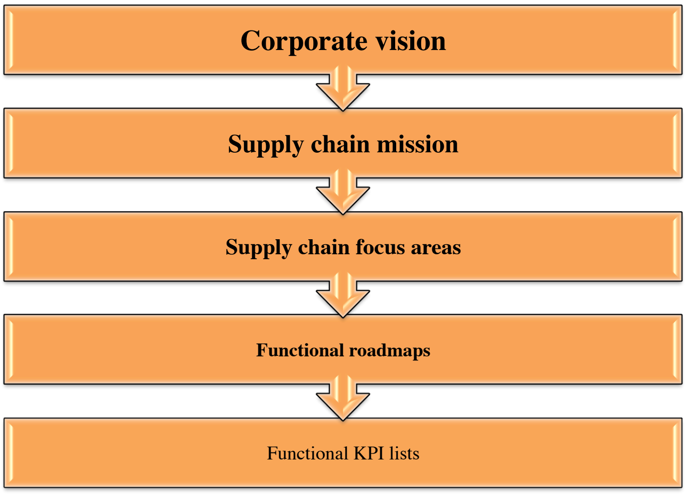

Figure 4-2 Visualisation of the steps for breaking down the corporate strategy at Swedish Match.

SM use visual control in order to communicate their goals and guidelines to all stakeholders in the company. The visual control is based on a visual tool, the QDE-STEP model, which displays and monitors the results and progress made. It also provides a common picture of the current situation and direction, regardless of the geographical and organisational affiliation. The information given from the QDE-STEP model also guide and motivate the personnel in their daily work. In practice, the model is implemented by using physical boards located in proximity to the respective function, thereby making the information visible to the personnel. Each level within the GSC function has their own specific boards with KPIs expressed in QDE- step components. The different components in the QDE step model are:

Q - Quality
D - Delivery
E - Economy
S - Safety
T - Technology
E - Environment
P – Personnel

In the case study conducted in this thesis the Swedish part of the GSC (GSC) function will be in focus, and in particular the functions associated with the Gothenburg factory (GF) and the Kungälv factory (KF). The main product families produced in these factories are displayed in Figure 4-3, for a richer description of the different products and packaging solutions see appendix C. In the case study all material flows will be considered except for the purchasing of raw tobacco. The purchasing process is excluded, because of its complexity and SM’s need for a one-year safety-stock of raw tobacco. The large amount of safety stock is due to the risks for bad harvests and SM’s dependency on a constant supply for high quality tobacco.

Loose	Random Merz	Star formation NYPS	Random NYPS
			
Loose filling for cardboard can	Traditional random filling for ▪ PSO Large Merz ▪ PSO Mini Merz ▪ PSO Long Merz	Star formation NYPS for ▪ PSW Large NYPS ▪ PSW Mini NYPS ▪ PSW Long NYPS	Traditional random filling for ▪ PSW Large NYPS ▪ PSW Long NYPS

Figure 4-3 Main product formats and filling possibilities at Swedish Match.

4.2.1 Gothenburg Factory

The main responsibility for the GF function is the day-to-day operative work in the factory, where the overall focus is on producing products as fast and as cheap as possible. This means producing according to the forecasts and production plans received, and to deliver the right amount, on-time to the distribution centres. The responsibilities also include quality controls and to ensure that the inventory levels are correct.

The corporate strategy is always present when planning for future work at the factory and the strategy is broken down into more tangible and accessible issues closer to the individual, in order to make everybody feel like they contribute to the success of the company. In current time the concept of working with a strategy is well implemented and more KPIs have been added to further enhance the connection to strategic goals, as well as KPIs that better describe the strategy on a more broken down level. The strategic goals are evaluated two times a year, by the management team of the GSC function and in the beginning of December the goals for the upcoming year are set and after approximately six months the progress and results of the work conducted is evaluated.

Apart from the meetings with the GSC management team, the GF management team has weekly meetings with a different focus each week. At lower levels the follow up is more frequent. For instance, in production KPIs and in particular the delivery precision is reviewed every week along with the frozen production plan for the coming week.

Current Challenges

The main challenge in the factory is the increasing number of stock keeping units (SKUs), where SM has seen an increase from 40 SKUs to approximately 220 SKUs. These increases in product variation have created a new need for flexibility. The challenges for the GF are mainly in the tobacco processing and at the packaging processes, where the portion-puches are made and placed in cans. This problem has been especially evident at one of the packaging lines where several low quantity SKUs are being packed. The many changes at the lines between different SKUs means that lower set up times will be necessary in order to increase the productivity of the factory. A reduction in set up times is one of the most important issues that the factory is facing today. In the batch preparation area the increased number of SKUs has also proven difficult. The system is not created to handle smaller batch sizes. The variation causes problems and a more automated system is needed in order to be able to handle the new requirements from the market. Another problem is the amount of prepared tobacco that is currently wasted, the inability to handle small batches becomes very evident when looking at waste from the preparation stages.

An area of improvement is also the amount of data that has to be handled and entered manually into the computer systems. Improvement projects are currently in progress to improve the automation of data handling. Inventory accuracy is another area that is gravely affected by the data handling, creating problems for everyone involved. The amount stated in the computer system, does not always match the amount stated in the system.

4.2.2 Kungälv Factory

Just as the case with the GF function, the main responsibility for the KF function is the day-to-day operative work in the factory, such as producing products as fast and as cheap as possible. Following the production plan is the main goal, which means delivering products in right amounts and on time.

The KF function has four meetings a month with the KF management team. Besides the meetings with the factory management team there is a meeting once a week where the staff is informed about current events. Once a month there is a larger meeting where results and other important news are shared with all personnel in the factory.

Current challenges

One area that the KF function is focusing on is quality, in particular to reduce the customer complaints. A large number of the customer complaints can be traced to the welds on the portion-pouches since the welding process is not reliable enough. Another area that needs improvement and which is more connected to capacity is the processing of raw tobacco into snus. A change in the components in the recipe for some brands has made the density of the raw tobacco lower. This means that the same weight of tobacco has a larger volume, creating a problem since not enough tobacco can fit into the containers where it is processed into snus. This makes the snus batches smaller than usual, hence lowering the capacity.

The increased variation creates problem on the individual snus packaging lines, where the main measure used is OEE. At the production lines with most variation it is hard to maintain a high OEE number because of the many changes between SKUs. The set up time and the ramp up time will affect the measure negatively and the planning process becomes more difficult since low volume SKUs has the same requirement for deliverability as the high volume SKUs. There is currently a discussion if there are any possible gains in having a lower requirement of deliverability on the low volume SKUs. Another issue in regard to the OEE measure is the fact that shortages will affect the number negatively, in combination with low safety stocks this means that overproduction in the beginning of the week will lead to decreased OEE numbers at the end of the week due to shortages. The low safety levels of some raw materials means that overproduction to cover for the beginning of next week, when the production line is up to speed is impossible. An increase in safety stocks could cover the problem of not being able to overproduce. However, larger safety stocks are costly, the problem could also be solved with a higher degree of flexibility from the suppliers.

Another issue with the increased variation is that lines that used to produce low volumes now have increased demand, since there are more SKUs that require specifications that only a specific line can provide. Each line is specified to be able to produce one type of pouch. Changing the lines to fit a different pouch means a lot of set up time and ramp up time. Therefore, it is avoided as much as possible. The market division is constantly making change request on products in order to increase sales, which puts a lot of stress on the factories that has to keep up with the changes. There is an on going project with a new automated system to increase the measurability at the production lines. The new system will help the factory to get a clear view of the different types of stops and the durations of stops.

4.2.3 Procurement

Procurement is responsible for all the purchasing decisions made at SM for the three factories in Gothenburg, Kungälv and Owensboro. The procurement organisation is in turn divided in two areas, the two Swedish factories in Gothenburg and Kungälv and the U.S. factory in Owensboro. This thesis due to the delimitations will focus on the two factories in Sweden. Just as the other functions within GSC, the head of the function is a part of the management team and is involved in the creation and evaluation of the strategy. The strategy is broken down into focus areas, which in turn are broken down into a roadmap containing the ten most important improvement projects. Every month there is a meeting to ensure that the work is heading in the right direction, and economic targets and recent events are evaluated. The function has meetings every Monday to evaluate the previous week and to plan for the upcoming week. Because of the large increase in SKUs, the way Procurement operates have become a lot more structured and systematic during recent years and there are well defined instructions for how the decisions in regard to design changes should be made. The increased product variation has lead to an increased collaboration with the suppliers, especially with the key suppliers providing high importance and high quantity items. The items are divided into categories and each category has a strategy for how they should be purchased. The categorisation and the strategic decisions are based on which parts are similar, what they are used for, their priority, quantity and how they are handled. However, each item always has one single supplier in order to keep it structured. Within the different categories there can be several suppliers, but never more than one supplier for each specific article.

All the everyday purchasing is done based on the information the purchasing team receives in the ERP-system (Dynamics AX). In the system, data such as inventory levels, the amount that will be needed according to the production plan, and the forecasted need of each items are represented. Procurement does not create the plans or the forecasts, but order the quantity specified by the Planning & Logistics (PL) function. Orders from Procurement are placed twice a week, where cans, lids and bottom labels are purchased on Thursdays based on the weekly production plan. Even though placed once a week the demand is broken down in daily quantities. Other direct materials are purchased on Wednesdays based on more long term forecasts. Besides the actual purchasing of goods procurement is also responsible for specifying the transportation arrangement between the suppliers and SM. Depending on the cost and what is the most practical, it is decided whether SM or the supplier should be responsible for the transportation. The collaboration between SM and its suppliers depends on the strategic importance of the supplier, the quantities purchased and the importance of the items for the end-products. With the largest and most important suppliers weekly production plans and monthly forecasts are shared and updated to the best of their ability with additional information. The smaller suppliers receive a rough estimate of the forecasts for the upcoming year. In addition to the planning and forecasting information shared with the largest suppliers additional long-term and strategic improvement meetings are held regularly. Once a week there is a meeting with a set agenda to discuss quality and continuous improvements, over time the goal is to only discuss continuous improvements in these meetings. On a management level there are more flexible meetings quarterly where the long-term goals of the collaboration is discussed. These meetings are held separately with 5-6 largest suppliers.

Current Challenges

One of the current problems described by the procurement department is the inaccuracy in inventory, planning and forecasting. Regarding inventory, there is an imbalance between the actual inventory levels and what is actually available in the warehouses. One reason for this is the inability to follow the structured way to report inventory changes into the system. When it comes to planning, there are too many changes in the frozen production plan for each week, which makes it hard to predict the material needed, leading to lack of raw material in production due to unpredictable changes. Lastly, the variation between the planned output and the actual output each week in production is too high, creating unbalance in inventory. The accuracy of the system needs to increase in order for purchasing to be more accurate with lower degrees of deviation.

The deviations in the system lead to higher inventories, since procurement has to compensate for the possible changes. Therefor the inventory levels are higher than wanted, which in turn leads to obsolete material that has to be scrapped. However, the demand for a low level of tied up capital is quite low, which means that inventory reductions are not the focus of improvement work. There are however restrictions in warehouse space, which means that due to space restrictions the inventories for raw material cannot get much higher.

Each year, 600 to 800 new items are added to the item master file due to new product launches and design changes on existing products. The date for which the new design is planned to replace the previous design, is set on a specific date. If not planned carefully, this exchange might cause planning errors which in turns leads to waste or shortages in material.

One of the activities at the supplier providing lids to SM is it to attach the labels. This means that the lids can only be used to manufacture one specific SKU, which makes it difficult to perform planning changes at SM.

4.2.4 Planning & Logistics

PL is responsible for supporting and executing the Scandinavian division's strategy as well as the GSC mission in the areas of logistics i.e. secure the global strategic plan within the logistic field. This involves developing 'best practice' in the factories such as securing and developing new enterprise resource planning (ERP) solutions and how these are to be implemented and used throughout the organisations and also to develop new KPIs and revising existing KPIs. The function is also responsible for evaluating and developing the value stream on a regular basis in order to meet the delivery performance requirements. Furthermore, the function has the task of improving the cross- functional collaboration, thus strengthen the cross-functional interfaces. It also includes working with the suppliers together with the procurement function as well as with the distribution centres. All sales figures are received from the distribution centres and each morning the PL function receive these data for the previous day. PL does not usually communicate with the end customers but rather with the distribution centres. Lastly, the function is also responsible for the production planning process and that forecasts are received from the sales function on time.

Current challenges

PL also suffers from problem caused by the increased number of SKUs. The majority of these newly added SKUs are low volume products with varying characteristic such as different flavours and packages. This implies that they are difficult to handle in an ERP system. Another issue is the fact that the process in which the tobacco is being processed into snus requires that the containers holding the tobacco are filled to a certain degree for the process to work properly. This means that the orders concerning the low volume SKUs needs to be merged and processed in one batch regardless of the planned delivery date. This causes disruptions in the planning process since the orders scheduled to be delivered later face the risk of becoming obsolete before being shipped.

As mentioned previously, the actual sales figures comes from the distribution centres with one day delay and the information is used by PL to calculate the days of supplies required. Calculating days of supplies in this manner however highlights the importance of taking external circumstances into account. One example of an external factor affecting the days of supplies required is the behaviour of the retailers. When the retailers initiate campaigns in their stores, the days of supplies at SM are reduced due to increased sales. One must be aware of the fact that this is only a temporary phase and one should not put too much faith in these numbers. Meetings are held with the distribution centres to gain information regarding certain extraordinary events regarding sales, such as future campaigns etc. However, an issue for SM and the PL function is the fact that these types of campaigns are sometimes made by the retailers without informing the PL function, which causes disruptions in the process. The PL function also has the number of days of supplies required calculated based on forecasts. These calculations are not primarily used but act as a complement to the days of sales information.

In general, SM has a high inventory turnover and the PL function tries to improve it further. During the interview other issues were raised, such as the fact that diversified supply chain strategies might be needed in order to cope with the complex circumstances with the increasing number of SKUs. In addition, the need for cross-functional meetings between SM and their supplier were also raised as a potential improvement proposal, since the majority of the communication with suppliers today is made through the purchasers at SM. The problem of delivering accurate and on time forecasts to the purchasing functions is also considered an issue.

4.2.5 Business Control

The Business Control (BC) function is responsible for all financial processes and for providing all financial reports related to the factories located in Kungälv, Gothenburg, and Owensboro. In addition, the function is also responsible for handling the investment processes and for budgeting. The financial measures are reviewed and updated with varying frequency depending on what level in the organisation hierarchy that is being reviewed. On an operational level the measures are reviewed once a month and on strategic level they are reviewed twice a year. One of the tasks is to coordinate the three different factories so that they all use the same measurements and definitions.

BC does not have any KPIs connected to their specific function and it does not own any KPIs. Rather, they obtain and compile information and measures from other functions. An example of this is the information that BC receives from the procurement function regarding quantities and the associated costs for tobacco and other materials. These costs are merged, calculated, and compared with the projected costs calculated at the beginning of the year. The possible difference between the projected cost and the actual cost is analysed in order to find the cause and what action to take. Hence, the BC function bridge the different functions financially and seeks to evaluate and summarise the other functions impact on the financial performance. An example of this is to decide upon different trade- offs such as the relation between inventory levels and sales. In the case of SM, one day of lost sales is more costly than the cost would be for holding the goods one extra day in stock. This is due to the relatively high margins of the product.

Current challenges

One of the issues raised in the interview with the head of the BC function was the increased requirement for being more flexible. The challenge is to find a way to maintain the current cost structure while increasing the flexibility. To quote the interviewee:

“ Flexibility costs money.”
(Business controller at SM (2015-05-27) Interview during case study)

Another issue highlighted by the interviewee is the difficulty of realising how certain measures contributes to the overall profitability. One example related to this issue is the difficulty of stating certain improvements made in production, such as decreased lead-times and increased OEE, in financial terms. In today’s situation, a ten percent increase of the OEE measure cannot be directly connected to the organisation’s profitability. Hence, there are few connections between overall profitability and factors that might affect the profitability indirectly. In addition, the interviewee stated that the organisation lacks routines for following up their business cases and calls for improvement within this area. The creation and execution of them are however satisfactory.

4.2.6 Engineering & QA

The Engineering & QA (E & QA) has several different responsibilities and is in some ways considered a supporting function to the other functions. It is responsible for developing new technology and packaging solutions. Within the technology area, project activities is also included such as project management for factory projects. The function is also responsible for ensuring that the certification requirements for ISO 9000 and 14000 are met. The function's assignment is also to submit and present future production arrangements, and productions techniques. As in the case of the BC function, many of the measures that the E & QA function monitors and evaluates stems from other functions, such as production and maintenance, which means that the function itself does not own any measures. This is elaborated on further in sub-section 4.3.6. Related to this, a task for this function is also to bridge the R&D function and the production function, and to facilitate the communication between these two. Finally, keeping up with the latest trends regarding new techniques and equipment available in the market comes with the responsibilities.

Current challenges

One of the task for this function is to handle the increased complex environment stemming from the increased number of SKUs. One of the issues is therefore to investigate how SM might be able to produce large batches with stable demand as well as small batches with unstable demand. An example of this is that the throughput time has increased with approximately five days the last four years due to the complexity. The increased throughput time has more to do with the complexity rather than SM being explicitly less effective.

In order to cope with the different market requirements there is a need for developing new and more attractive product solutions, in line with the strategy. Since the E & QA is responsible for developing new products and at the same time for reducing the complexity, they sometimes find it difficult to balance the two, which means that trade-offs need to be made regarding what to prioritize.

4.2.7 Business & Operations Support

The Buisness & Operations Support (BS) function as the name suggest is a supporting function. Amongst other things it is responsible for the internal information flows and the intranet. However, it is also responsible for facilitating the business development work, providing templates for roadmaps, meeting agendas and protocols. It is also responsible for coordinating improvement work, to visualise progress made, and to ensure that everybody is striving towards the same direction.

4.3 Current performance measures at GSC

This section presents what the different functions within the GSC function are measuring and the KPIs used to monitor, evaluate, and display their results and performance. The collected data is based on the information obtained from the interviews as well as from written documents and data sheets. Each sub section begins with presenting a table of the KPIs and is followed up with some general reflections from the interviewee and from observations made.

As mentioned in the previous chapter the different functions have their own roadmaps and KPIs connected to their specific activities. However, they are all presented in terms of the QDE-STEP components. At the highest level in the GSC hierarchy, KPIs are followed up at factory level and the definition of these KPIs are presented in Table 4-1. The KPIs that are followed up at this level are the same used at factory level, which can be seen in section 4.3.1 and 4.3.2. Other functions also have KPIs stated in terms of QDE-STEP components but these vary in some ways.

Table 4-1 QDE step components with their respective definition and formula

	KPI	Unit	Definition	Formula
Q	Total consumer complaints	ppm	Total number of complaints per million sold units	Number of complaints/Total sales units
D	Delivery performance	%	Sales unit delivered on time to customer (excluding Norway, export and travel retail	Sales units delivered on time/ Total sales units
E				
S	Near miss	Total number	Number of near misses reported work injury reported	Number of recordable accidents/ Total hours worked
T	OEE	%	Output efficiency based upon production time. Excel. Time when production is stopped due to high stock levels	Total outputs unit / Theoretically possible output
	Productivity	Units/ man-hour	Total output per direct labour hour	Total output/ Direct labour hour
E	Energy consumption	MWh/mTon outgoing products	All energy consumption within site boundaries (no transport services)	Energy consumption / mTon outgoing products
	Total waste	mTon/mTon outgoing products	Total waste leaving site, including fraction recycled material	mTon waste leaving site/ mTon outgoing products
P	Health attendance	%	Blue and white collars	Health attendance/ Working hours

4.3.1 Gothenburg Factory

At the GF, two main KPI tables are used, one for the factory as a whole and one for production as an entity. The production table is displayed on the wall as the 'Production and Maintenance QDE-STEP-board' along with a Long Range Plan (LRP) summary for the factory. Besides being displayed on the board, the QDE-STEP measures are used to monitor progress by the different levels of management teams.

Table 4-2 The Gothenburg Factory QDE-STEP-table Long Range Plan.

	KPI	**Unit**	**Factory**	**Format**	**FY 2014**	**2015**	**2016**	**2017**
Q	Total consumer complaints	ppm	GF	LS PSOL	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]
D	Delivery performance	%	GF	Tot.	[redacted]	[redacted]	[redacted]	[redacted]
E	COGM		SWE Op.	Snus				
S	SWE: Near miss per work injury	Total number	GF	Tot.	[redacted]	[redacted]	[redacted]	[redacted]
T	Productivity	Units/ man-hour	GF	LS PS	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]
E	Energy	MWh/ mTon outgoing product	GF	Tot.	[redacted]	[redacted]	[redacted]	[redacted]
	Waste	mTon/ mTon outgoing product	GF	Tot.	[redacted]	[redacted]	[redacted]	[redacted]
P	Health attendance	%	GF GF + KF	Blue White	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]

Table 4-3 The Gothenburg Production QDE-STEP table Long Range Plan

	KPI	Unit	Factory	Format	FY 2014	2015	2016	2017
Q	Total consumer complaints	ppm	GF	LS PSOL	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]
D	Plan attainment	%	GF	LS PS	[redacted]	[redacted]	[redacted]	[redacted]
E	Productivity	Products/ man-hour	GF	LS PS Pilot plant	[redacted] [redacted] [redacted]	[redacted] [redacted] [redacted]	[redacted] [redacted] [redacted]	[redacted] [redacted] [redacted]
S	Near miss per work injury	Total number	GF	Tot.	[redacted]	[redacted]	[redacted]	[redacted]
T	OEE	%	GF	LS PS Pilot plant	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]
E	Electricity	MWh outgoing product	GF	Tot.	[redacted]			
P	Health attendance	%	GF	LS PS	[redacted]	[redacted]	[redacted]	[redacted]

From the tables above (Table 4-2;Table 4-3) it can be seen that some measures differs between factory and production. Q is measured in the exact same way in both tables; ‘Delivery’ however differs, on a factory level Delivery is measured in delivery performance (see the definition in Table 4-1) and on a production level Delivery is measured in ‘Plan attainment’, defined as: production ordered quantity divided by reported as finished. The deviation is calculated using absolute number for each order. While delivery performance is displayed as a total number for the entire factory, plan attainment is divided into ’Loose Snus’ (LS) and ‘Portion Snus’ (PS) because of the difference in production processes. ‘Economy’ (E) also differs between the two tables, at factory level the measure is displayed in ‘Cost of goods manufactured’ and at the production level E is measured in productivity presented according to the formats LS, PS, and one of the packaging lines that has been especially affected by the increase in SKUs. The productivity measure is however used as a ‘Technology’ (T) measure at the factory level. The ‘T’ measure at the production level is different and is measured in OEE, displaying the numbers from LS, PS and the production line also displayed in the ‘E’ measure. OEE is defined in the same way for both factories, as the actual amount of cans produced divided by the theoretically possible amount for the same time period. The theoretically possible amount is calculated by multiplying the number of hours possible to produce with a theoretically ‘best case’ amount that can be produced each hour. In production the OEE measures are monitored for each shift and each production line, to be able to visualise how each line performs on a daily basis. The second ‘E’ measure, environment, differs between the two levels as well. On a production level the electricity used is measured and on a factory level 'E' is measured in energy used per mTon products and mTon waste produced per mTon products produced. On a factory level the energy measurements can be further divided into more detailed measures describing the energy usage of electricity, gas, district heating, and water. Additionally figures are received from the waste pick up company, where the percentage of the different types of waste is shown. The final category in the QDE-STEP table is Personnel 'P' and these measures differs as well, at a factory level both blue collar and white collar health attendance is measured, while production looks only at the blue collar attendance divided on the LS and PS lines in the factory.

One of the measures that have been discussed as to whether it could be measured in a different way at production and factory level is 'Quality'. Today, customer complaints is used and seen as a fairly good measure on an aggregated level. However, a more appropriate measure that is less reactive is still desirable in production. All of the measures from the aggregated QDE-STEP tables are broken down. Each of the measures is also reviewed at each specific line in, enabling the production managers to review the lines separately. Production also has a second board for daily monitoring, where the individual lines are reviewed regarding quality, delivery, and safety. The Production teams review the board three times a day and shares the information between the shifts. There is currently an on-going project for improving the reporting systems on the lines, the goal is to be able to gather more and accurate data to support the decision making regarding what improvements and maintenance work to prioritise in order to increase the overall efficiency and capacity utilisation in production.

4.3.2 Kungälv Factory

In the KF function the main KPI tables are divided in the same way as at the GF, one for the factory as a whole and one for production as an entity. The KPIs are used to measure the progress made in the factory and the different management teams are using the measures to evaluate improvements and detect issues. However, there are some differences between the tables, for example the KF only produces one type of snus, 'White portion snus' (PSW). Below are the two tables of the KF.

Table 4-4 The Kungälv factory QDE-STEP table

	KPI	Unit	Factory	Format	FY 2014	2015	2016	2017
Q	Total consumer complaints	ppm	KF	PSW	[redacted]	[redacted]	[redacted]	[redacted]
D	Delivery performance	%	KF	Tot.	[redacted]	[redacted]	[redacted]	[redacted]
E	COGM		SWE Op.	Snus				
S	SWE: Near miss per work injury	Total number	KF	Tot.	[redacted]	[redacted]	[redacted]	[redacted]
T	Productivity	Units/ man-hour	KF	PSW	[redacted]	[redacted]	[redacted]	[redacted]
E	Energy	MWh/mTon outgoing product	KF	Tot.	[redacted]	[redacted]	[redacted]	[redacted]
	Waste	mTon/mTon outgoing product	KF	Tot.	[redacted]	[redacted]	[redacted]	[redacted]
P	Health attendance	%	KF	Blue	[redacted]	[redacted]	[redacted]	[redacted]
			GF + KF	White	[redacted]	[redacted]	[redacted]	[redacted]

Table 4-5 The production QDE-STEP tale for the Kungälv factory

	KPI	Unit	Factory	Format	FY 2014	2015	2016	2017
Q	Total consumer complaints	ppm	KF	PSW	[redacted]	[redacted]	[redacted]	[redacted]
	Product revision	ppm	KF	PSW	[redacted]			
D	Plan attainment	%	KF	PSW	[redacted]			
E	DMC	Deviation from forecast	KF	PSW	Handled by BS			
S	Work injury	Total number	KF	PSW	[redacted]			
T	OEE	%	KF	PSW	[redacted]			
	Productivity	Products/ man hour		PSW	[redacted]	[redacted]	[redacted]	[redacted]
E	Waste tobacco	%	KF	PSW	Report missing			
	Waste tobacco - exclusive process	%		PSW				
P	Health attendance	%	KF	PSW	[redacted]			

From the tables above (Table 4-4;Table 4-5) it can be seen that some measures differs between the factory and production. 'Q' is measured not only in customer complaints in production, but also in how many defect products per million products that was detected before they were shipped to the DC. 'D' is measured in the same way as in the GF. COGM is measured at factory level as the 'E' measure, while production measures the Direct Material Cost (DMC). The Safety (S) measure at production level is measured in number of work injuries, while the factory measures it the same way the factory and production measures it in Gothenburg. Both tables displays productivity on 'T', but production also has OEE as one of their KPIs. 'E' is measured in waste and energy consumption at factory level, while production measures the total tobacco waste and the tobacco wasted excluding the process. Personnel is measured the same way in Kungälv as in Gothenburg. In fact all of the factory level measures are the same in Gothenburg and in Kungälv.

The most operative measure that is measured and the one reviewed most frequently is OEE. It shows the degree of utilisation on the machines for a given period of time and is reported in to the system for every shift in production. Another important measure in production is plan attainment, producing the correct amount each week is prioritised over the improvement work on the lines. The increase in SKUs puts a lot of pressure on the factory especially when they have to switch between the 'star' pattern and the 'unstructured' pattern in the cans.

Besides the measures in the QDE-STEP tables, the inventory levels are monitored closely. A part from the waste measured in QDE-STEP, the KF sometimes measures waste at each production line. By doing so, it can be seen that high volume products have less waste compared to low volume products. Measurements have also been performed on the different packing units attached to one of the lines. The measures revealed that there is a considerable difference between the different packing units, as well as between the different SKUs. It has to be evaluated further whether the difference in performance is affected by the operation of the line, the units, or if the recipe needs to be developed. The low performance is bad for the OEE and cost money in waste.

4.3.3 Procurement

The Procurement function has one QDE-STEP-table for both factories and some of the measures are measured over both sites, while some of them are measured at each site separately. Most of the measures used in the everyday work are gathered from the ERP-system and the measures in the QDE-STEP-table are measures of deviations, except for the 'S' measure. In Table 4-6, the KPIs from the Procurement function are displayed.

Table 4-6 Measures from the Procurement QDE-STEP-table.

	KPI	Unit	Underlying Componenets	Factory
Q	Deviations Direct Material	Number per month	Received	KF+GF
			Answered	KF+GF
			Longer than 4 weeks until cause determined	KF+GF
D	Delivery precision	Number per month	Number of stops in production due to not communicated material shortages	GF/KF
E	Price variance Direct Material vs LRP YTD	Deviation from standard	Actual price deviations from standard prices LRP	KF+GF
	Actual expenses 2014-2015 vs LRP	Actual deviation from target	Actual expenses compared to target expenses	KF+GF
S	Accidents and near-accidents	Number per month	Accidents and near-accidents purchasing direct material and factory supplies	GF/KF
T	Matching invoices	Percentage each month	Percentage of invoices received correct with no extra handling needed	KF+GF
E	No measure			
P	No measure			

The quality measure is divided into three different measures, related to deviations in direct material. The first measure is the amount of deviations reported every month; the second one is the amount of deviations that could be explained every month. The final 'Q' measure is the amount of times it took more than four weeks to figure out the root cause of a deviation. Procurement measures the delivery performance in number of stops in production due to material shortages that was not communicated on beforehand i.e. the number of times that production runs out of material unexpectedly. The E component has more than one measures connected to it. The first one is a comparison between the actual price paid for direct material and the expected standard price calculated on beforehand. The second 'E' measure is the actual expenses compared to the expense target calculated on beforehand. When measuring safety, procurement looks at the number of near-accidents and the accidents that occurs in connection to purchasing direct material and factory supplies. The final Procurement measure is a technology measure and is visualised as the percentage of invoices that are correct when scanned into the SM database. To be considered as correct, all amounts, dates, and figures have to be faultless. At the procurement function the 'T' measure is the last one, they currently do not display any environment or personnel measures on their board.

Procurement uses the QDE-STEP as a framework to ensure that the function continuously work towards reaching their goals and contribute to the overall strategy of the company. The deviations in material are defined as unplanned shortages of materials. If a shortage is known to be an issue on beforehand it is not viewed as a shortage. There are many reasons why shortages occur; one quite common reason is faulty inventory levels. However, it is very uncommon that it is due to suppliers not delivering on time, the delivery performance from the suppliers is very high. As stated above, quality is measured in deviations, and is reported when noticed in production. Further more an incoming inspection where the amount and contents is inspected.

4.3.4 Planning & Logistics

In Table 4-7, seven KPIs relevant to the PL function are displayed. The first 'Q' KPI monitors the amount of scrap of finished goods in terms of number of cans. The second KPI related to quality is forecasting accuracy and it measures the forecast accuracy. The forecast is compared with actual sales and the accuracy is the ratio of the two. It is monitored both at the GF and the KF as well as on an aggregate level. Plan attainment, where the planned quantity is compared with the produced quantity, is the third quality KPI, which describes to what extent the production function manage to produce according to schedule. It goes hand in hand with the OEE measure but is not the same measure, since OEE studies the equipment utilisation and plan attainment the actual number of products produced according to plan. The last quality KPI is called plan stability and measures the number of changes within a frozen plan.

The first 'D' KPI, delivery precision, is a measure describing to what extent the distribution centres are able to deliver products to the customers. A deviation is reported when the distribution centres are unable to ship an order due to inventory shortage. Parameters included are ordered quantity, delivered quantity, deviation, and the service level, which is the ratio of delivered quantity divided by the ordered quantity. The second 'D' KPI is monitoring the finished goods inventory coverage, expressed in days. It uses the measures inventory on hand and sales per days and calculates the ratio between the two.

Table 4-7 Measures from the Planning and Logistics function QDE-STEP-table.

	KPI	Unit	Underlying components	Factory
Q	Scrap finished goods	total number of cans		GF/KF/Total
	Forecast accuracy	%	forecast, actual sales, deviation	GF/KF/Total
	Plan attainment	%	production order quantity, reported as finished, deviation	GF/KF/Total (all products)
	Plan stability	number of changes within frozen plan	-	GF/KF
D	Delivery precision	%	ordered quantity, delivered quantity, deviation, service level	GF/KF/Total
	Inventory finished goods coverage	coverage per day	on hand, sales per day	GF/KF
	Expected on hand coverage	coverage per day	-	GF/KF/Total (all products)
E	-	-	-	-
S	-	-	-	-
T	-	-	-	-
E	-	-	-	-
P	-	-	-	-

4.3.5 Business Control

As mentioned in section 4.2.5, the BC function does not own any KPIs, but are responsible for the updating and follow up of financial measures linked to the processes in which BC operates. In general, the BC function is responsible for the economic measures on the QDE-STEP boards. On a factory level 'E' is measured as COGM and at production level it is measured as direct material cost in Kungälv and as products per man-hour in Gothenburg. The financial measures can be broken down to reflect the performance of each individual production line. BC is also responsible for the follow up of cost saving activities at each plant, as well as for identifying areas of improvement. Table 4-8 is a summary of some of the measures that are monitored and analysed by the BC function.

Table 4-8 A summary of different measures used at the Business Control function

KPI	Components
Total manufacturing costs	direct labour
	raw tobacco
	direct material other
	other direct costs
Total overhead costs	depreciations
	indirect investment costs
	freight costs
	scraping & FDM deviation
	plant overheads
Total COGM	total manufacturing costs+ total overhead
Total COGS	
Produced volumes	total/LS/PSO/PWO
Sold volumes	total/LS/PSO/PWO
Total DMC (SEK/ prod can)	
Total OH (SEK/ prod can)	
Total COGM/ can	
Total losses	scraping
	waste

The financial measures in Table 4-8 can be broken down into more detailed levels, and most of them can be reviewed down to each production line separately. Because of the different production processes for the different formats the measures are also analysed for each format alone, LS, PSO, PSW, and the pilot plant. Total losses are divided into Scrapping and waste, where scrapping refers to losses that are intentional in the sense that they are excess tobacco or material which cannot be used. Scrapping can also be materials or finished goods that are obsolete or deemed faulty. However, most of the scrapping at SM is due to overproduction in the processing of raw tobacco into snus. Waste on the other hand is due to undefined losses in tobacco and direct material during production. The tobacco waste can appear in the production process during, milling, processing, or packaging, while the material is usually, cans, lids, banners, pouch paper, and labels that are wasted during packaging. BC in cooperation with the management team sets the goals for the financial measures and KPIs, with input from top-management and the sales department.

4.3.6 Engineering & QA

The E & QA function is responsible for monitoring and performing measurements for some quality measures in production. This includes following up on consumer complaints, hygiene statuses and performing sample test of products in production. The sample tests are performed to identify what type of quality issues that occur. These measures are mainly used to help improve production and not as internal measures within the E & QA function. In a similar way the function is responsible for measuring the energy usage and the amount of waste.

E & QA is also following up on the consumer contact performance, measures such as response time on the phones are monitored in order to ensure that the customers with complaints are met by a high service level. At the technical development department the different projects are followed up, by looking at budgets, delays and outcome of the specific projects.

Apart from the supporting functions and measures mentioned above, the E & QA function also define their own internal measures such as patent applications made every year and the amount of new ideas created during a period of time. These measures are used to stimulate creativity and innovation, and the goals are set internally at the function as a way of driving the development performance. They also use the number of projects that are currently active within the organisation in order to follow up on the workload and effectiveness of the function. However, these measures are more connected to the way the function operates and are not considered to be actual KPIs. In Table 4-9, some of the measures used at E & QA are summarized.

Table 4-9 Measures used at the Engineering & QA function

Internal measures	Definitions
Product revision	Quality samples in production
Consumer contact	Response time
Project evaluation	Budget
	Time
	Deliverables/outcome
Creativity and innovation	Number of patents and new innovative initiatives

In terms of OEE, technical availability is one of the parameters that the function is trying to enable. An increase in technical availability can be achieved by procuring and installing the right equipment, which will enable increases in OEE. The function cannot affect the way work is carried out on the lines, but can affect the work environment, safety issues, and the technical availability.

4.3.7 Business & Operations Support

The BS function currently has no measures connected to QDE-STEP, but are supporting the other functions in how measures should be visualised and communicated through out the organisation.

5. ANALYSIS

In this chapter the developed framework for selecting and evaluating KPIs in order to increase supply chain performance is tested. The test investigates to what extent this new framework based on findings from literature might help a company, in this case SM, to evaluate and/or create new KPIs. The result will be evaluated and discussed in chapter 6 and 7.

5.1 Step one – Corporate strategy evaluation

From the observations and interviews made at SM the corporate strategy was found to live up to the criterions stated in section 2.1.2. The objective of the strategy is broad and focused towards the overall goals and without being too specific it sets a general long-term plan for achieving the goals and objectives. It is also detached from the distractions of individual day-to-day activities, while still being concrete and well defined enough to let everybody know what the main objectives of the company are. Along with the business model it is easy to break down and translate into important focus areas for each department.

In the case of GSC they have broken it down to their own strategy, "We shall secure future market- and customer demands, by continuously deliver uncompromising quality with the right service level at a competitive cost. (QDE-step).", which in turn has been broken down into focus areas applicable across all functions within GSC. Hence making sure that all employees know what their focus should be and how they can contribute to realising the corporate strategy.

5.2 Step two- Supply chain strategy evaluation

The empirical findings show that there exists a structured approach for breaking down the corporate strategy throughout the organisation. The supply chain strategy derives from the strategic focus area of the PSI function, which has been established based on the overall corporate strategy. In order to realise the focus areas of the PSI function, the GSC function has its own focus areas, which are communicated to the different sub functions within the GSC function. These focus areas are broken down further into roadmaps by the different sub-functions within the GSC function. Suitable KPIs are then used by the sub-functions to evaluate the outcome of the different roadmaps.

As mentioned in section 2.1.2 it is of great importance for companies to have a corporate strategy that can be broken down and shared further down in the organisation. It was also highlighted that measures used to evaluate and monitor performance should be derived from the developed strategies. As can be seen in the case of SM, they follow the recommended strategy guidelines.

Regarding the supply chain strategy at SM, it is not defined in terms of responsiveness and efficiency. However, the empirical findings clearly show that SM are aware of their current situation and existing problems and have a good idea of how to develop a proper supply chain strategy based on these issues. Even so, it might be relevant to concretise this process further in order to easily be able to prioritise certain KPIs and areas of improvement.

As mentioned in section 2.1.2 in the theoretical framework, one way of categorising and determining supply chain strategies is by studying different product attributes. Studying the different product attributes along SM's products provide indications whether the products can be considered to be functional or innovative. The first attribute to elaborate on is the product lifecycle. The product lifecycle for SM's products differs and products in the portfolio considered as standard products, included in the portfolio for longer periods of time, have substantially longer lifecycles than non- standard. The product lifecycle for some standard products can be considered to be approximately 30 years, which is much longer than the specification for a functional product, according to Fischer. Non-standard products have life cycles of approximately one year, which matches the specification of an innovative product. By looking at the product life cycle attribute alone, it is thereby difficult to draw a general conclusion about whether the products are functional or innovative.

The contribution margins, the second attribute, in the case of SM they are high, which fits with the specifications for innovative products. The third attribute, product variety, is relatively high. SM does not have as many product varieties needed in order for the products to be considered innovative according to Fischer's specifications. However, the amount of product varieties has increased significantly the recent past and has reached a level considered to be high in terms of industry standards. This fact support that the products can be seen as relatively innovative. The forecast errors, the fourth attribute, are low at SM, which corresponds to and fits with the characteristics of a functional product. The average stock-out rates as well as the markdowns are kept low which is in line with Fischer's specifications of functional products. To sum up the comparison between SM's products and Fischer's product attributes, two of the attributes indicate an innovative tendency with the products and three of them indicates a functional tendency.

The second way of characterising supply chain strategies is by looking at the implied demand uncertainty. The first parameter to study is the quantity of the products needed in each lot. If the requirements for being able to manufacture a wide range of volumes increases, this also increases the implied demand uncertainty. This requirement is present at SM and some products such as standard products are delivered in much greater quantities than non-standard products, such as seasonal and 'temporary' products. The second parameter is the response time that customers are willing to wait. It is difficult to put this in the context of SM since they are not producing based on orders but rather on the number of inventory days available at the DC. However, if the cans with snus are out of stock at the retailers for a longer period of time, this will probably have consequences in the long run. The variety of products needed, the third parameter, describes to what degree a company manage to provide customers with a variety of products. If more variants are requested, the implied demand uncertainty increases. Due to increased competition and the fact that customers are increasingly demanding different types of snus with varying characteristics, the implied demand uncertainty increases at SM. The required service level is another factor influencing the level of implied demand uncertainty. SM's current situation requires that the service level is kept high and stable, since there is an imminent risk of losing customers for each occasion when a can of snus is not available in the fridge at the retailers. Since SM has many products that all require more or less the same degree of service level this increases the required service level. Thereby, the implied demand uncertainty increases in regards to the required service level. The fourth parameter, the desired rate of innovation of the products, has increased at SM, indicating an increase in implied demand uncertainty. This has to do with new customer requirements as described earlier. To sum up the comparison between SM's situation and the implied demand uncertainty parameters, it can be found that four out of six tends to increase the implied demand uncertainty. As stated in section 2.1.2, the higher the implied demand uncertainty the higher is the need for having a responsive supply chain.

Based on the two ways of characterising supply chain strategies it can be found that some factors indicate the need for SM to have an efficient supply chain strategy, while some indicates the need for having a responsive. However, when summarising the empirical findings it became clear that all functions within the GSC function highlighted the issue of the complex environment stemming from the increased number of SKUs and the many product variations. The wide variation in volume needed between the products was also highlighted as an issue. These empirical accentuations, along with the findings from the previously made comparisons, support the assumption that SM's supply chain strategy should be angled towards responsiveness rather than efficiency.

5.3 Step three- Selecting and categorising performance measures

According to the findings in step 2, the main focus of SM's supply chain strategy is to become more responsive. In addition there are some separate goals and focus areas that should be dealt with. In this step the different measures listed in section 2.3 are analysed and evaluated in order to decide what measures that are important when trying to achieve a higher degree of responsiveness. The current state at SM will also be taken into account when creating the list of measures. In order to utilise the structure of the drivers in full, the drivers are analysed separately starting with the facility measures and continuing with the rest of the drivers separately in the same order as they are introduced in section 2.3.

5.3.1 Facility

When analysing the list of facility measures, the main focus is on the GF and the KF. However, in order to get a better supply chain perspective, the facilities of the distribution centres and the suppliers has also been taken into consideration. Decisions regarding the chosen measures all stems from the findings in step 2, which means that some measures that might be important in general for companies has been overlooked in order to get a narrow list that focus on the current challenges at SM.

Two measures chosen as facilitators for increasing responsiveness are, 'Percentage of new parts used in new products' as well as 'Percentage of existing parts reused in new products'. If more items can be reused in new products it can increase the responsiveness of the supply chain. Fewer items will decrease the complexity, since the same item can be used to produce different products. This will lead to fewer items in stock and reduced complexity in items purchased. Further, the cost of direct material can be reduced since a large quantity of a single item is usually cheaper than small quantities of many items. In the case of SM, these measures can increase the understanding of the complexity caused by the large amount of SKUs, especially in regard to purchasing where the many changes often leads to obsolete material and cost increases due to the many new items needed. In production, fewer items would possibly reduce setup times and decrease changes in the lines and ramp-up times.

The setup time and ramp-up time is very much related to another measure chosen from the facility list, which is 'Processing/setup/down/idle time'. This measure is a combination of measures that tracks how the equipment is utilised in production. These measures are necessary to increase the flexibility in production, since one key factor for SM is to realise what areas that are most crucial to improve. These measures are also good indicators that can explain variations in the OEE measure that is currently used at SM, especially since lead times and setup times will affect the outcome of the OEE. OEE itself is one of the measures on the facility list that is always useful for a company, regardless of a focus on efficiency or responsiveness. Since the focus is on responsiveness and the special needs of SM, the measure is not included in the selected list. However, other similar measures were chosen, for example 'Capacity' and 'Utilisation'. Both these measures are important for both responsive and efficient supply chains. However, the utilisation of the capacity should be at different levels depending on what strategy is used. In a supply chain like SM's, where responsiveness is in focus it is beneficial to have a buffer of extra capacity for unexpected changes. Traditionally SM has been trying to have as high utilisation as possible, which is good in regard to costs. However, with the increasing complexity a buffer of extra capacity might be necessary because of the increase in changes due to the many new products and design changes requested from the market department.

For the same reason, 'Average release cycle of changes', is also considered a good measure. It measures the average time it takes to implement a change in production i.e. from the time that the decision for a change is made, until the change has been implemented. The measure is a good indicator of how an organisation is improving their work with change projects, but also visualises how much time that is spent on implementing the changes made on the products. Therefore, the measure can be used to prevent flexibility issues and to evaluate how the organisation is developing. A low value is a good indicator of the responsiveness of a facility.

'Flow time efficiency' is another measure that can help SM to become more responsive. It measures how well production is able to produce products at the theoretical flow level. It is important to know the theoretical flow, since it can be used to set production goals and to create production plans that facilitate the accuracy needed when trying to be responsive. 'Flow time efficiency' is also a good measure when trying to be efficient, as it shows how well you perform your processes. The 'Total build cycle time' is another measure that should be measured regardless of the strategy. It measures the total time it takes to manufacture a product, from the time manufacturing is started until the product is finished. A measure that is useful for measuring the degree of service level, which is an important part of being responsive, is 'Delivery promise slippage'. In the current situation SM is not producing according to customer orders but rather to number of days of supplies required at the distribution centres. However, the measure might be relevant to monitor at the DCs, since their performance directly affect SM's customer service. 'Production service level' is also a measure that is important for a responsive supply chain. It measures the ability of a production site to deliver orders in full and on time, which is very important when trying to achieve a high degree of service level.

The measure 'Product variety' is a good measure to use when analysing other responsiveness measures. An increase in product variety will probably increase the complexity and therefore it can be used as a reference when evaluating changes in

KPIs. If an increase or decrease can be seen in a measure that is directly affected by the number of different products produced, the increase or decrease in ‘Product variety’ might be the reason for the deviation, and the underlying flexibility problem can be analysed and fixed. ‘Average production batch size’ is also a measure that can be used in combination with other measures. If the average production batch sizes are small it might imply that many setup changes have been made during production. This will most likely affect the productivity negatively, and large batch sizes will in the same way probably affect the productivity positively. Therefore the measures together can be a very good indicator of how well variation is handled at a production site. If the productivity increases at the same time as the batch sizes decreases, it indicates that the machine setup times are shortened.

In all facilities in a supply chain it is important to have accurate inventory levels. Deviations between the actual amounts in stock and the registered amount in stock, will cause problems when purchasing material, when creating production plans, and in production. Therefore, the measure ‘Putaway accuracy’ is an important measure to monitor. ‘Putaway accuracy’ measures the percentage of times that a mistake is made when putting material into stock. The definition of the measure is limited to only consider incoming material, but the same measure is also relevant when retrieving material from warehouses to production and vice versa. The measure is a clear indicator of an activity that directly affects the inventory accuracy, which has been mentioned an issue at SM.

A measure important regardless of the supply chain strategy is ‘Quality losses’, which measures the percentage of losses in production that occurs due to defects in materials and finished goods. This measure is affected at SM since the many setup changes in production requires ramp-up time where the scrap percentage is usually slightly higher than during normal production. ‘Quality losses’ is also affected by the inability to process low quantities of raw tobacco. Therefore, the same batch sizes in processing raw tobacco have to be used for high volume SKUs as well as low volume SKUs. The amount of ‘Quality losses’ directly affects the ‘Cost Of Goods Manufactured (COGM)’ and in extent the profitability of a company. In addition to measures that are useful for both types of supply chains, there are also measures that are directly affected by some of the responsiveness measure that are suggested in this section. One example is ‘Cost of Goods Sold (COGS)’. COGS is affected since responsiveness often means that a company needs larger inventories and more product variations which leads to cost increases in production.

5.3.2 Inventory

As in the case of the facility measures, some inventory performance measures are selected and believed to increase SM ability to be more responsive. The first selected measure is ’Average inventory’ since this measure provides a good general perception of current inventory levels. In general, the inventory levels should be relatively high when striving for responsiveness, in order to be able to deliver products when needed. In SM’s case they have short due dates since the products share some characteristics of food products. This requires the inventory levels to be kept as low as possible in order to reduce occurrences of obsolete products. In contradiction, the importance for having higher inventory levels are important due to the high product margins and the fact that losing sales leads to bigger financial losses than for keeping some extra days of inventory. Even though considered a standard measure it should still be used at SM in order to make sure that the inventory levels are not kept too high.Another selected measure is 'Average backorder length' and in the case of SM there are no customer orders, instead the production quantity needed is based on the number of days of inventory required at the DCs. Due to the high service level needed by SM it is a relevant measure.

As mentioned in section 2.3.2 it is of high importance to have accurate inventory levels since this affects production planning and purchasing. Therefore, the measure 'Inventory accuracy' is important to include. One supporting factor for selecting this measure is also due to the fact that SM currently has problems measuring the inventory accuracy. As mentioned previously, poor inventory accuracy affects both responsiveness and efficiency. One of the root causes for this is the issues when receiving and placing inventory at the stock shelves. It might be the case that certain SKUs are displaced and put in the wrong place. Operators trying to retrieve this SKU might not find it, which in turn might lead to new items being purchased even though already available. This incurs additional costs and also more waiting time which affects the ability to deliver products.

5.3.3 Sourcing

The first measure selected in this category is 'Supply lead-time'. It describes the time it takes a supplier to manufacture and deliver an order placed by the customer. Since the aim for SM is to handle the increased complexity it is relevant to investigate to what extent the suppliers can help SM in this quest, by investigating the suppliers' level of responsiveness. In general, having suppliers that are able to supply goods with short lead-times is beneficial when striving to become more responsive, since this increase the ability to receive goods in a timely manner.

Another selected measure is 'Supplier reliability' since it provides indications of a supplier's service level. Poor supplier reliability hurts responsiveness. It is important to realize that while 'Supply lead-time' describes the time it takes a supplier to manufacture and deliver an order, 'Supplier reliability' measures the lead-time and quantity deviations. The measures should preferably be studied jointly in order to gain a more comprehensive picture of the aggregated delivery performance of the suppliers. One can argue that it is advantageous to use suppliers that can promise short lead-times. However, this is true as long as the lead-time deviation is kept low, since the deviations cause disruption in the planning and manufacturing processes. Longer lead-times with few deviations might be preferable compared to shorter lead-times with many deviations. For example it is relevant to investigate the aggregated delivery performance at the suppliers, when new product launches and changes on existing products are made at SM.

'Fraction of on-time deliveries' is also considered a relevant measure. 'On time' can be defined differently, which means that one has to decide what definition or definitions to use. Two measures are selected related to this issue i.e. 'Orders received on time to commit date' and 'Orders received to required date'. The later of the two is more relevant since it provide information regarding a supplier's ability to supply goods according to a customer request. The above mentioned measures are mostly concerned with a supplier's ability to deliver 'on time'. However, being able to deliver on time and with sufficient quality is also an important matter. Therefore, 'Orders received defect free' is also selected.

5.3.4 Information

As stated in section 2.3.4, information is crucial when creating forecasts and production plans. Therefore a measure that is of importance when trying to be responsive is ‘Variance from plan’. Deviations from the production plan can occur due to several different factors. One of these factors might be flexibility. However, it is a relevant responsiveness measure since the ability to produce products according to plan is important in order to maintain a high service level. To minimize the variance in plan information from production and sales is needed. The quality of the information that the plan is based on is of high importance, since a poor plan will affect the variance as much as factors in production. One negative aspect of the measure is that it does not consider the number of times deviations occur but rather look at the overall quantities. The measure should be monitored for production plans as well as for inventory levels. However, a similar measure concerning inventory has already been taken into consideration, ‘Inventory accuracy’. Another important measure regarding information is ‘Forecast error’. If the accuracy is high, the need for last minute changes are reduced and a more stable environment is obtained which facilitates a responsive approach.

‘Ratio of demand variability to order variability’, is a good measure regardless of the strategy used, since it gives a good idea of how much excess material that is tied up in production and inventory. Even though more excess material can facilitate responsiveness it is not chosen as a responsiveness measure, but as an overall good measure, since too much inventory is always costly. Here it is important for SM to work closely with the suppliers since this can affect SM’s ability to deliver products in a flexible way. At the same time communication is important to ensure that the suppliers do not have too much inventory that will increase the cost for both parties. The measure is a good indicator for monitoring the bullwhip effect. If the communication is sufficient and changes in volume are explained properly the bullwhip effect can be minimised.

5.3.5 Pricing

A measure that can be used to achieve a higher degree of responsiveness is ‘Range of sales price’ and in the case of SM this can be done by looking at the changes in price for the different product segments over time. The changes in price probably affect the number of sales for a certain SKU or price segment. The combination of ‘Range of sales price’ with ’Range of periodic sales’, provides a good base for forecasting the effects price differentiation has on sales volumes, since ‘Range of periodic sales’ monitors the variation in quantities sold for a limited time period. This type of data can be used to foresee how new product launches, termination of products, and sales campaigns will affect the demand for different SKUs and price segments. For a responsive supply chain this information can create a better understanding of how demand varies and in what aspects flexibility is needed. Close monitoring of these measures can thereby enhance the ability to be responsive.

Apart from these two measures it is difficult to find a direct connection between the different pricing measures and responsiveness, especially in the case of SM. There is however measures that are important regardless of the supply chain strategy used. One of these measures is COGS, which measures all of the costs associated with sold products. Because it measures the actual cost of the products that have been sold, it is a good indicator of how much a specific manufacturing or strategic change affects costs. In the case of SM it is a good way to measure how the changes made in order to be responsive affects the actual costs. Notable is that SM uses menu pricing, which means that the price of the products varies along with different attributes, such as quality. Even though all of SM's products contain high quality tobacco, different mixes vary in cost and price. The attributes of flavours and cans also vary and affect the price.

5.3.6 Transportation

Most of the measures included in Table 2-15 might be relevant when evaluating and investigating transportation related issues. Sometimes the responsibilities for transporting goods are allocated to a third-party logistics provider (3PL). If this is the case the 3PL should also be evaluated. Many of the measures mentioned in the theoretical framework take this point of view. However, in this case most of the transportation related issues are allocated to the supplier, which means that SM does not separate the transportation performance from the supplier performance, but rather include the transportation performance into the supplier performance. However, one could argue that it could be useful to separate these from each other since this could be useful when trying to find and evaluate potential delivery performance errors.

Table 5-1 displays a summary of the selected measures from each driver. In total, 26 measures were selected and considered to have a potential effect on the current situation at SM. In addition Table 5-2, displays five measures that are considered relevant for SM, even though not directly linked to responsiveness. In section 5.5 these measures are compared with the measures presented in step four in order to investigate to what extent they might contribute to help SM in its work to find new KPIs in order to improve supply chain performance.

Table 5-1 Selected measures from drivers

Selected Measures from step 3 in regard to responsiveness		
1	Percentage of new parts used in new products	Facility
2	Percentage of existing parts reused in new products	Facility
3	Processing/setup/down/idle time	Facility
4	Capacity	Facility
5	Utilisation	Facility
6	Average release cycle of changes	Facility
7	Flow time efficiency	Facility
8	Delivery Promise Slippage	Facility
9	Production service level	Facility
10	Product variety	Facility
11	Average production batch size	Facility
12	Putaway accuracy	Facility
13	Average inventory	Inventory
14	Average backorder length	Inventory
15	Inventory accuracy	Inventory
16	Inventory availability	Inventory
17	Supply lead-time	Sourcing
18	Supplier reliability	Sourcing
19	Fraction of on-time deliveries	Sourcing
20	Orders received on time to commit date	Sourcing
21	Orders received on time to required date	Sourcing
22	Orders received defect free	Sourcing
23	Variance from plan	Information
24	Forecast error	Information
25	Range of sales price	Pricing
26	Range of periodic sales	Pricing

Table 5-2 Selected extra measures from Drivers

Chosen Measures from step 3 as overall good measures		
1	Overall Equipment Efficiency (OEE)	Facility
2	Total build cycle time	Facility
3	Quality losses	Facility
4	Ratio of demand variability to order variability	Information
5	Cost Of Goods Sold (COGS)	Pricing

5.4 Step four- Host company PMS evaluation

The measures currently used at SM are those presented in the empirical chapter. This section aims at evaluating these measures in order to investigate to what extent these are supporting the suggested strategy presented in step two. From the information obtained in the empirical study it appears that SM breaks down the overall corporate strategy in several steps. According to literature, this is a prerequisite for selecting relevant performance measures. Since the strategy is broken down in several steps, it is relevant to investigate to what extent the existing measures are supporting the different strategies at the respective organisational level.

5.4.1 Global Supply Chain

When studying the first QDE-STEP component, the Q-component, it monitors and measures the number of consumer complaints. At this level it is considered a suitable measure and provides a holistic perspective of the overall customer satisfaction. However, the exact same measure is also used at factory level and production level, which in this case, can be considered too holistic. A more detailed and proactive measure could be more useful at these levels. The fact that consumer complaints are measured and monitored, points to the fact that SM strives towards gaining a more customer oriented perspective. By reducing the response time related to the complaints, a higher customer service level is pursued. This in turn reflects the willingness to become more responsive.

The D-component includes a relevant measure but might need some complementary measures. Currently, the measure includes the number of sales units delivered on time divided by total sales units. 'On time' in this case refers to when the distribution centres are able to pick the products belonging to one order directly from stock and then delivering it to the customer. As soon as they are not able to pick it from stock, a deviation is reported. Even though a relevant measure and a measure that depicts the delivery performance from SM to the distribution centres, the measure does not actually describe to what the extent the products are delivered to the customers on time. Therefore, it is reasonable to propose an additional measure that includes the distribution centres ability to deliver orders to the customers more explicitly. To accomplish this, more information exchange and collaboration with the distribution centres are required.

When it comes to the E-component, all financial measures are handled by the BC function. No financial measures are displayed at the QDE-STEP board at the GSC level. These measures are however frequently communicated between BC and GSC. The S-component is not considered a relevant measure given the scope for the thesis. However, it is considered an important measure in order to secure the work standard and internal environment standard.

The T-component differs between the two Swedish factories and the Owensboro factory. In Sweden the T-component is expressed in 'Productivity', which is defined as the number of produced units per man-hour. Since SM is facing a more complex environment, it could be feasible to investigate how the productivity is affected by the increasing complexity. Today, the productivity measure is not directly measuring SM ability to handle the complexity. Therefore, developing a set of measures to be able to find a correlation between the increased complexity and the productivity might be useful. In step 5, measures that points to the correlation will be suggested.

The second E-component, measures the energy consumption and total waste. Both are considered important measures. All companies in today's business world have an impact on the environment in some way and it is therefore important that they try to reduce the environmental impact as much as possible. These measures should be monitored regardless of the selected strategy.

5.4.2 Factory

As mentioned in section 4.2, the measures at the factories are evaluated at three different levels, factory, production and at different areas within production. At the factory level the Q-component is the same as it is at GSC, except for at this level the different formats LS and PS are measured individually. The measure is believed to be a good indicator of the quality at this level. The D-component, 'Delivery precision' is also the same at the factory level. It is a good measure that reflects the ability to be responsive. The Delivery precision is extremely high, and even though considered important for being responsive, it can be questioned whether it is too high. Therefore, it is important to investigate if it is possible to maintain market shares and the number of sales units whit a slightly lower service level. A lower service level might decrease the complexity and the need for being responsive. A lower service level is usually less expensive to maintain.

As mentioned in section 4.3, the E-component, 'COGM' is handled by BC. COGM is an important financial measure for any manufacturing company, in this case it can be used to look at the increased cost due to the increased complexity. The waste and scrap produced in the factory is another measure that will affect COGM and is therefore an important measure. Even though waste and scrap do not directly affect responsiveness it is still valid to measure. The S-component is represented by a good measure and is always hard to connect to the responsiveness of the supply chain, nevertheless it is a very important measure.

One component that does not take into account responsiveness in the current system is the T-component. Today it is measured as units per man-hour, which gives a good indication of the effectiveness of production. However, the T-component should reflect the responsiveness of production in a better way. For example set-up times, ramp-up times, unplanned stops, and the frequency at which they occur could be visualised here. A measure that visualises the issue is suggested in step 5.

The second E-component at the factory level is measured by two measures that visualises the environmental impact at an aggregated level. A part from being environmental these two measures also indicate areas where costs can be reduced and therefore creates a win-win situation where not only the environment but also SM will benefit.

5.4.3 Production

Analysing the production measures at both of the two factories it can be seen that most of the measures are the same, even though a few components differ. The two E-components, as well as the Q-component are not measured in the same way and at KF they only have one format, PSW, while GF produces and measures both LS and PS. The Q-component measured at both factories is 'Consumer complaints' and KF also measures the number of product revisions where the products did not pass the quality inspection. As stated earlier 'Consumer complaints' is a good measure on a more aggregated level, however the measure is very reactive and in production a more proactive measure should be used to indicate the quality level.

The D-component at production level is measured as 'Plan attainment', which is a good indicator of the responsiveness in production. If production can follow the plan, the flexibility is sufficient. However, it is important to track how a high degree of

‘Plan attainment’ affects other measures. A high degree of plan attainment might decrease the level of the OEE measure, especially since set-up time is excluded from the OEE at SM.

In the GF, production the E-component is the same as the T-component at the factory level. The measure does to some extent show the effects of responsiveness, since a lower productivity can be the result of increased complexity. However, it would be preferable with a measure that more clearly shows the effect the complexity has on the cost of producing products. At the KF the E-component is measured in ‘Direct material cost (DMC)’, which in a better way reflects the cost implication of the increased complexity, especially if it is compared with the OEE. An increase in set-up changes in production should result in more ramp-up time and waste. The increase of waste should lead to a direct increase of the DMC. It can also be used to analyse how the introduction of changes and product launches tends to affect the costs in production.

OEE is the T-component at both the GF and KF, but the KF also uses productivity as a measure. The common measure at the factories OEE is a good measure, which clearly shows how well the equipment is utilised in comparison to their max capacity. However, the way OEE is measured at the factories today is contradictory to the ‘Plan attainment’ measure in regard to the way they are trying to be flexible. The goal is to be able to run smaller batches and to produce more in accordance with the weekly consumption at DC. This means that by following the plan and making set up changes more often, the production lines will automatically reduce their OEE results. In general the OEE definition used at SM differs significantly from the definitions found in existing literature. Therefore the definition should be re-evaluated and re-designed. An overall effectiveness measure, very similar to the OEE measures is already used in the productivity measure, which is a part of the E-component in the GF and the T-component at the KF. The same measure should be measured under the same component in both factories in order to minimize the risk for confusion. The last difference in the measures between KF and GF is the second E-component where GF measures the energy consumption and KF measures the waste in tobacco. The tobacco waste is probably a measure that is more suited to be measured under quality or as a part of DMC accumulated in production.

5.4.4 Procurement

The Q-component on the Procurement board is measured as ‘Deviations Direct Material’, and measures the amount of deviations that are reported and can be connected to incoming material from suppliers. Notable with this measure is that the number of reported deviations is greater than the number of deviations that can be explained. During observations and interviews it was discovered that the reporting of deviations is a problem area. The reports are done manually and there is a large risk that deviations are never reported. A large issue is how the withdrawal and adding of inventory between production and the warehouse at SM is conducted. Guidelines for how to add and deduct inventory in the systems are not followed properly and the computerised system should be reviewed to enhance the user interface. Another issue at this stage is that not all deviations are reported since there is a risk for the operator to be blamed for the problem and also since there is a lack of routines for how to follow up when deviations are found. Found deviations should be rewarded, since they will help in the improvement work towards better inventory accuracy. Especially since many of the deviations can be traced back to incorrect inventory levels.

The measures included in the E-component are both measures that are important for any procurement function regardless of the type of supply chain strategy. The measure could however be more explanatory if compared and analysed with the amount of new product launches and product changes for the specific period. This would clearly show how the extended product portfolio affects the costs for direct material.

A problem detected during observations and interviews was that the amount of material stated on the purchase orders and the amount of incoming material often differ in quantity. Currently there is no systematic way of working with the issue. The T-component at procurement however measures how often there are deviations on the invoices received that require extra work. A common error here is deviations in the amount received and the amount in the purchase order. In order to visualise the problem a measure that monitors the issue should be implemented.

5.4.5 Planning and Logistics

The measures belonging to the Q-component are in general good and relevant measures. The first Q-measure, 'Scrap finished goods' is decreasing which indicate that the production processes are becoming more stable. Reduction of waste leads to less rework and facilitates planning. 'Forecast accuracy' is also monitored, and describe SM's ability to create accurate forecasts. A high ratio facilitates planning and might result in cost reduction. Furthermore, the need for last minute changes in production might be reduced. This in turn, facilitates the ability to be responsive. The third and the fourth Q-measures, 'Plan attainment' and 'Plan stability' are relevant measures, especially if studied simultaneously. If the number of changes in frozen plan increases, the need for being able to shift the production set-up increases. If plan attainment at the same time decreases, it can be concluded that flexibility is an issue.

'Delivery precision' at PL is defined in the same way as the 'Delivery performance' measure at the GSC level. The measure is relevant to measure at both levels, but at the PL function it should be complemented with a more detailed measure. For instance, the current measure does not take into consideration the amount of time the DCs are out of stock, or the actual number of inventory coverage days differs from the agreed number of inventory coverage days. The second D-measure, 'Inventory finished goods', is related to this issue. Since this measure exists, it would be fairly easy to note each event where the level deviate from the agreed levels. Fewer deviations will lead to higher customer service levels.

5.4.6 Business Control

The BC function does not state their measures in terms of the QDE-STEP. Instead the measures are those commonly present in financial statements and financial reports, as well as measures presented on the other functions QDE-STEP boards. The measures used by the BC function are evaluating actions taken to reach the strategy and other underlying goals. For instance the function is monitoring the costs of waste and areas where costs should be reduced. However, they are not directly affecting the outcome of the measures. The financial measures used takes into account not only financial measures, but also operational. This supports the fact that both financial and operational measures are important in order to obtain a holistic view of the whole organisation, in line with theory. It is important to monitor the financial implications of actions taken to be more responsive. They are an important function when it comes to making decisions whether some responsive actions are feasible in terms of the associated costs.

5.4.7 Engineering & QA

As in the case with BC, E&QA does not present measures in terms of QDE-STEP. The list of measures is rather determined based on the formulated roadmap established by the function. Even though the measures used are relevant in many ways, it is difficult to identify to what extent they are supporting the strategy stated in step two. However, both the 'Products revision' measure, which includes taking quality samples in production, and the 'Consumer contact' measures might increase the customer service level. Another measure used is the 'Creativity and innovation' measure, expressed in total number of patent and new innovative ideas initiated. One could argue that providing new ideas is always positive, but a more relevant measure would probably be to investigate how many initiatives and ideas that were actually initiated and approved to become a project. This relates to the 'Project evaluation' measure. When evaluating a project, budget, time and the deliverables/outcomes are considered. One important aspect in this evaluation is to investigate to what extent the output or deliverable of the project was useful and to what degree it contributes to the current issues or strategy. In SM case the output should be assessed based on to what extent a project could help reducing the complex environment, for example increasing flexibility or reducing waste.

5.4.8 Business & Operations support

BS currently does not measure any KPIs internally at their function. However, a lot of their work is connected to the improvement work and the follow up of the other functions KPIs and improvement work. It is their responsibility to ensure that the other functions have the tools necessary for structured and systematic cross-functional improvement work, such as common templates for meetings and evaluation of the progress made.

In general, the QDE-STEP model is a well structured PMS, and the structure of the model ensures that different areas are not neglected. Some of the measures directly support the strategy, while others are important measures that should be measured by any manufacturing company. There are however gaps where additional measures could be added or replace current measures in order to better reflect the strategy and challenges expressed by the researchers in step two of the framework. Filling these gaps would increase the understanding of the current challenges observed at SM, as well as help to improve current challenges. The measures will be suggested and elaborated upon in the next step of the model presented in section 5.5.

5.4.9 Information sharing at SM

As stated in section 2.2, selecting and categorizing performance measures is just one part of improving supply chain performance. Another issue to consider is how the performance measures are communicated. Therefore, the second part of this step includes an evaluation of how SM is sharing their performance measures, both internally within SM as well as externally with other actors in the supply chain.

The fact that the head for each function within the GSC function are present during the annual strategy meetings supports the cross-functional collaboration and helps aligning goals and setting up common targets. Apart from the managers GSC meetings, the head for each function host their own meetings with their respective function, approximately once a week. At these meetings a KPI evaluation is a point on the agenda, where existing measures are evaluated and new measures proposed. This is an important element when striving for improvement within the respective function. All the different meetings point to the fact that SM value cross-functional collaboration and that they have a good understanding of the importance of sharing information.

However, there is a lack of communication between certain functions causing disruptions in daily operations. For instance, a lack communication exists between production, PL, Procurement and the internal warehouse, regarding inventory accuracy. Even though the KPIs are shared through meetings and boards, the availability of them can be improved. By making them more available, for example by posting them on the intra net, they could become more frequently studied, since not all of the personnel has the time to study the different boards at the place where they are hanging.

Another area of improvement could be to improve the layout and design of some KPI charts. The QDE-STEP boards are not exclusively for those working at that particular function, but also for those working at other functions. Thereby, the importance for designing them for all to understand is important. Today, there are several abbreviations present that might be difficult for an outsider to understand. In addition, some tables and graphs are missing units of measure on their axes. If corrected, some issues previously not understood could be solved with the help from a person at another function, due to an increased understanding. Also there is one measure that is displayed at several functions and levels, but named differently at different levels, delivery performance and delivery precision is the same measure. Another issue for sharing information is the fact that some KPIs are calculated and measured manually, due to limited functionality of current systems. These KPIs are easily overlooked since they are not a part of the original existing system where KPIs are usually stored.

Externally, information is shared on a daily basis between SM and the DCs and the majority of the communication is handled by PL. Every morning PL receives sales numbers from the previous day, which helps PL create a production plan, as well as more long-term forecasts. A part from the sales figures, information such as inventory levels are shared (VMI). The inventory levels are also used to create the production plan and SM is responsible for making sure that the inventory levels at the two DCs are at the desired level. During the interviews and observations it became clear that SM is quite pleased with the relationship with DCs. Additional sales information and closer collaboration between DC and SM could probably increase the accuracy of the forecasts and the production plans. It would bring SM closer to the end-customer and a better understanding of sales patterns and customer behaviour.

On the supplier side, SM has good relationships with their key suppliers and forecasts are shared on a monthly basis. Further, the key suppliers and SM has meetings where improvement work and forecast are discussed in order to improve the collaboration. Important when collaborating with suppliers is to have mutual understanding of each other's operations and activities and how different decisions made internally at the respective party, will affect the collaboration. In regard to the literature review the collaboration between SM and its suppliers would most likely be improved if more information was shared. If inventory levels and production plans could be shared with key suppliers a deeper understanding of the effects of changes would be more visible. However, this requires a lot of trust between two companies and a willingness to share sensitive information. Therefore it will not be possible to achieve overnight, but should be a long term goal in order to strengthen the collaboration. An issue detected during the observations and interviews was the fact that it is quite common that the amount on the purchase orders and the received amount often deviate. A closer relationship with the suppliers would possibly help minimizing this problem and help SM to improve the inventory accuracy and presumably being more responsive.

5.5 Step five- Comparison of measures from step 3 and 4

In this step the measures from step 3 is merged with the existing measures at SM.

The measures 'Percentage of new parts used in new products' and 'Percentage of existing parts reused in new products' are best suited to be measured at the Product development function. However, it should also be measured at the E & QA function since they are responsible for the development of the packaging, i.e. cans and lids. These measures will show how the E & QA function can contribute to reducing the complexity. The measure affects the procurement department as well, since the amount of purchased items can be reduced. Another measure that should be measured by the E & QA function is 'Average release cycle of changes', which is a good measure for measuring the average time it takes to perform a change. Even though the sizes of projects differ it is still a valid measure since it helps in registering what and how different variables affects the implementation of a change. Therefor it should be measured at the factories as well as, at E & QA.

'Processing/setup/down/idle time' are not measured at SM today. The measures should therefore be used at the T-component at production and factory level, the measure indicates the implications of being flexible, which in turn can increase the responsiveness. To know exactly how the machines are used makes it easier to create production plans and also points to issues that need attention. A measure that should be added to the measures is 'Ramp-up time', since it shows not only how much time is lost during stops, but also how long time it takes until production is running at full speed again. This is important when trying to be flexible, since running at half speed increases cost and possibly waste.

The four measures included in 'Processing/setup/down/idle time' are all included in the definition of OEE used in section 2.3.1. The OEE measured today is the measure defined as 'Flow time efficiency' in the facility driver. 'Flow time efficiency' is a good measure that should be kept on the QDE-STEP-boards, with only scheduled stops deducted from the shift time. However, the OEE measure should also be measured and visualised at all the levels it is currently being displayed, but as defined in section 4.3. The definition in the literature visualises the actual equipment utilisation in a better way and provides a better basis for analysis of the improvement in flexibility in production. Currently all of the inputs to the OEE measure from literature are not measured at SM, which makes the implementation difficult. Therefore it is proposed by the authors that SM starts with deducting the setup time when calculating the measure. As it is measured today it is contradictive to the plan attainment measure. A high level of plan attainment for a plan with many setup changes will automatically result in a reduced OEE, and vice versa. However it might be useful to start using the complete definition as soon as possible.

‘Average production batch size’ is a measure that becomes relevant when looking at the responsiveness of a company. However, in the case of SM, because of the large differences in batch sizes, the authors suggest that it should be measured in ‘Number of setup changes’ instead. The number of setup changes is relevant when looking at the flexibility of production and the effectiveness measures. Therefore, the measure should be visualised on the QDE-STEP boards at the factory level and at PL. [4,7,9]

As stated in step 3, ‘Capacity’ and ‘Utilisation’ are important measures when trying to be responsive. In the case of SM the researchers has not found a good way to measure the overall capacity and how it is utilised, therefore this measure will not be added to the existing measures However, ‘Flow time efficiency’ and OEE are measures that sufficiently describe how well the equipment is utilised.

As stated in step three, ’Average backorder length’ is selected since it might improve the service level towards the DCs. The measure monitors how long time it takes to replenish the inventory at the DCs. No measure exists today that measures the time that the DCs are out of stock-. Hence, the ’Average backorder length measure complements the existing measure “Delivery precisions”, which is monitored by the PL. ’Average backorder length’ is limited to only include the portion of time it takes to replenish the inventory. However, it is equally important to monitor how much the actual number of inventory coverage days that differs from the agreed number of inventory coverage days. This measure is not found in the list from the drivers in section 2.3 or in the lists from SM, but is defined by the authors.

Average inventory, is measured at SM defined as in ’Inventory finished goods coverage’. Therefore, the ’Average inventory’ measure is not considered a complementary measure. Since SM is not producing according to customer orders, the ‘Production service level’ measure is not contributing to the existing measure at SM related to service levels. Based on the information from step 3, the D-component at the GSC level might need a complementary measure that more in detail describes the DCs ability to deliver products to customers. The ‘Delivery promise slippage’ measure monitors the deviation between the final promise delivery date and the original promised delivery date, and contributes to evaluate the DCs delivery performance. ‘Delivery promise slippage’ is relevant to monitor both at the GSC level but also at PL, since this function is communicating with the DCs on a regular basis.

Today it is apparent that SM has problem with the increasing complex environment in which it operates. This is mostly due to the increasing amount of SKUs. Even though SM is aware of the situation no records can be found that presents a summary of the SKU evolution, displaying when new product introductions or changes on existing products were made. Therefore, the measure ‘Product variety’ should be used to monitor the changes over time in regard to the SKU evolution. Even though it is possible to obtain this information from the current systems, the information is not used. The authors believe that compiling this information into one chart on an aggregated level could be useful since this information might provide an understanding of the performance related to other measures. If using this information, a potential correlation between the increased complexity and other measures might be found.

For example, a connection between the number of set up activities in production and the number of SKUs could be found as well as the correlation between the number of SKUs and the number of consumer complaints, supplier reliability, COGM, and OEE. When comparing the SKU evolution and COGM it might be necessary to break down the COGM and study how the different components included in this measures, such as total DMC and DMC used in production, are affected by the increasing number of SKUs. The product variety might not be relevant to display on the QDE-STEP boards but is a measure that the respective functions should be aware of, since it was found in the empirical chapter that the majority of the functions within the GSC function is affected by the increased number of SKUs.

A measure not measured in a satisfactory way at SM today is 'Inventory accuracy', even though it is described as a major problem area since it affects both the performance in production but also the performance of the activities performed by the procurement function and the PL function. The 'Inventory accuracy' measure was selected from the drivers in order to highlight the importance of monitoring this measure. However, the selected measure fails to describe how a company might improve the accuracy of inventory levels more in detail. Therefore, the authors define two measures that provide information regarding the performance of this measure. The first measure includes measuring the number of times that the inventory levels were corrected from current levels to actual current level. The second measure includes monitoring the amount related to the corrections. The measures might be considered somewhat basic but could still be used by SM as sufficient initial measures even though they should be complemented with complementary and more detailed measures on a long term basis. The new measures could mainly be useful at the warehouse function and should be displayed on their QDE-STEP board, but could also be relevant to monitor at the PL function and the procurement function but perhaps not be displayed on the QDE-STEP board.

Related to the previous measure is the measure 'Putaway accuracy'. Since the activities related to retrieving and placing material at the stock shelves are factors causing inaccuracy in inventory levels at SM, being able to place and retrieve material in a correct manner is crucial. 'Putaway accuracy' is a measure that could help evaluate an operator's ability to do this. According to the definition, the measure includes reporting the correct quantity along with correct documentation. The quantity is covered in the previous measure but does not take into consideration whether the material was placed at the correct location. Therefore, it is relevant to evaluate the number of times a correction was made due to goods placed at the wrong location. Important to remember is that these errors might occur both when placing incoming material at the shelves but also when the production function return products that were not used in production. This measure is most relevant to measure at the warehouse function and should be displayed on their QDE-STEP board.

A part of 'Variance from plan', defined as the difference between the actual values and planned values in production plans and inventory levels, is already measured at SM through the measure 'Plan attainment'. Plan attainment only measures the ability to produce according to plan and does not consider the inventory levels. This support the need for measuring inventory levels, mentioned above. Since plan attainment already exists and 'Inventory accuracy' already has been added, there is no need for the 'Variance from plan' measure since its components are already measured at SM.

Another measure also existing at SM today is 'Forecast accuracy' which means that the 'Forecast error' measure selected in step 3 does not provide any additional information. Since it is included in both lists, SM should continue to monitor it. 'Ratio of demand variability to order variability' is a measure from Table 5-2, which is currently not measured at SM. The measure might provide information regarding how much excess capital that is tied up in the organization and should thereby be measured. The measure should be monitored by Procurement and the demand quantities should be equal to the order quantities, unless safety inventory is wanted for important items.

A measure that was selected in step 3 is 'Supply lead-time', which is a measure that SM is already monitoring. It is currently not displayed on any board, and the researchers do not see a need for more focus on this measure. However, a measure that should be measured in more detail is 'Supplier reliability', which will complement the measure 'Matching invoices' on the Procurement QDE-STEP board. In accordance with the discussion in step 3 it is of importance to keep track of the deviations in lead-times and quantities from suppliers. At SM's the measure could also help improving the inventory accuracy, since incoming material will be mapped better. The researcher suggests that 'Supplier reliability' at SM should be measured as the difference between the waybill and the purchase order, both in accordance to the quantity received and the receive date. It should also be registered how often the two differs in any of the two areas. Therefore, new routines and perhaps also new technology might be needed in order to follow up on this measure without increasing the work load at the warehouse.

'Fraction of on-time deliveries' is a relevant measure when trying to be responsive, the measure is included in 'Supplier reliability'. However, it is a cornerstone when measuring the two measures 'Orders received on time to commit date' and 'Orders received to required date' and is therefore included as an important measure. The difference between the two underlying measures is relevant to measure since it reflects how good the suppliers are at supplying items to SM's wanted lead-times, which reflects their ability to facilitate SM's need for responsiveness. The measure should be monitored by the Procurement function, but is not relevant to visualise on the QDE-STEP board.

Another measure that is currently not measured at SM is 'Orders received defect free', the reason it is not measured at SM today is due to the large quantities received each day. Therefore, the measure cannot be measured in an effective way at SM. However, since product revisions are made and consumer complaints are measured, these two measures can be used to identify whether defects on supplier items are common, rather than performing receiving inspections on the high volume items. A better way of controlling the quality of the incoming material is close collaboration with the suppliers, ensuring that all of the items shipped to SM are in compliance with the quality needed. If investments are needed at the suppliers, sharing the cost can be a way of helping the suppliers to reach the quality standard needed, instead investing in costly inspections at SM. It is important that Procurement monitors the relevant measures at other functions, in order identify quality problems at the suppliers.

To a large extent the measures ‘Rang of sales price’ and ‘Range of periodic sales’ are already measured at SM, but the measures can be broken down even further. If the effects of product launches and price changes was monitored to reflect how the products cannibalise on existing products and to what extent they steal markets shares from competitors. It would increase the understanding of market effects, which would increase the ability to create better forecast. As mentioned in section 4.2.5, SM is good at creating business plans forecasting the effects of a product launches. However, they can improve the extent to which they follow up on the accuracy of the forecasts. Better forecast will facilitate forecasting and production planning. The measure should be monitored by BC, with the help from the Sales and Marketing and shared with the rest of GSC.

As stated in section 5.4.3, the GSC, Factory, and Production levels all use the same Quality measure on their QDE-STEP boards. To include another perspective of the quality in production, a new measure is suggested for the production board and on the individual lines, ‘Quality losses’. Measure the amount of waste due to defects in products is usually a good indicator of how stable the production process is running. A more stable process usually means less defects, which should result in fewer customer complaints. ‘Total build cycle time’ is another measure that is important to have in mind when trying to be responsive, since a short ‘Total build cycle time’ makes it easier to be responsive. It enables a company to quickly change and produce a product if demand changes.

Table 5-3 List of recommended measures from framework.

Measures taken directly from drivers
Percentage of new parts used in new products
Percentage of existing parts reused in new products
Processing/setup/down/idle time
OEE
Delivery Promise Slippage
Product variety
Supplier reliability
Fraction of on-time deliveries
Orders received on time to commit date
Orders received on time to required date
Range of sales price
Range of periodic sales
Quality losses
Measures defined by the researchers with inspiration from drivers
Number of setup changes (Average production batch size)
Average backorder length
Inventory accuracy
Putaway accuracy
Orders received defect free
Measures from drivers already in use at SM
Flow time efficiency
Average inventory
Variance from plan
Forecast error
Supply lead-time
Total build cycle time
Measures reject in step 5
Capacity
Utilisation
Production service level

5.6 Step six- Verification of performance measures characteristics

In step 6 the newly selected measures and the kept existing measures will be checked against the list of characteristics criteria in Table 2-8, in order to assure that the created system of measures fulfil the requirements of a PMS. All of the measures were evaluated with the criterions listed and in this section the results will be analysed.

The first characteristics to be evaluated were 1, 5, and 10 of the PMS design characteristics, which are related to the strategy, the organisation, and the organisational goals. Because the framework is based on the strategy of a company, the strategy and goals of the organisation was included from the beginning of the work and all of the measures from step 3 was selected based on the strategy and the current goals of SM highlighted in step 2. In Step 4 the current measures was evaluated in regard to how well they fulfil the output from step 2. Therefore the measures selected from Step 5 together cover the criterions in 1 and 10. All of the measures chosen do fit the organisation of SM and the measures deriving from the drivers that did not fit, has been redefined or excluded from the final list in Step 5. Therefore, criteria number 5 is fulfilled as well as criteria number 2, since all measures chosen considers the organisation and all measure chosen has a purpose.

Even though the researchers have made the selection of the measures, the selection is still based on the information from interviews and observations at SM. Therefore, it can be argued that criteria number 4 is fulfilled, since the opinions of employees and managers from different levels form the base for the selection. Also customer needs like freshness and wanted service level has been considered, which includes the customer opinions in the selection.

All the selected measures can be displayed in numbers, even if some of them need clear definitions of how they are measured, such as ‘number of innovative initiatives’ at E & QA, where it is important to have a clear definition of what an innovative initiative is. One issue that is evident at SM is that even though the calculations and collection of data is clearly defined, a lot of the data collection and the calculation of measures are done manually today. Therefore, the systems and the processes should be reviewed and developed to create systems where the data is registered and calculated automatically. Despite these small issues criteria number 3 and 9 can still be considered to be fulfilled in the new system of measures.

Another criterion, number 8, is whether the operating conditions will affect the ability to compare the measures. The system of measures proposed from the framework is not bound to any specific operations conditions, and the measures can be compared regardless of changing conditions. However, if the operating conditions were changed drastically, a new evaluation of the measures would be necessary. If needed the framework can be used again and the list of measures in step 3 can be used if a specific area is in need of a new measure. The different functions can also use the framework to evaluate their own measures without looking at the entire organization. Therefore, criteria number 6 is also fulfilled.

Since the framework is based on the drivers and the fact that QDE-STEP in itself is created to include all important aspect at every function, the measure can be considered to be very inclusive. The drivers ensure that the different drivers that drive performance are considered and the different components of the QDE-STEP ensures that the components of each function is considered, hence criteria number 7 is also covered in the system of measures selected. The last criteria number 11, states that operational, tactical and strategic measures should be included in a PMS. The measures selected can be argued to be mostly operational. However, the measures can be used at a strategic and tactical level to evaluate and set goals for the organization on an aggregated level. More strategic measures are used at an aggregated level at the functions above GSC in the organization hierarchy and some of the financial measures are strategic and tactical to their nature.

The measures are to some extent providing benchmarking opportunities. Some measures facilitate internal benchmarking, such as comparison of the OEE measure between different production lines. The measures also provide external benchmarking opportunities against competitors and actors in similar industries. For instance, COGM can be used to compare the cost associate with manufacturing.

The majority of the measures are not expressed as ratios. However, many of the measures are of the nature that they in the future can relatively easily be expressed as ratios. In addition, even though it is preferable to present measures in ratios it is not reasonable to exclude a relatively well defined measure not currently presented as a ratio as long as they reflect important issues.

Some measures are not under the control of the evaluated organizational unit. An example of this is the BC function. For instance, they are measuring the amount of waste and scrap but cannot affect it. Another example is 'Plan attainment' monitored by the Pl function. This measure monitors to what extent the production function manage to fulfil planned orders. The PL function is not directly affecting this measure even though the formulated production plans might affect it in some ways. The majority of the measures are however under direct control of the evaluated function.

The majority of the performance measures have defined targets, which reduce the number of subjective opinions whether a goal related to a certain performance measure is reached. Some new measures are yet to be defined which indicates that room for subjectivity is present.

The list from step 5 along with the already existing measures consists of both financial and operational measures, which is important, as mentioned in the theoretical framework. Financial measures usually monitored at a higher organizational level are not present, which might be seen as a limited factor when trying to evaluate how the overall company financial performance is affected by the selected measures.

Some of the measures are relatively simple to use and are today measured in a sufficient way. However, some measures are still in need of manual handling, which takes time and increase the risk for errors when compiling the information. Therefore, some new proposed measures might need some additional system support in order to be used in a satisfactory way, and these might cause some difficulties.

The seventh characteristic requirement states that the measures should provide fast feedback. This is the case to some extent when it comes to the measures in the new PMS. Most of the measures provide fast feedback but there are measures that do not. Examples of two are 'Percentage of new part used in new products' and 'Percentage of existing parts reused in new products'. Even though it is reasonable to believe that the complexity might be reduced if fewer items are needed, it might take some time before such conclusions can be made.

6. DISCUSSION

The purpose for this master thesis was to develop a new framework for measuring supply chain performance by evaluating and creating KPIs. To what extent the purpose is fulfilled and in what way is presented in chapter 7. This chapter elaborates on the strengths and weaknesses in the framework and also suggests some areas of improvements.

The output from the project provides existing literature within the field of supply chain management with a new way of measuring supply chain performance by developing a new framework for evaluating and selecting KPIs. One of the unique features of the framework is that the selection and categorising phase of performance measures stems from six elements that drives supply chain performance. By doing so, the framework might provide the reader with a different viewpoint of how to select KPIs and categorise KPIs. In addition to this new perspective, the framework also consists of well-known approaches already mentioned in existing literature and incorporates these into a new framework.

As mentioned in the theoretical framework, it is of great importance that a PMS is developed based on the strategy**,** but that companies fails to do so. Therefore, the foundation of the framework consists of a strategy evaluation (step 1 and 2), which is used to determine what type of strategy a company has and what type of supply chain strategy to pursue. The fact that the developed framework uses the strategy as a starting point when selecting KPIs strengthens the link between strategy and KPI selection. Another important criteria mentioned in the theoretical framework is that KPIs should exist in the whole organisation. This is also considered in the framework, since one step in the framework evaluates if the KPIs are present at the strategic, tactical, or operational level. The evaluation in this step reveals if only one type of KPIs is used. Another advantage with the framework is the fact that it takes into consideration how information is shared within SM and between SM and its suppliers and customers. As stated before, sharing information retrieved from KPIs is equally important as selecting the KPIs. As seen in the analysis chapter related to step 4, it can be seen that SM has a structured way of sharing information internally, even though the information sharing with external parties could be improved.

There are some factors that might affect the result and outcome of the project, one being the fact that the developed framework only has been tested in a single case study, and that further tests by companies in other industries and environments could have contributed to the evaluation of the framework in order to evaluate the potential of it and making it more generalizable. Even so, Table 5-3 indicates that the framework, when tested at SM, contributed with some new measures and reflections, which means that one cannot exclude the possibility that the framework might be applicable and useful when used by other companies as well. This is supported by the fact that the model was not developed in a particular context. Another factor affecting the outcome of the framework is related to the selection activity, step 3 in the framework. The selected measures are retrieved from a base of measures presented in the theoretical framework. The quality and comprehensiveness of this base of measures directly reflect the output performance in the selection activity and the selection output can only be as sufficient as the base allow it to be. A third factor influencing the outcome is the way collection of data and information was obtained. Even though a lot of time were spent on collecting information on how the PMS is structured and what measures that are used, the possibility for overlooking some measures and losing some information is imminent, since SM has several different systems in which measures and information exists. This problem is probably more prominent if the framework is to be used by external workforce such as consultants, since they might not be familiar with the existing PMS structure. Furthermore, the obtained information is to some extent based on second-hand information, which reduces the objectivity.

During the work process some areas of improvements have been discovered. One is the fact that even though suppliers and customers were taken into consideration, the relationship between SM, suppliers and customers could have been investigated further. An interesting aspect to investigate further would be to test the framework at one of SM suppliers to investigate to what degree their KPIs and strategies correlate with those at SM. This relates to another aspect, namely that the framework to some extent focuses too much on internal optimisation instead of optimising the whole chain. However, having internal processes is a prerequisite for being able to improve external collaboration. So, one can argue that internal optimisation in some ways are necessary when trying to improve supply chain performance.

Another area of improvement could be to include tools for facilitating and improving the KPI selection step in the framework. For instance, it could be of interest to investigate if tools where KPIs are compared and weighted against each other can be used in order to facilitate the prioritisation of KPIs. It would also be interesting to further develop the measures list for each of the drivers. Additional measures could facilitate the selection process further and perhaps increase the flexibility and the generality of the framework. However, at the same time additional measures might create confusion and make the selection process harder.

For further research in the area, it would be of interest to test the framework on all of the entities in a supply chain, including suppliers, manufacturers, wholesalers, and retailers. Instead of using the functions as categories in the selection process, each company would be a category instead. The framework was developed with the whole chain in mind and it would be interesting to see the result of such a test. However, a project of that magnitude would be incredibly time and resource consuming. Another issue that would have to be dealt with in such project would be the evaluation of the existing PMS, mainly since the different entities would have different PMSs. However, this could also be one of the possible gains from such a project, a unified PMS through out the chain and increase collaboration between the entities. Testing the framework on an entire chain would also test the usefulness of the drivers. The drivers are general categories and can be applied to basically any supply chain, but it still has to be tested if the same measures will work a cross all entities in supply chain as well. Another highly relevant research area would be to test how general the framework is by testing it in several different industries and compare the results. Testing the framework in different context is probably the next step for future research.

7. CONCLUSION

This chapter presents the findings of this thesis by answering the research questions and to what extent the purpose is fulfilled. It also presents the result from the test of the developed framework presented in chapter 2.

RQ1 What factors influence supply chain performance?

The first step towards measuring supply chain performance is to fully understand what factors that influence the performance of a supply chain. According to existing research, one of the most important factors is the ability to view the entire supply chain as one large entity. When all actors in the chain work together with a common strategy and a common goal the chance for success increases. If not, there is a large risk that each actor sub optimises their operations and the performance of the supply chain suffers. To be able to work together it is important to have a clear and well communicated strategy. The strategy is important since it guides the improvement efforts in the supply chain and it is important that the strategy is developed in regard to the customer requirements. In order for all the actors to be able to work together towards a common strategy, collaboration is needed, since it enables long lasting relationships and common targets.

Apart from the factors above it is important to consider what it is that actually drives the performance of a supply chain. There are many different ways of categorizing important aspects. In this thesis six drivers were chosen as a good categorization, Facilities, Inventory, Sourcing, Information, Pricing, and Transportation. The drivers are all important parts in a supply chain and they all have to be considered in order for a supply chain to be effective.

RQ2 What current methods exist when measuring performance in a supply chain context?

As the theoretical framework reveals, there are several different methods for measuring performance in a supply chain context and several methods and requirements exists for describing how to categorise and include appropriate measures and how to structure a PMS. In this thesis four different approaches were selected as a base of important aspects and viewpoints to consider when studying how a PMS can be structured.

The first approach highlights the fact that a supply chain measurement system must focus on three types of measures, i.e. resource, output, and flexibility, in order to be sufficient.

The second approach, named Performance of activity, suggest that a process-based approach should be used to analyse the supply chain. The supply chain is viewed as one entity, which is divided into core-processes, which in turn comprises of several sub-processes, which is a set of activities. A seven-step method is proposed when breaking down and analysing the processes to be measured. The core processes, sub-processes, activities and the measures they contain are what create the framework for the PMS.

The third approach put emphasis on two aspects. The first aspect is focusing on the importance for managers and researcher to put equal emphasis on financial and non-financial measures. The second aspect highlights the importance of having metrics at strategic, tactical and operational levels. With this point of departure, different measures are discussed, derived and elaborated upon along the four links in the SCOR- model.

The fourth approach, the balanced scorecard approach, develops performance measures across four balanced perspectives, i.e. financial, customer, internal business processes, and learning and growth. By using this categorisation, companies are provided with the opportunity to measure financial results as well as monitoring progress in building the capabilities and obtain the intangible assets needed for future growth.

The similarity between the approaches is that they all emphasizes and enables structure to ensure that important factors are considered. The structure also helps selecting and finding relevant measures and placing them in suitable contexts.

RQ3 How should performance measures be managed within organisations in order to improve supply chain performance?
In order for performance measures to be utilised within an organisation several factors are important and the first factor is to have a structured model to select and evaluate measures. In order for the system to work, all functions within an organisation have to be willing to share information. Sharing measures externally is also necessary and companies have to share potentially confidential and sensitive information and trust their partners. Another important factor for the effectiveness of a PMS system is the ability to include all functions and employees when selecting performance measures. The personnel utilising and performing the measuring should be consulted in order to ensure that the measures are useful and suitable for the organisation. The measures should also be visualised in a way that make them available for everybody concerned with the outcome of the measures.

Result
From the information obtained when answering the research questions a framework was developed and tested. The result from the test is presented in Table 5-3. The table is divided in four different categories and these categories are presented in the following paragraphs.

The first category includes measures from step 3 in the framework, measures taken from theory, but not present in SM existing PMS. Since these measures were considered relevant in theory these could possibly contribute to SM existing PMS. However, such a conclusion cannot be made until these measures are actually implemented and tested in practice.

The second category consists of measures defined by the researchers with inspiration form measures presented in step 3. This can be seen as a limiting factor in the framework since these measures are not actually included in the measures from step three but rather adapted. However, it can also bee seen as an advantage since some measures allows to be changed depending on the current environment. These measures are also not present in SM existing PMS and therefor require to be implemented and tested before any conclusion concerning these measures can be made.

The third category includes measures that were selected from step three, measures taken from theory, and also present in SM current PMS. The fact that the measures were present both in theory and at SM points to the fact that these measures can be considered to be generally important. It shows that the model include relevant measures that can be useful to a company.

The last of the four categories includes measures considered to be relevant in step three in the framework but were excluded since they were not possible to measure at SM, or because they could be replaced with other measures.

To answer upon the purpose which aims at 'developing a structured framework for creating and evaluating supply chain performance indicators with the aim of facilitating organisations efforts when measuring supply chain performance' it can be concluded that the output of the tested framework developed by the researchers consisted of twenty-four measures that could be useful to SM. Therefore it can be concluded that the framework developed, shows potential when it comes to facilitating a company's efforts to measure supply chain performance.

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Appendix

Appendix A – Measure Definitions

In this appendix all of the Measures listed in section 2.3, are listed and defined.

Facility measures		Definition/Description
1	Percentage of new parts used in new products	"Divide the number of *new* parts in a bill of materials by the *total* number of parts in a bill of materials."(Bragg, 2011)
2	Percentage of existing parts reused in new products	"Divide the number of approved parts in a new product's bill of materials by the total number of parts in the bill." (Bragg, 2011)
3	Putaway cycle time	Is the sum of the time difference between arrival time and the putaway time for each arrival, divided with the total number of arrivals for a specific time period (Bragg, 2011).
4	Putaway accuracy	Is calculated as the number of accurate putaways (including correct documentation and quantity), divided by the sum of all putaways (Bragg, 2011).
5	Scrap percentage	If the scrap percentage is not measured throughout a value chain. An accumulated number can be calculated as: the difference between actual cost of goods sold and the standard cost of goods sold, divided by the standard cost of goods sold (Bragg, 2011).
6	Average Picking time	Total number of order completed divided by the total number of hours worked by picking staff (Bragg, 2011).
7	Picking accuracy for assembled products	Is a ratio between where the sum of quantity errors and parts errors are divided by the total number of product kits sampled (Bragg, 2011).
8	Order lines shipped per labour hour	Sum of order lines shipped divided by the total amount of labour hours used to ship orders (Bragg, 2011).
9	Dock door Utilization	"To measure dock door utilization, multiply the average dock time per trailer by the number of trailers docked during the measurement period. Then divide the result by the total number of hours in the period, multiplied by the number of dock doors"(Bragg, 2011)
10	Percentage of Warehouse stock locations Utilized	"To measure the percentage of warehouse stock locations utilized, divide the number of stock locations containing any amount of inventory by the total number of stock locations in the warehouse" (Bragg, 2011)
11	Square footage of Warehouse storage space	Add together the square footage of the storage spaces. (Bragg, 2011)
12	Warehouse cycle time	Is calculated as the deviation between the date/time that the order was entered into the company order entry system and the date/time that the last order line was delivered(Bragg, 2011).

13	Storage density percentage	The cubic volume of a storage space, divided by the warehouse square footage (or square meters) (Bragg, 2011).
14	Inventory per square foot of storage space	The cubic volume of inventory on hand, divided by the warehouse square footage (or square meters) (Bragg, 2011).
15	Average pallet inventory per SKU	To be able to determine the amount of pallet space that will be needed for each SKU, the forecasted SKU unit sales can be divided by the historical or forecasted turnover. The ratio can then be divided by the amount that fits on a pallet (Bragg, 2011).
16	Delivery Promise Slippage	Measures how well a company can deliver on their original promised delivery date. It is calculated by subtracting the final promised delivery date from the original promised date for all orders and then dividing it with total number of deliveries. (Bragg, 2011).
17	Capacity	Is the maximum amount a facility can produce (Chopra and Meindl, 2013).
18	Utilisation	Measure to what degree the capacity of facility or a machine is used, i.e. how much of the maximum capacity is used (Chopra and Meindl, 2013).
19	Processing/setup/do wn/idle time	Processing is the fraction of time that a facility or machine was used to produce, setup is the fraction that was used for setting up machines, down time is the fraction time when the machines cannot be used, and idle time is the amount of time when there are no units to produce (Chopra and Meindl, 2013).
20	Production cost per unit	The cost of manufacturing one unit of a product(Chopra and Meindl, 2013).
21	Quality losses	Measures the percentage of manufacturing losses due to defects (Chopra and Meindl, 2013).
22	Theoretical flow/cycle time	The time it takes to manufacture a unit when there are absolutely no delays of any kind(Chopra and Meindl, 2013).
23	Actual average flow/cycle time	Measures the average time it took to manufacture all units during a period of time. A good measure when setting delivery dates (Chopra and Meindl, 2013).
24	Flow time efficiency	Is the ratio between actual flow time and the theoretical flow time (Chopra and Meindl, 2013).
25	Quarantine / hold-time	The average time that products are on hold waiting for being cleared from a quality control (Huang & Keskar, 2007).
26	Product variety	Measures the amount of different products or product families produced in a factory, a high number of product variety is often costly (Chopra and Meindl, 2013).

27	Volume contribution of top 20 percent SKU's and customers	Is a measure to evaluate how much of the total volume produced that comes from the top 20% SKUs or customers. If 80% or more is used it might be profitable to focus on separate lines for the top 20% (Chopra and Meindl, 2013).
28	Average production batch size	A measure that shows the average amount produced in every batch, large batches might be cost efficient, but often increase the need for inventories (Chopra and Meindl, 2013).
29	Production service level	The percentage of orders delivered in full and on time (Chopra and Meindl, 2013).
30	Fill Rate	The ratio of orders shipped within 24 hours from order entry (Huang & Keskar, 2007).
31	In process failure rate	The percentage of work in process that is not completed and scrapped (Huang & Keskar, 2007).
32	Yields during manufacturing	The ratio of the output from a process compared to the input for the process (Huang & Keskar, 2007).
33	% of errors during release of finished product	The percentage of products that are not released from the final control (Huang & Keskar, 2007).
34	Incoming material quality control	Quality assurance of incoming material from suppliers and their suppliers (Huang & Keskar, 2007).
35	% of orders scheduled to customer request date	The fraction of orders that are scheduled for delivery, within the delivery date requested by the customer (Huang & Keskar, 2007).
36	Average release cycle of changes	The sum of the time it takes to implement a change, divided by the total number of changes (Huang & Keskar, 2007).
37	Total build cycle time	The average time it takes from start of production until the order is ready to be shipped (Huang & Keskar, 2007).
38	Upside order flexibility	The time it takes to for a company to be able to handle a sudden and un forecasted stable increase in orders of 20% (Huang & Keskar, 2007).
39	Downside order flexibility	The fraction of the total amount of orders that can be reduced 30 days in advance without receiving inventory or cost penalties (Huang & Keskar, 2007).
40	Average days per engineering change	The sum of all days each change impacts the delivery date, divided by the total number of changes (Huang & Keskar, 2007).
41	Published delivery cycle time	The standard lead-time communicated to customers by the sales department (Huang & Keskar, 2007).
42	Package cycle time	The amount of time needed to containerize products for storage or sales (Huang & Keskar, 2007).
43	Overall Equipment Efficiency (OEE)	Defined in section 2.3.1

Inventory Measurements		**Definition/ description**
1	Cash-to-cash	A measure that includes customer and supplier payment times and total inventory. Provides a tool to investigate the relation between the time it takes to pay suppliers and the time it takes customers to pay. (Hofman, 2004)
2	Average inventory	Can be calculated by dividing annual cost of gods sold by period end inventory levels. If dividing 365 by the this result, one gets the number of days of inventory. (Bragg,2011)
3	Inventory turns	"Measure the number of times inventory turns over in a year. It is the ratio of average inventory to either costs of goods sold or sales."(Chopra & Meindl, 2013, p.61)
4	Average replenishment batch size	"Measures the average amount in each replenishment order. The batch size should be measured by SKU in terms of both units and days of demand." (Chopra & Meindl, 2013, p.61)
5	Average safety inventory	"Measures the average amount of inventory on hand when a replenishment order arrives. Average safety inventory should be measured by SKU in both units and days."(Chopra & Meindl, 2013, p.61)
6	Seasonal inventory	"Measures the difference between the inflow of product (beyond cycle and safety inventory) and its sales that is purchased solely to deal with anticipated spikes in demand." (Chopra & Meindl, 2013, p.61)
7	Fill rate	"Measures the fraction of orders/demand that were met on time from inventory. Fill rate should not be averaged over time but over a specific number of units of demand (every thousand, million etc.)."(Chopra & Meindl, 2013, p.61)
8	Fraction of time out of stock	"Measures the fraction of time that a particular SKU had zero inventory. This fraction can be used to estimate the lost sales during the stock out period." (Chopra & Meindl, 2013, p.61)
9	Obsolete inventory	"Measures the fraction of inventory older than a specified obsolesce date." (Chopra & Meindl, 2013, p.61)
10	Raw material content	Determine the proportion of raw material costs included in a typical sale in order to make sure that a company is adding a sufficient amount of value to the product. Calculated by dividing raw material dollars sold with sales. (Bragg, 2011)
11	Bill of material accuracy	Bill of material specifies exactly what components that are needed to build a product plus the quantities required for each part. In order to make sure that all part are available when manufacturing start, one can calculate the accuracy of the bill of material. Divide the number of accurate parts listed in bill of materials and divide it with the number of part in bill of materials. (Bragg, 2011)

12	Economic order quantity	With this measure it is possible to derive the point at which the carrying cost of inventory equals its ordering cost. This is the theoretically ideal quantity that should be ordered but should only be used as a guideline. Multiply the total number of units with cost per order times two and divide it with the carrying cost per unit. (Bragg, 2011)
13	Distribution turnover	Measures if a company is making progress in achieving just-in-time deliveries. Calculated by dividing dollars of manufacturing purchases per year with dollar value of incoming inventory. A high ratio indicates a just-in-time delivery system. (Bragg, 2011)
14	Inventory availability	In order to calculate the inventory, divide total number of completed orders received by customer by required date with total number of orders that customers should have received during a certain period. (Bragg, 2011)
15	Average backorder length	If a customer cannot receive a shipment on time, it is important to make sure that it can receive it as fast as possible. It is therefore needed to measure the average backorder length. It can be calculated by the sum of the number of days past the required customer receipt date for each order and divide it with total number of backordered customer orders. (Bragg, 2011)
16	Inventory accuracy	If the inventory records at a company are incorrect it is difficult to have timely production. Keeping track of the quantity, location, units of measure and part number are therefore important. The accuracy can be calculated by dividing number of accurate test items with total number of items sampled. An accurate test item is one whose actual quantity, location, unit of measure, and description match those indicated in the warehouse. (Bragg, 2011)
17	Inventory turnover	Inventory turnover indicates whether or not the inventory is being used by operations or shipped out from the company. It can be measured by dividing cost of goods sold with inventory. It can also be calculated by dividing direct material expenses and with raw materials inventory. (Bragg, 2011).
18	Storage cost per item	Storages costs such as insurance coverage, opportunity costs, and lack of rack space is expensive. It is therefore important to keep track of the storage cost. It can be calculated by dividing total warehouse expenses with total SKUs on hand. (Bragg, 2011)
19	Obsolete inventory percentage	Calculated by dividing cost of inventory items with no recent usage with total inventory cost. (Bragg, 2011)
20	Current ratio (current assets, current liabilities	Current ratio measure of an organisations overall liquidity i.e. the ability of a company to meet its short-term obligations. It is calculated by dividing current assets with current liabilities. Current assets is cash and assets that can easily be converted into cash within one year. (Müller, 2011)

Sourcing measurements		Definition/ description
1	Days payable outstanding	“Measures the number of days between when a supplier performed a supply chain task and when it was paid.” (Chopra & Meindl, 2013, p. 67)
2	Average purchase price	“Measures the average price at which a good or service was purchased during the year. The average price should be weighted by the quantity purchased at each price.” (Chopra & Meindl, 2013, p. 67)
3	Range of purchase price	“Measures the fluctuation in purchase price during a specified period. The goal is to identify quantity purchased correlated with price.” (Chopra & Meindl, 2013, p. 67)
4	Average purchase quantity	“Measures the average amount of purchased per order. The goal is to identify whether a sufficient level of aggregation is occurring across locations when placing an order.” (Chopra & Meindl, 2013, p. 68)
5	Supply lead-time	“Measures the average time between when an order is placed and when the product arrives. Long lead-times reduce responsiveness and add to the inventory the supply chain must carry.” (Chopra & Meindl, 2013, p. 68)
6	Fraction of on-time deliveries	“Measures the fraction of deliveries from the supplier that were on time. (Chopra & Meindl, 2013, p. 68)
7	Supplier reliability	“Measures the variability of the supplier’s lead-time as well as the delivered quantity relative to plan. Poor supplier reliability hurts responsiveness and adds to the amount of inventory the supply chain must carry. (Chopra & Meindl, 2013, p. 68)
8	Delivery reliability	Delivery reliability describes the variability in delivering a customer requests. Calculated by taking maximum delivery time minus minimum delivery time and then divide this by average delivery time. (Kasilingam, 1998)
9	Order received complete	“Number of orders received complete divided by total number of orders processed in measurement time.” (%) (Huang& Keskar, 2007, p. 515)
10	Orders received on time to commit date	“Number of orders received on time to commit date divided by total numbers of orders processed in measurement time.”(%) (Huang& Keskar, 2007, p.515)
11	Orders received on time to required date	“Number of orders received on time to required date divided by total numbers of orders processed in measurement time.”(%) (Huang& Keskar, 2007, p.515)
12	Orders received defect free	“Number of orders received defect free divided by total number of orders processed in measurement time.” (Huang& Keskar, 2007, p.515)

13	Percentage of purchase orders released with full lead-time	This measure is important in order to make sure that the purchasing department is preparing purchase orders on time. Bad preparations force the suppliers to deliver less than standard lead-times or changing to more expensive transportation modes. Calculated by taking by dividing purchase order lines with full lead-time with total purchase order lines released. (Bragg, 2011)

Transportation Measurements		Definition/description
1	Transit time	Transit time is a measure representing the time it takes to move a shipment from origin to destination. It is defined as travel time plus waiting time at terminals or dock plus transfer time plus handling time (Kasilingam, 1998).
2	Transit time variability	This is a measure that measures the variation in transit time. It indicates whether the transport function is reliable or not. Calculated by taking maximum transit time-minimum transit time and then divide this with average transit time. Should be as low as possible. (Kasilingam, 1998)
3	Transportation cost per unit	Transportation cost per unit multiplied with annual demand. (Kasilingam, 1998).
4	Perfect shipments	An overall quality measure of the transportation function. A perfect shipment is considered perfect when it is damaged free, on time and with complete documents. Calculated by dividing number of perfect shipments with total number of shipments. (Kasilingam, 1998)
5	Equipment utilization	Transportation equipment is often expensive. Therefore, the rate of utilisation of the different modes are of importance. Higher utilisation means lower cost of moving goods. It is calculated by dividing loaded travel time with total travel time. Total travel time includes waiting time, loading and unloading time and actual travel time. (Kasilingam, 1998).
6	On time arrival and departure	Calculated by dividing the number of on time arrivals or departures with total number of arrivals or departures. (Kasilingam, 1998).
7	Average inbound transportation costs	"Typically measures the costs of bringing products into a facility as a percentage of sales or cost of goods sold. Ideally, this cost should be measured per unit brought in." (Chopra & Meindl, 2013, p.63)
8	Average incoming shipment size	"Measures the average number of units or dollars in each incoming at a facility." (Chopra & Meindl, 2013, p.63)
9	Average inbound transportation cost per shipment	"Measures the average transportation cost of each incoming delivery. Along with the incoming shipment size, this metric identifies opportunities for greater economies of scale in inbound transportation." (Chopra & Meindl, 2013, p.63)

10	Average outbound transportation cost	"Measures the cost of sending products out of a facility to the customer. Ideally, this cost should be measured per unit shipped." (Chopra & Meindl, 2013, p.63)
11	Average outbound shipment size	"Measures the average number of units or dollars on each outbound shipment at a facility." (Chopra & Meindl, 2013, p.63)
12	Average outbound transportation cost per shipment	"Measures the average transportation cost of each outgoing delivery. Along with the outgoing shipment size, this metric identifies opportunities for greater economies of scale in outbound transportation." (Chopra & Meindl, 2013, p.63)
13	Fraction transported by mode	"Measures the fraction of transportation (in units or dollars) using each mode of transportation. This metric can be used to estimate if certain modes are overused or underutilised. (Chopra & Meindl, 2013, p.63)
14	Shipping accuracy	Shipping accuracy information comes from the customer, who keeps track of the complaints about incorrect order fulfilment. Shipping accuracy is calculated by taking total order line shipped minus incorrect order lines reported by customer and is then divided with total order lines shipped. (Bragg, 2011)
15	Percentage of products damaged in transit	To be able to deliver goods in proper conditions and provide customer satisfaction one must keep track of the quality of the transportation service. This can be done by keeping track of percentage of products damaged in transit. It is calculated by dividing damage related customer complaints with number of orders shipped. (Bragg, 2011)

Pricing measures		Definition/description
1	Profit margin	Is measured as a percentage of the revenue. In order to get a broad view of the pricing possibilities, different types of margin (gross, net, etc.), scope (SKU, categories, divisions, etc.), should be monitored (Chopra & Meindl, 2013).
2	Days sales outstanding	Is the averaged time between time of sales and the time that payment is received (Chopra & Meindl, 2013).
3	Incremental fixed cost per order	"Measure the incremental costs that are independent of the size of the order."(Chopra & Meindl, 2013, p 70).
4	Incremental variable cost per order	"Measures the incremental costs that vary with the size of the order" (Chopra & Meindl, 2013, p.70).
5	Average sale price	"Measures the average price at which a supply chain activity was performed in a given period. The average should be obtained by weighting the price with the quantity sold at that price." (Chopra & Meindl, 2013, p.70).
6	Average order size	"Measures the average quantity per order." (Chopra & Meindl, 2013, p 70).
7	Range of sales price	"Measures the maximum and the minimum of sales price per unit over a specified time horizon" (Chopra & Meindl, 2013, p.70).
8	Range of periodic sales	"Measures the maximum and minimum of the quantity sold per period (day/week/month) during a specified time horizon. The goal is to understand any correlation between sales and price and any potential opportunity to shift sales by changing price over time." (Chopra & Meindl, 2013).
9	Cost Of Goods Sold (COGS)	Direct materials and suppliers, Cost of raw materials and inputs, Direct labour, Cost of transportation and processing, Depreciation, Direct Manufacturing, Overheads, Cost of freight, Cost of warehousing, Inventory Shrink, Obsolescence, Mark downs, Inventory carrying, Handling. (Lapinskaitė & Kuckailytė, 2014)

Information measures		Definition/Description
1	Forecast horizon	The forecast horizon is the time ranging from the forecast to the activity it tries to foresee. The horizon has to reach further than the lead-time of the activity it estimates (Chopra and Meindl, 2013).
2	Frequency of update	Is a measure of how often a forecast is re-evaluated. The frequency should be higher than the frequency of decisions (Chopra and Meindl, 2013).
3	Forecast error	Is a measure of the deviation between forecast and the actual outcome (Chopra and Meindl, 2013).
4	Seasonal factors	Measures how demand deviates from average during different seasons (Chopra and Meindl, 2013).
5	Variance from plan	Measure the difference between actual values and planned values in production plans and inventory levels (Chopra and Meindl, 2013).
6	Ratio of demand variability to order variability	Is defined as the deviation between demand from customer and order quantity to suppliers. A good tool to identify bullwhip effects (Chopra and Meindl, 2013).

Appendix B – Interview form

This appendix contains the interview form in Swedish. The interviews were held in Swedish in order for the interviewers and the interviewees to be bale to discuss the topic without any language barriers.

Intervjuformulär

1 Personligt

Vad är din roll inom företaget/vad är du ansvarig för?

Hur länge har du arbetat på den avdelningen du befinner dig på just nu?

Hur länge har du jobbat på Swedish Match och har du jobbat på samma avdelning hela tiden?

2 Strategi och Ansvarsområden

Är din avdelning delaktig vid utvecklingen av Supply Chain strategi?

Vilka parametrar tar ni hänsyn till då ni utvecklar er Supply Chain strategi?

Vilka aktiviteter, processer och operationer är er/din avdelning ansvarig för?

Hur arbetar ni med planering och prognoser?

3 ’Performance measures’

Vilka mått använder ni idag för att mäta ‘performance’?

Hur många mått har ni/ följer ni upp?

Hur ofta mäter ni?

Hur samlar ni in data till måtten(datasystem, manuell rapport, osv)?

Hur bidrar måtten för utveckla företaget?

Har ni interna mått som inte delas utanför avdelningen?

Hur tar ni beslut om på vad ni skall mäta?

Hur fria är ni att definiera egna mått?

Hur samlar ni in data till måtten(datasystem, manuell rapport, osv)?

Hur ofta utvärderar ni era existerande mått?

4 Information och kommunikation

Hur kommunicerar ni det ni mäter inom er avdelning idag (QDE-tavla, möten, datasystem)?

Med vilka andra avdelningar delar ni era mått?

Hur många mått delar ni med andra avdelningar och hur ofta?

Hur är kvalitén (detaljrikedom, feedback, användbart, osv) på måtten ni delar med andra avdelningar?

Hur många mått tar ni del av från andra avdelningar?

Hur många mått får ni in från andra avdelningar och hur ofta?

Hur är kvalitén på de mått ni får in från andra?

5 Förbättringar av mätning

Vad har ni för förbättringsprojekt i pipeline?

Vad ser du för förbättringspotential inom din avdelning angående mätning av verksamhet?
(mätning, systemprestanda och samarbete)

Önskar ni mäta något i framtiden som ni inte mäter idag?

Finns det något som ni skulle vilja mäta men inte har något bra mått för?

6 Funktions specifika frågor -

-Funktionspecifika frågor- VP Global Supply Chain
-Funktionspecifika frågor- Factory Managers
-Funktionspecifika frågor- Procurement
-Funktionspecifika frågor- Planning & Logistics
-Funktionspecifika frågor- Business Control
-Funktionspecifika frågor- Engineering & QA
-Funktionspecifika frågor- Business Operation & Support

Appendix C – Product formats and Packaging

Below are figures displaying the different formats and packaging solutions at Swedish Match.