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Internal Supply Chain: Process and Performance Measurement Development

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This thesis describes the development project of the case company's internal supply chain. The case company is a Finnish family-owned company manufacturing and importing consumer and professional goods as well as functioning as an agency for large international companies, small and middle sized industrial companies and wholesalers. The purpose of the project was to develop specifically the internal supply chain of the own manufactured products and the performance measurement for it. The project goals were divided into two subprojects and main objectives: creating the internal production and supply chain process description and measurement tools for the process; and developing the production planning system by transferring the internal sales forecasts straight to the system without manual processing in between systems.

The literature review and theoretical framework consist of wide material around the main themes of supply chain management, supply chain management processes and supply chain performance measurement. Both qualitative and quantitative data was collected and used on the decision making process. The project data was collected from the company's quality system, individual departments' documents, internal discussions and the SAP reporting system.

The project produced the process description for own production and supply chain in the company's quality system. The following key performance indicators were chosen to quide, develop, ensure quality and measure performance in the main process: forecasting accuracy, internal delivery accuracy, stock reach follow up, stock value follow up and customer delivery accuracy.

The project laid the foundation for further development. Ensuring a continuous target-oriented measurement follow up, improving the internal co-operation on all cross-functional levels as well as creating more efficient and transparent use of information systems remain to be central challenges within the internal supply chain.

Keywords	Supply chain management, Supply chain management processes, Supply chain performance measurement

Contents

1 Introduction

1.1 Background – the Case Company Project

This thesis will focus on internal supply chain development. The development work was executed as a project and this thesis will bring together the results of the project as well as offer theoretical framework for the supply chain management, supply chain management processes and supply chain performance measurement.

The case company is a Finnish family owned company manufacturing and importing consumer and professional goods as well as functioning as an agency for large international companies, small and middle sized industrial companies and wholesalers. The company was established in 1883, has ca 500 employees and 275M€ turnover in 2014. The company's main office and product development centre are located in Helsinki, while its three production plants are located in Heinävesi. The company has subsidiaries in Sweden and the Baltic Countries.

This thesis concentrates on the internal supply chain of the own manufactured brands. The company has over 600 items in production and close to 20 brands. The three production plants are divided in production; first produces mainly water based hygiene and cosmetics products, second produces ethanol based hospital products, desinfectants and car care products and third produces vinegar and vinegar-based products. The three production plants have ca 50 employees.

The production plants work in cooperation with the sales divisions, product development, logistics and procurement department including MDM-team (Master Data Management). There have been three significant changes in the company during last 2-3 years; the establishment of the centralized procurement department along with a new product portfolio management and sales forecasting, the establishment of the centralized Master Data Management and the establishment of two new production plants. In hindsight; these large projects did leave some grey areas in processes ultimately resulting in out-of-stock situations and unclear responsibilities.

The out-of-stock situations experienced in spring 2014 resulted in meeting among the top management including heads of divisions and managing director, factory manager and HR manager. They decided to set up an internal supply chain development project and work as a steering group. The project group was named and strict timetable given.

1.2 Goals, Objectives and Scope

The steering group's goals for the project group were:
a) Securing stock availability and customer satisfaction with optimal stock levels
b) Improving the quality and efficiency of the internal supply chain
c) Transferring the Sales Forecasts straight to the production planning system (SAP – separate module)
d) Developing the supply chain measurement tools and practices for own production
e) Cost savings
f) Minimizing the overlapping work tasks
g) Ensuring the good internal co-operation

The deadline given to the development suggestions was 4,5 months.

The project group's goals were to fullfill the steering group's goals in given timeframe. The project was divided into two subprojects and main objectives:
1. Creating the internal production and supply chain process description and measurement tools for the process
2. Developing the production planning system by transferring the internal sales forecasts straight to the system without manual processing in between systems

The development project was limited in describing and developing the existing internal supply chain's main process between functions. The other department level processes were not included and the goal was not to change well-functioning existing processes. The subcontracting processes regarding own brands were also limited out of the project's scope.
Project's goal was also to identify different experts within own production chain and if necessary, to organize further process training. Individual job descriptions unrelated to the own production processes were also limited out.
The main responsibility of developing the production planning tool was given to the main users of the system itself, with access to the system and daily use of it in their work. The project group was to help when needed.
In developing the internal supply chain measurement tools and practices the project group's goal was to utilize the existing tools and systems as far as possible. The steering group's more precise goal for measuring was to get regular and visible follow up.

Very soon after the project group had started the three main focus areas arose: out-of-stock situations, unclear responsibilities within the internal production and supply chain and the measurement tools needed.

1.3 Project Goals and Current State Analysis

The steering group's seven goals were naturally arosen from everyday needs and even problem situations.

First goal was to secure stock availability and customer satisfaction with optimal stock levels. There had been out-of-stock situations in spring 2014 in spite of the relatively high average days of stock and stock value. The customer satisfaction was in danger and also in some cases there was a threat of penalty fees for late deliveries.

The second goal was improving the quality and efficiency of the internal supply chain. The company has a quality system in use and the company's quality certificate ISO 9001:2008 include product development, production functions in own manufacturing plants as well as selling the finished products, customer service and logistic functions. Correspondingly the environmental certificate ISO 14001:2004 include product development, production functions in own manufacturing plants and logistic functions.
The departmental processes and measurement tools were in most part already described in the quality system but the main process that crosses the departmental functions had not been yet described and the internal supply chain was not measured as an entity of functions.

The third goal of transferring the internal sales forecasts straight to the production planning system was one very concrete goal. The internal rolling 12-18 month sales forecasts are monthly updated in SAP reporting system that is a totally separate module from production plants SAP system where the production planning is done. The production planning system also does not have the latest stock data available as the other module does. For this reason the extra manual updating work with excel needed to be done before transferring the forecasts and stock data to the production planning system. In addition to the inefficiency of this practice there is a danger of human error in manual combining of the sales forecasts, stock data and minimum production batches every month.

The fourth goal was developing the supply chain measurement tools and practices for the own production. As mentioned a few lines before, the company had already several measurement tools and practices in use along the internal supply chain due to legal reasons only but also for production profitability view. However, the measurement tools and practices for measuring the whole internal supply chain's performance were missing. The measurement tools for the internal supply chain were also expected to ensure the smooth flow between departmental functions and to guarantee the right-time availability for the customers.

The fifth goal of cost savings is normally a reason behind all development projects. In the internal supply chain context the most visible and easiest measured savings could come from tied-up capital and warehousing cost development. The savings brought by more efficient process for example minimising the overlapping work tasks and clearing the responsibilities is not that easily measured.

The sixth goal was minimising the overlapping work tasks. As mentined before, the manual excel work between the sales forecasting and production planning system is clearly inefficient and also somewhat overlapping work task repeated on monthly basis. Another overlapping tasks were occuring in unclear responsibilities regarding the stock level follow up, especially in low stock or out-of-stock situations. The sales divisions thought that it was procurement's responsibility to function as an informant between sales and production and procurement had been told that in case of own production items and not outside supplier situations, the product manager and production plant should be in straight contact regarding the reasons for delay and expected availability. At worst, five persons from sales were sending urgent e-mails and calling to factory manager, factory foreman and procurement planner. One major problem was in this case also the production system being separate from company's reporting system and daily sales and logistics system. There was no direct visibility to production situation and product availability for others than the production plant personnel.

The seventh goal was ensuring the good internal co-operation. After the major projects involving the two new factories, establishing the centralized procurement department and master data management, some gray areas were left in responsibilities and processes. The production meeting practices were somehow forgotten along the way and no department or company level *regular* meetings took place anymore. Also, the straight daily communication between relevant parties was diminishing. It is clear that

each person working along the process should know with whom to communicate and how to proceed in certain situations. This is however not easy if there are no given clear structures, agreed practices and common goals.

On Figure 1 the steering group's goals and the current state analysis are explained side by side.

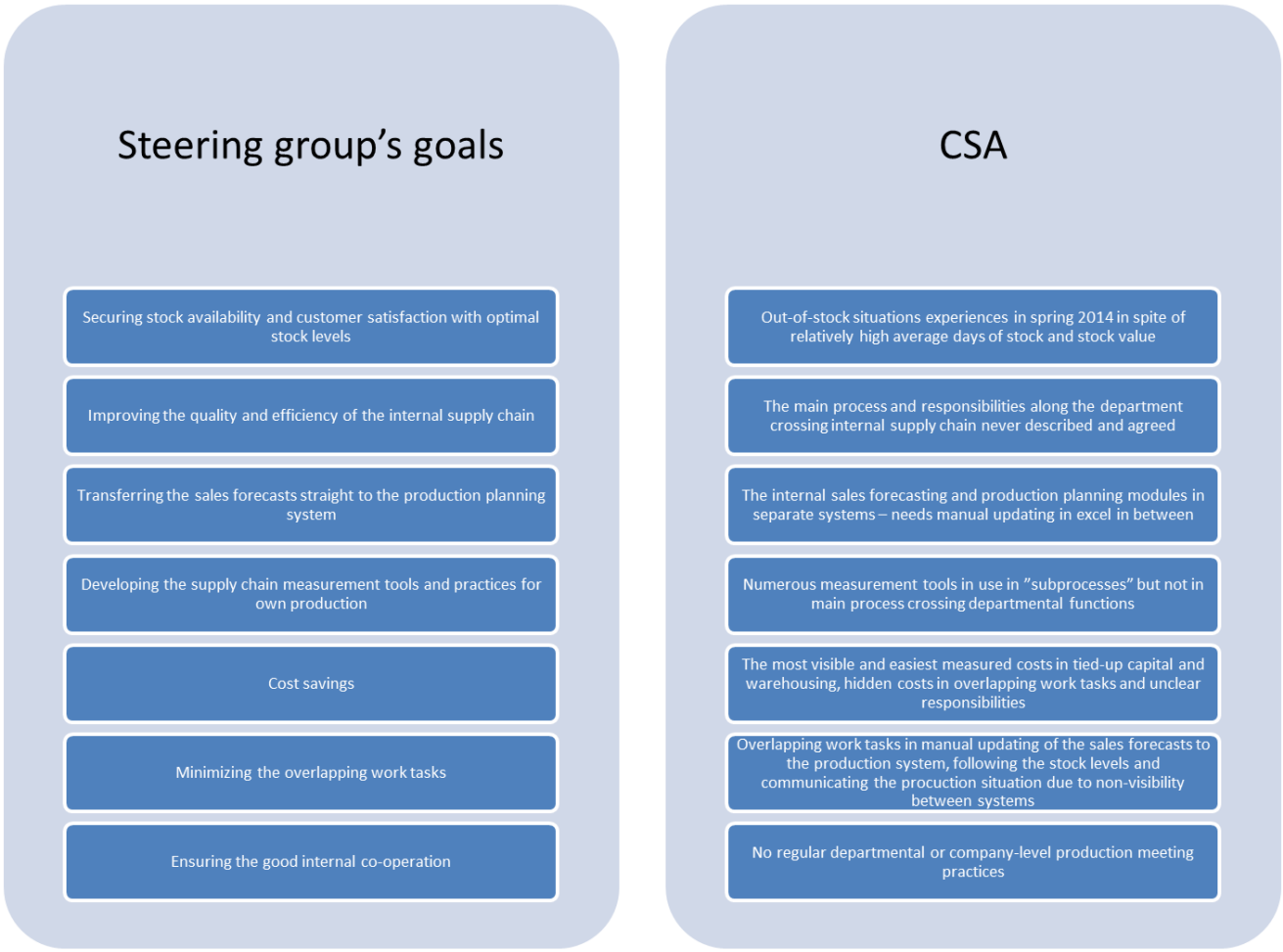


Figure 1. Steering group's goals vs CSA

1.4 Thesis Structure and Research Methods

1.4.1 Thesis Structure

This thesis starts with introduction to the project background and explains the goals and objectives based on the steering group's list of goals and project group's main objectives. The current state analysis (CSA) is explained in comparison to steering group's goals. The research methods from the project management perspective will also be discussed in the first chapter.

The second chapter of literature review will provide theoretical framework for the central topics of the project under main headings of Supply Chain Management, Supply Chain Management Processes and Supply Chain Performance Measurement. At the end of the chapter the literature review will be summarized in the project's context.
The third chapter will summarize how the project progressed and what were the most central development needs identified. The development suggestions in form of new main process description and measurement tools will be explained.

The last chapter will concentrate in analysing the project's results and impacts in everyday practices. The following figure 2 summarized the thesis structure.

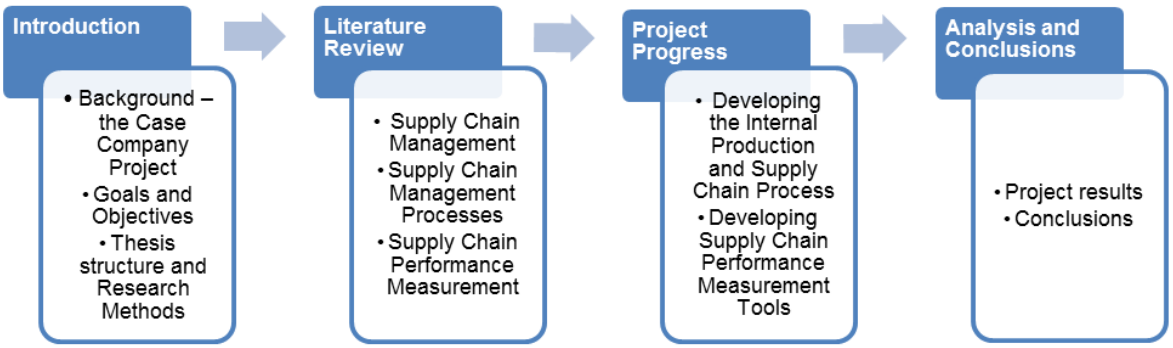


Figure 2. Thesis structure

1.4.2 Project Management Tools and Data Collection

Lester (2007, 5) defines the project management as “the planning, monitoring and control of all aspects of a project and the motivation of all those involved in it, in order to achieve the project objectives within agreed criteria of time, cost and performance”.
While the project management can also be seen as management of change, one definition for a project itself is the following:

> A unique set of co-ordinated activities, with definite starting and finishing points, undertaken by an individual or organization to meet specific objectives within defined schedule, cost and performance parameters.
>
> (Lester, 2007, 1)

A project has a definite starting and finishing point and must meet certain specific objectives (Lester, 2007, 2). The project objectives must meet three fundamental criteria:

1. The project must be completed in time;
2. The project must be accomplished within the budgeted cost;
3. The project must meet the prescribed quality requirements.

(Lester, 2007, 3)

The scope is added on the project triangle offered by Tutorials point webpage (Figure 3). Managing the scope and any changes in it will affect time and cost.

Figure 3. Project management triangle, source of image:
http://www.tutorialspoint.com/management_concepts/project_management_triangle.htm

Project planning and alignment from the beginning is important. According to Villachica et al. (2004, 9) “the alignment phase lays the foundation for successful development and implementation efforts, as well as ensuring that any resulting performance improvement interventions positively affect the organization’s bottom line by providing a positive return on expectations”. Major part of the project alignment is the project plan specifying the project’s scope of work, estimated costs and schedule (Villachica et al.,2004, 10). Many of the causes of success or failure lie in the way we develop and define the project (Morris, 2010, 140). According to Thomsett (2010, 2) “ a project has to be planned out, defined, and organized before you can know what you are up against in terms of actual management”.

According to Lester (2007, 61) the project management plan or simply project plan is one of the key documents required by the project manager and his/her team and the contents and volume of it depends on the type of the project. The project plan in the case project was presented for the steering group as a basic Powerpoint presentation. The plan included the goals of the project (steering group’s and project group’s), the scope and limitations of the project, the project stages and duration on a timeline, the roles of individuals listed, the documentation and communications plan, the first version of the model for the product in the case company’s internal manufacturing and supply chain, some examples for project success measurement in the light of the steering group’s goals, the already noticed challenges in the internal co-operation and some questions for the steering group for decision making and moving on with the project. As the project was done alongside of each member’s daily work, no actual financial budget was prepared.

The actual support tools used in the project were the project timeline template, project meeting template and project communications template. All these as well as all additional data and meeting materials were saved at company level drive with access for the steering group and project group from different departments.

The project timeline template (Figure 4) was kept as simple excel form and the progress was followed on weekly basis. The partly goals were split so that for each steering group meeting some results and/or suggestions for decision making would be offered.

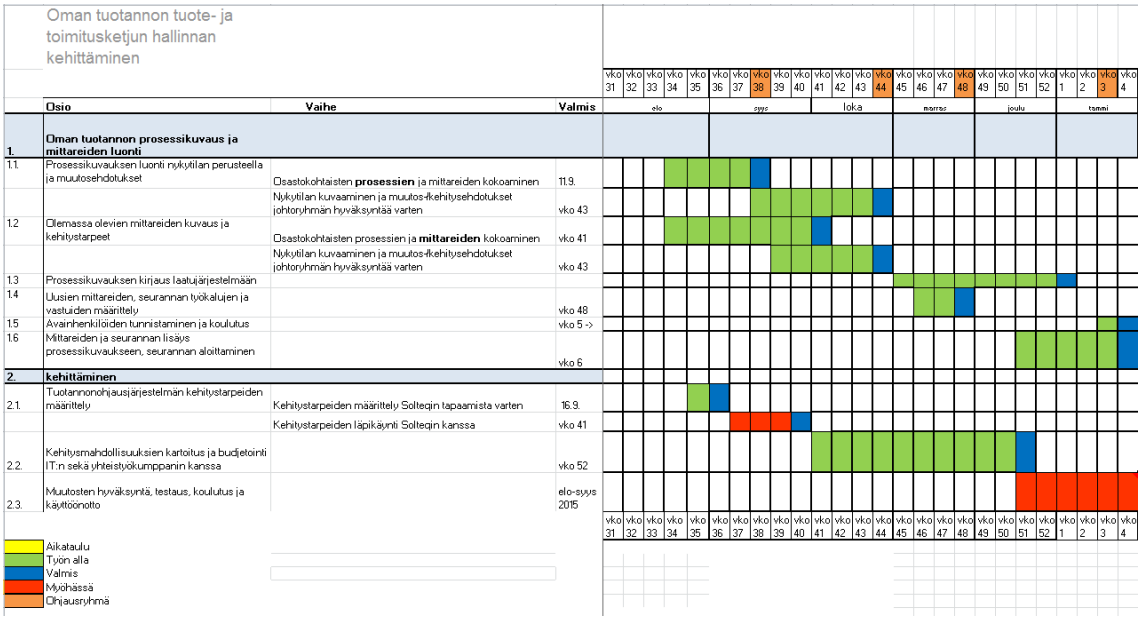


Figure 4. Project timeline template

The meeting template (Figure 5) was also kept in excel and each new meeting was saved as a new table. In the template itself the meeting description, date and agenda were given, the notes taken and the agreed actions, schedules and responsible persons described. Also the next meeting with the group in question was agreed. The keeping of regular meeting template helped the writing of the final or close-out report. The final report was given in Word document and included the description for the project background, the project goals, the achieved results, the project stages progress description, evaluation of the results, the training material description, further development suggestions and the project organization description.

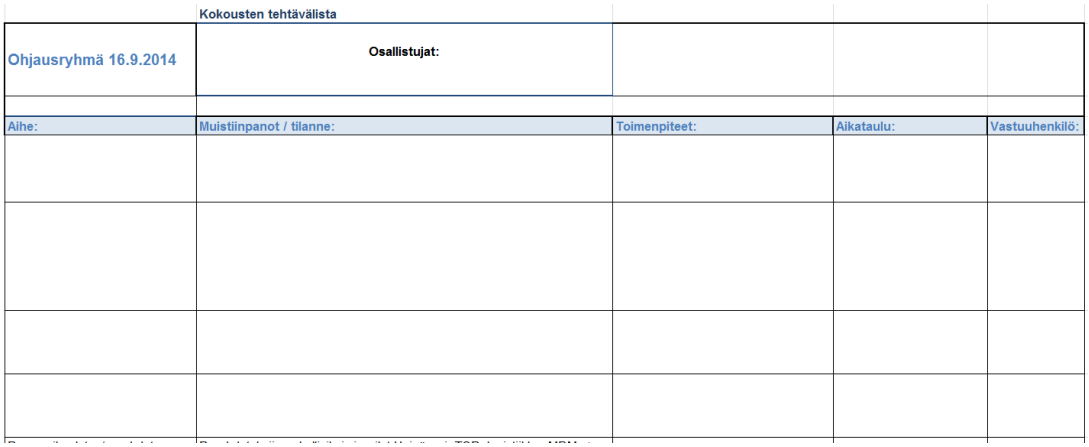


Figure 5. Project meeting template

According to Bourne et al. (2004, 234) “communication is a vital tool for project managers to develop and maintain robust and effective relationships with stakeholders within all organizational structures”. In the case project, the communications were planned from the beginning. The project group was given a weekly status update by e-mail, the steering group was given the meeting materials one day in advance to enhance the decision making and project progress; and the staff was informed about the project progress in intranet after each steering group meeting. Even though there was no extensive communications activity; the communications template was kept (Figure 6).

PROJEKTISUUNNITELMA	SIDOSRYHMÄT	VIESTINNÄN KANAVAT	AJANKOHTA	VASTUUHENKILÖT
Mitä viestitään?	Kenelle?	Miten?	Koska?	Kuka?

Figure 6. Project communications template

In addition to the management of time, cost, scope and technology, relationship skills are required to aid the effective application of “hard” skills – it is people, using knowledge, creativity (and often technology) that realise projects not techniques or hardware (Bourne et al., 2004, 227).

The actual data in the project was collected from the company’s quality system, individual departments’ documents, internal discussions and the SAP reporting system.

2 Literature Review

2.1 Supply Chain Management

2.1.1 Supply Chain

Lamb et al. (2014, 228) define the supply chain as “the connected chain of all business entities, both internal and external to the company, that perform or support the logistics function”.

Stevenson (2005, 693) defines the supply chain as “a sequence of organizations – their facilities, functions, and activities – that are involved in producing and delivering a product or service”.

Krajewski et al. (2010, 344) take a wider view and define supply chain as “the interrelated series of processes within a firm and across different firms that produces a service or product to the satisfaction of customers” and specify the definition even further to be “a network of service, material, monetary, and information flows that link a firm’s customer relationship, order fullfillment, and supplier relationship processes to those of its suppliers and customers”.

Rushton et al. like to see the participants of the chain as an entity:

> “the supply chain is viewed as a single entity rather than a series of fragmented elements such as procurement, manufacturing, distribution, etc. This is also how logistics is viewed in most forward-looking companies. The real change is that both the suppliers and end users are included in the planning process, thus going outside the boundaries of a single organization in an attempt to plan for the supply chain as a whole”.
> Rushton et al. (2006, 29)

Stevenson (2005, 694) offers illustrations for typical (simplified) supply chains and points out that the number and type of organizations in a supply chain are determined by whether the supply chain is manufacturing (Figure 7) or service (Figure 8) oriented:

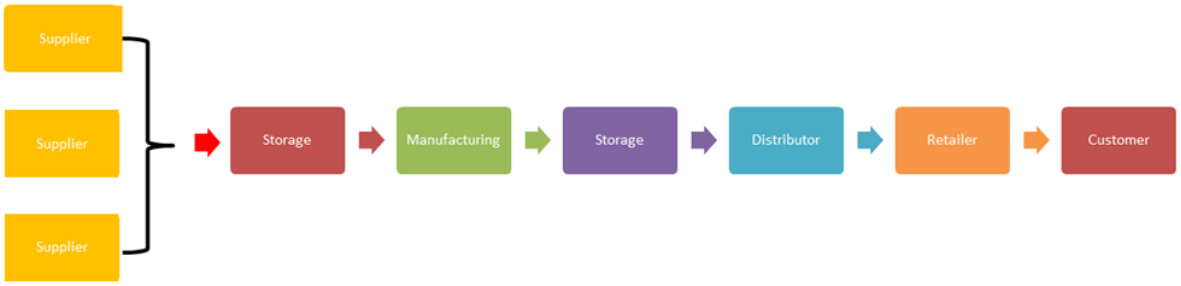


Figure 7. Typical manufacturing oriented supply chain adapted from Stevenson (2005, 694)

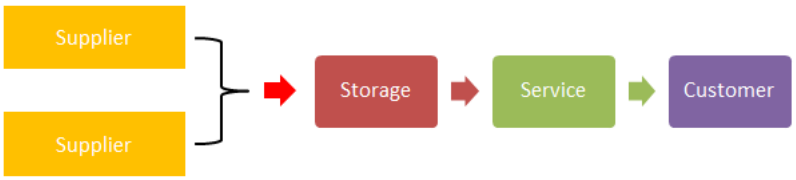


Figure 8. Typical service oriented supply chain adapted from Stevenson (2005, 694)

Ofcourse real life supply chains are longer, more complex and connected with other supply chains and as Christopher (2011, 3) states “the word chain should be replaced by network since there will normally be multiple suppliers, and, indeed, suppliers to suppliers as well as multiple customers and customers’ customers to be included in the total system”. This statement is followed by quotation of the suggested supply chain definition: “A network of connected and interdependent organisations mutually and co-operatively working together to control, manage and improve the flow of materials and information from suppliers to end users”.

As the previous definition mentions both materials and information, also Stevenson (2005, 693) points out that not only physical activities take place: “there are two kinds of movement in these systems: the physical movement of material, generally in the direction of the end of the chain..., and exchange of information, which moves in both directions along the chain”. Thus supply chain needs to be managed from many per-spectives. The flow of information and physical (material) is illustrated in the following image on Figure 9:

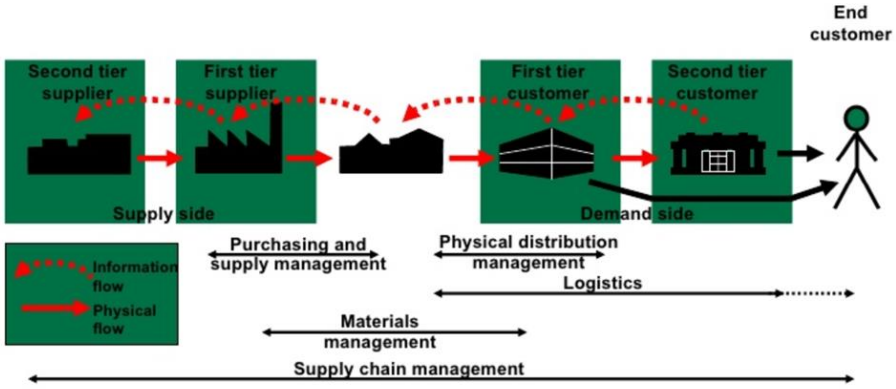


Figure 9. The flow of information and physical (material) illustrated, source of image: http://image.slidesharecdn.com/presentationmdc-100619061951-phpapp02/95/supply-chain-management-in-the-motor-vehicle-industry-the-example-of-mini-21-728.jpg?cb=1276946975

Schary and Skjott-Larsen (2003, 47) emphasize that the supply chain begins with the customer. They further define the supply chain as “a process that transforms materials into products and delivers them to customers through specific activities”.

2.1.2 Internal Supply Chain

In the article “The measurement of internal supply chain integration”, Basnet writes about the internal supply chain and its management as follows:

> Internal supply chain refers to the chain of activities or functions within a company that results in providing a product to the customer. Integration of these functions involves the holistic performance of activities across departmental boundaries. A well-integrated internal supply chain should result in excellent customer service and company performance.
>
> Basnet (2013, 153)

Effective internal supply chain integrates the internal functions for example from marketing to logistics. Chen et al. (2007, 7) write in their article that “marketing/logistics collaborations and interactions can provide valuable input to support broader-based decision making and planning within the firm” and continue further:

> “Interdepartmental collaboration can bring departments together into a cohesive organization. Firm performance and, ultimately, supply chain performance depend on such collaboration”
>
> Chen et al. (2007, 7)

Companies should achieve internal integration before implementing supply chain management that will eventually include other supply chain partners. According to Gimenez et al. (2005, 32) “internal integration has a positive effect on external integration because coordination among internal functions facilitates coordination among different companies”. Gimenez et al. (2005, 33) however remind that “SCM is not easy to set-up: there can be internal barriers to change processes, and there can also be difficulties to shifting from traditional arms-length or even adversarial attitudes to a partnership perspective”. Burt et al. (2010, 529) write about the internal integration as follows: “the first priority of a business enterprise is to integrate and optimize its own operations before making any attempt to extend supply chain rationalization to external organizations” and “the internal customers need to acknowledge the presence of the supply management organization when they are implementing the product development and planning process”.

Ellinger et al. (2000, 14) found in their study that collaborative behaviour positively impacts effective interdepartmental relations. However, “unless participants in the process see value in the information that is exchanged and are somehow motivated to use it, increasing the amount of information may be somewhat worthless” (Ellinger et al, 2000, 15).

Schary et al. (2003, 101) write that the strenght of the supply chain is in interorganizational relationships and that “the ability to assess and establish these relationships will govern the future actions of the corporation”.

2.1.3 Supply Chain Management

Rushton et al.(2006, 29) define the supply chain management as “very much a strategic planning process, with a particular emphasis on strategic decision making rather than on the operational systems”.

Schary et al. (2003, 262) state that “supply chain management establishes strategic direction, designs the activity and organizational structures and processes to integrate operations, selects and negotiates with potential partners and monitors operations”.

According to Stevenson (2005, 696) “supply chain management involves coordinating activities across the supply chain. Central to this is taking customer demand and translating it into corresponding activities at each level of the supply chain”.

Krajewski et al. (2010, 344) define the supply chain management quite clearly as “the synchronization of the firm’s processes with those of its suppliers and customers to match the flow of materials, services and information with demand”.

Ellinger et al. (2014, 118) define supply chain management in their article introduction as “the proactive management of supply chain activities and processes to maximize customer value and achieve sustainable competitive advantage through the cumulative effort of multiple entities”.

Lamb et al. (2014, 228) describe that “the goal of supply chain management is to coordinate and integrate all of the activities performed by supply chain members into a seamless process, from the source to the point of consumption, ultimately giving the supply managers *total visibility* of the supply chain both inside and outside the firm”. This description is followed by more philosophical point of supply chain management: “by visualizing the entire supply chain, supply chain managers can maximize strengths and efficiences at each level to balance the supply and demand needs of each member in the supply chain”.

The definition for the supply chain management by Christopher (2011, 3) takes a very holistic view in terms of relationships management, customer value and cost-savings as follows: supply chain management is “the management of upstream and downstream relationships with suppliers and customers in order to deliver superior customer value at less cost to the supply chain as a whole”. It is also argued further by Christopher that “the phrase *supply chain management...*should really be termed *demand chain management* to reflect the fact that the chain should be driven by the market, not by suppliers”.
Also many other sources underline the fact that the *push* manufacturing has strongly changed to *pull* manufacturing in recent years and even decades, one example as follows:

> “in the mass-production era, manufacturers produced standardized products that were *pushed* down through marketing channels to consumers, who were convinced by salespeople to buy whatever was produced. In today’s marketplace, however, customers who expect to receive product configurations and services matched to their unique needs are driving demand. The focus of businesses has shifted to determining how products and services are being *pulled* into the marketplace and partnering with members of the supply chain to enhance the customer value”.
> Lamb et al. (2014, 228)

According to Krajewski et al. (2010, 344) fundamental to supply chain management is developing a strategy to mobilize and provide for all the resources in the supply chain to meet customer demand. The *supply chain design* is seen as an essential aspect of a supply chain strategy. Krajewski et al.(2010, 346) describe the fundamental purpose of the supply chain design for manufacturers to control inventory by managing the flow of materials.

Schary and Skjott-Larsen (2003, 47) state that there is a fundamental issue in the conflict between the process of supply chain and organizational boundaries. The organizations manage and supply resources, but activities must have both coordinated operations and physical links to make the supply chain operate. Thus; according to Schary and Skjott-Larsen, “supply chain management must organize and manage a potentially worldwide supply and distribution network that delivers a variety of products and services that respond directly to customers in global markets”.

The following image (Figure 10) of SCM focuses on five areas of the supply chain also known from the supply chain operations reference model (SCOR) which will be discussed later on the thesis: plan, source (buy), make, deliver (sell/move), and return (service):

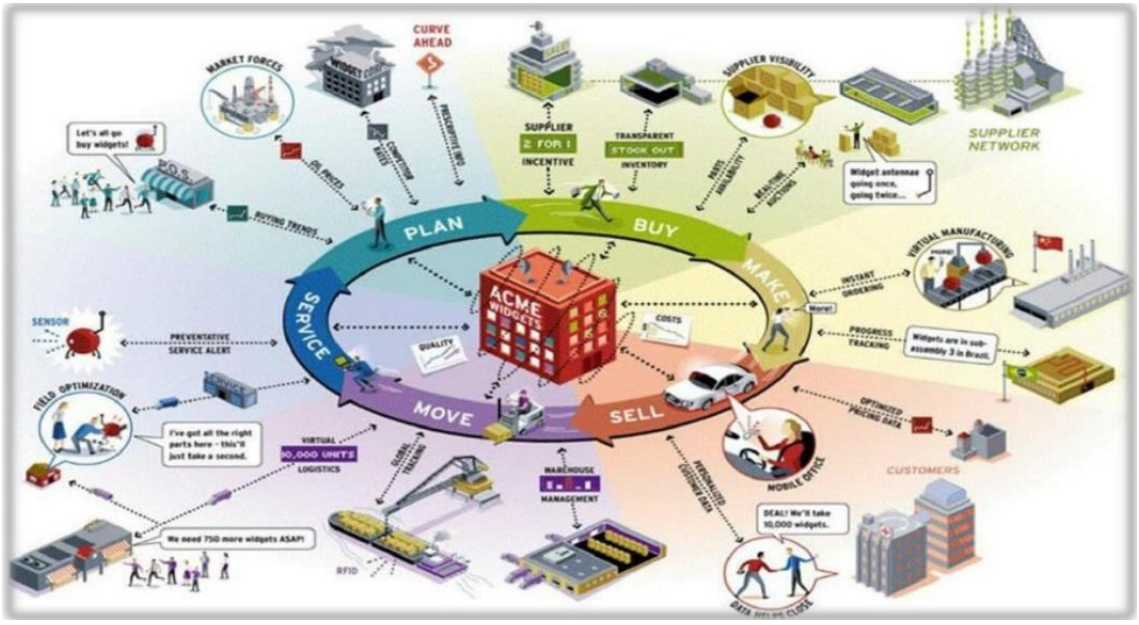


Figure 10. What is SCM?, source of image: http://www.slideshare.net/YSFSHIPPING/basics-of-supply-chain-managment?next_slideshow=2

2.1.4 Supply Chain Integration

In search for Supply Chain Management and related topics the term of Supply Chain Integration soon comes up and it is also mentioned in this thesis. In their article Chen et al. (2007, 6) provide the following definitions: “Integration is a process of interdepartmental interaction and interdepartmental collaboration that brings departments together into a cohesive organization” and “Integration refers to the extent to which separate parties work together in a cooperative manner to arrive to mutually acceptable outcomes”. It is stated that managers may well understand the importance of integrating activities, but as a practical matter, integration is often quite difficult to achieve.

Two levels of integration are considered in the context of supply chain management: internal and external. According to Chen et al. (2007, 6) “internal integration examines integration across various parts of single organization; external integration examines integration that occurs between organizations”. It is worthwhile to mention that logistics has been proposed to be in an ideal interface position to facilitate integration:

> Internally, logistics must work closely with production and marketing to plan, coordinate, and integrate the cross-functional activities to create value for customers. Externally, logistics can serve in a boundary-spanning capacity and interface with suppliers, carriers, and customers.
>
> Chen et al. (2007, 6)

Chen et al. (2007, 6), also mention that “it is generally believed that firms achieve a relatively high degree of internal integration before they attempt to develop a higher degree of external integration”.

For encouraging a firm-wide cross-fucntional integrated approach, it is important to create a team-oriented corporate culture as well as long-term commitment. According to Chen et al. (2007, 15), “the prevalence of a “functional silo” orientation often makes it difficult to develop cooperative cross-functional teams”. Also, “the compensation system and the particular mix of pay components used can send powerful signals to employees as to the organization’s goals – if different signals are sent to the various functions, coordination will suffer” (Chen et al., 2007, 15).

2.1.5 Benefits of Supply Chain Management

The importance and influence of supply chain management can be seen clearly in the light of the fact that firms expend up to 75 percent of their revenue on supply chain activities (Ellinger et al., 2014, 118).

Stevenson (2005, 696) lists the benefits of effective supply chain management to be lower inventories, lower costs, higher productivity, greater agility, shorter lead times, higher profits, and greater customer loyalty.

AlSagheer et al. (2011, 80) have listed the benefits of supply chain integration in their article “Impact of Supply Chain Integration On Business Performance and Its Challenges”. It is stated that “supply chain integration enhances the process of information sharing within the organization and outside the organization (suppliers, channel partners, customers and other stakeholders)”. The supply chain integration also “enabled the organization to do effective business renovation and business process modeling that increased the efficiency and profitability of a business”. Further “supply chain integration enabled the organization to gain a sustainable competitive advantage in the marketplace and it enhances organizational performance by enabling it to reach its goals and objectives effectively and efficiently”. Supply chain integration “enables the organization to satisfy the needs and wants of target customers “superiorly” relative to competition and thus customer satisfaction/loyalty increases” providing a sustainable competitive advantage to the organisation. Supply chain integration also enhanced the fi-

nancial performance of an organization as well as improved the financial ratios. In the end, “sales were increased because the firm was in a position to satisfy the needs and wants of customers superiorly and increased customer loyalty boosted sales revenues”. The following image (Figure 11) summarizes the benefits associated with supply chain integration:

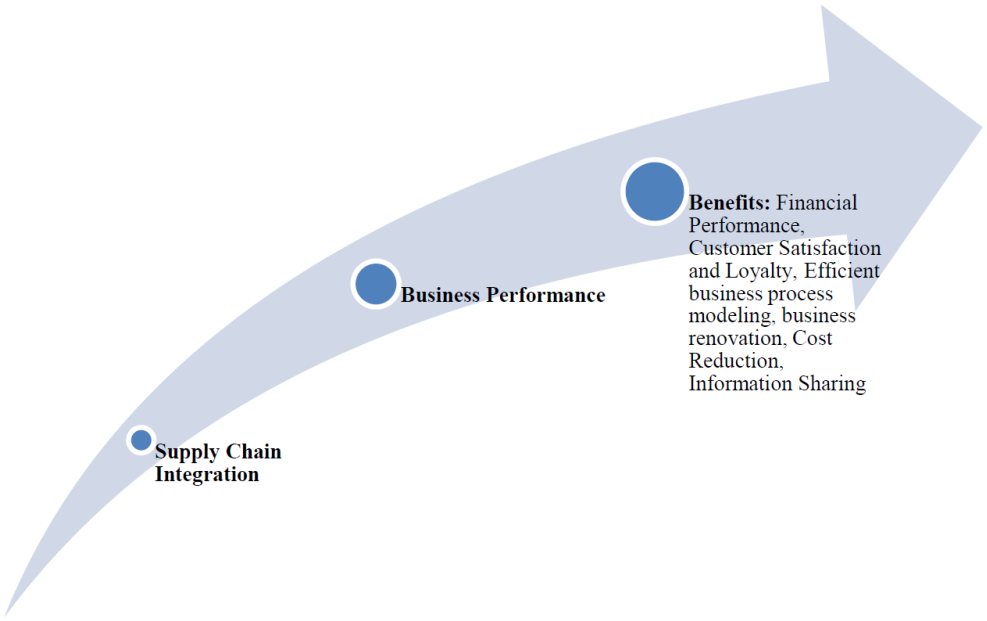


Figure 11. Impact of supply chain integration on business performance in terms of benefits, source of image: AlSagheer et al. (2011, 81)

Chen et al. (2007, 16) summarize the gains from “embracing firm-wide cross-function integration” or simply put as internal supply chain management as follows:

> The results of the current study indicate that firm-wide integration not only could improve a firm’s financial performance including sales volume, profitmargin, and return on assets, it could also enhance a firm’s customer satisfaction and competitiveness in the market. Furthermore, organizational employees should be better informed as a result of the cross-functional interactions, which can lead to better decisions and, ideally, less conflict.
> It may also lead to speedier decisions. Because of a greater awareness of the trade-offs involved, it may be easier to solve operational-level problems, and at the same time more focus can be placed on longer-term strategic thinking.
>
> Chen et al. (2007, 16)

According to Kazemkhanlou et al. (2014, 274), the “effective supply chain management (SCM) has been associated with a variety of advantages including increased customer value, increased profitability, reduced cycle times and average inventory levels and even better product design”.

2.1.6 Challenges of Supply Chain Management

Storey et al. (2006, 766-767) have identified three core enablers and inhibitators for supply chain management in their study: transparency of information and knowledge; supply chain behaviour; and performance measurement. For example, they found that even with existing collaborative planning, forecasting and replenishment practices there was vulnerability to erosion, revision and withdrawal from the argeed arrangements. Also, the traditional inter- and intra-organizational boundaries tended to remain intact, the intra-organizational complexity in responsibilities was usual and promotional activities were frequently not pre-announced. The use of KPIs was guided by top level business objectives or metrics pursued at functional level could at worst jeopardise the performance of the supply chain as a totality and the end customers needs were forgotten.

The further future challenges facing the supply chain management are the trend towards outsourcing, the trend towards fragmentation and variety in product and service offerings and globalization (Storey et al., 2006, 769-771).

AlSagheer et al. (2011, 81) have listed several concrete examples of challenges in supply chain integration in their article as follows:

> (1) it was essential for an organization to consider supply chain integration strategy as an essential component of business only if it could relate it to its strategy theory and concepts,
> (2) customer order management was a tough challenge because different value chain partners integrated their supply chains to satisfy the needs and wants of their customers “differently” from competitors for gaining a sustainable competitive advantage,
> (3) Logistics management could cause several challenges for firm integrating their supply chain because different value chain partners had different supply chain or value chain structures with different organizational cultures,
> (4) Operations flexibility also became a challenge due to organizational differences when firms wanted to integrate and collaborate,
> (5) it was difficult to maintain standards in case of organizational differences while integrating supply chains such as size, culture, structure and people etc.,
> (6) procurement management became difficult,

> (7) It was difficult to integrate two organizations having different values, visions, missions, cutlures, leaderships, and structures etc,
> (8) application integration was very difficult because of different Enterprise resource planning (ERP) systems adopted by organizations,
> (9) there were certain extranet adapting challenges,
> (10) it was not easy to integrate different business processes at different organizations,
> (11) Culture and Change Management themselves became a challenge for organizations,
> (12) supplier competence requirements were important to consider,
> (13) the process of data and information integration was complex and complicated, and
> (14) the forces of globalization and commoditization were not stoppable and they could impact supply chain integration decisions.
>
> AlSagheer et al. (2011, 81)

The following image (Figure 12) identifies some of the challenges associated with supply chain integration:

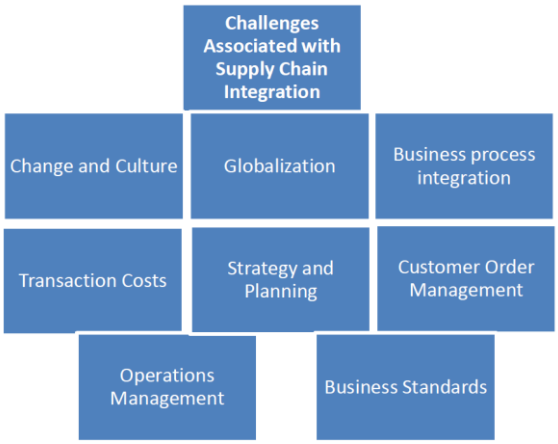


Figure 12. Challenges Associated with Supply Chain Integration, source of image: AlSagheer et al. (2011, 84)

2.1.7 Supply Chain Management Skills

In the fast changing business environment there is a greater need for new skills to manage the supply chain systems. Mangan et al. (2005, 178) state in their article that there is “an emerging realisation that more investment is needed to develop appropriate managerial skills and and competencies for supply chain managers”. The skills Mangan et al. (2005, 180) list are for example business skills, logistics skills, manage-

ment skills, interpersonal/managerial basic skills, quantitative/technological skills, “SCM core skills” but summarize it all in form of “significant cross-functional skills”.
Rahman et al. (2014, 276) list in their research findings that the areas the supply chain managers should devote their attention to are warehousing management, distribution planning, demand forecasting, negotiation skill, cross-functional coordination skill, and knowledge of environmental issues in supply chains. Art et al.(2013, 19) discuss the “new basics of supply chain management” in their article and comment on what are most important of “the new basics” in rather philosophical way: “the scope and scale of supply chain management may not be infinite, but like galaxies in our celestial universe, they will continue to expand”. However, they summon most important factors or “new basics” under subheadings “The Role of Leadership”, “The New Diversity”,”Green as a Way of Life”, “We Are All Numbers People”, “Mastering Relationships” and “Strategy and Planning”.

Lorentz et al. (2013, 358) conclude in their research of the current supply chain management skill development priorities in manufacturing firms (154 manufacturing companies operating in Finland) that top five skills for development are: demand forecasting and supply planning; sourcing and supplier management; customer and distribution channel management; production planning and control; and information systems for logistics and production planning. Their research results also show an apparent need to focus on the development of inter-organisational skills; it seems that the supply chain management skills with an inter-organisational focus tend to have a higher development priority.

It seems that the skills needed to effectively manage the supply chain really are close to infinite but they definitely are related to the supply chain processes that need to be managed.

2.2 Supply Chain Management Processes

Process can be defined as “converting inputs into outputs and a way in which all the resources of an organization are used in a reliable, repeatable and consistent manner to achieve its goals” (Psomas et al., 2011, 440).

According to Krajewski et al. (2010, 25) all processes have inputs and outputs and include both external and internal customers as well as external and internal suppliers.

The inputs, such as combination of human resources in form of workers and managers, capital in form of equipment and facilities, purchased materials and so on go through processes and operations and become outputs such as goods and services (Figure 13):

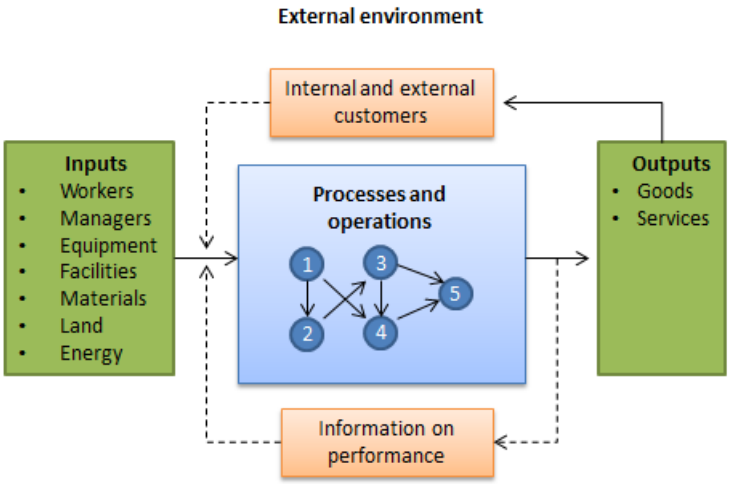


Figure 13. Processes and Operations (Krajewski et al., 2010, 25)

Krajewski et al. (2010, 146) mention three effective techniques for documenting and also for evaluating processes: flowcharts, service blueprints and process charts. Examples of the three can be seen on the following images (Figures 14-16):

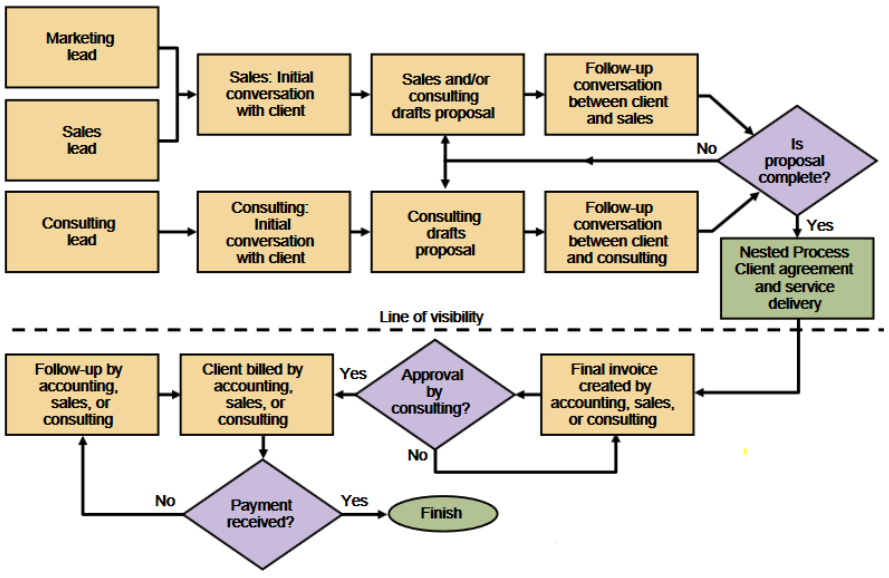


Figure 14. Flowchart of the Sales Process for a Consulting Company (Krajewski et al., 2010, 148)

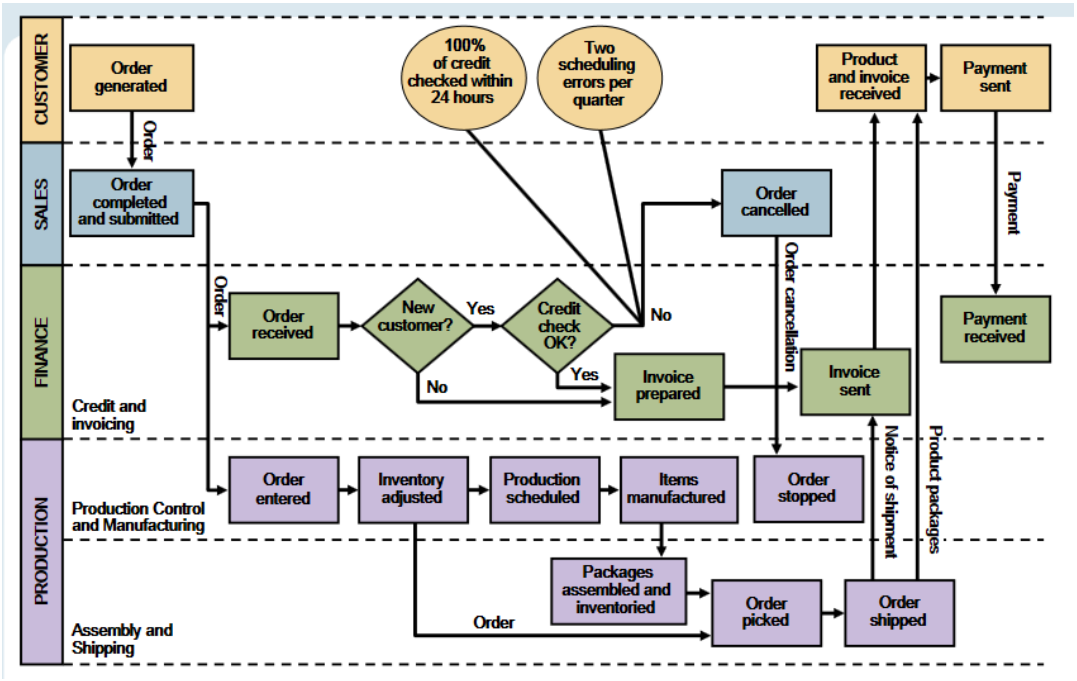


Figure 15. Flowchart/Service Blueprint of the Order-Filling Process Showing Handoffs Between Departments (Krajewski et al., 2010, 149)

Step No.	Time (min)	Distance (ft)	●	➡	■	◗	▼	Step Description
1	0.50	15.0		X				Enter emergency room, approach patient window
2	10.00		X					Sit down and fill out patient history
3	0.75	40.0		X				Nurse escorts patient to ER triage room
4	3.00				X			Nurse inspects injury
5	0.75	40.0		X				Return to waiting room
6	1.00					X		Wait for available bed
7	1.00	60.0		X				Go to ER bed
8	4.00					X		Wait for doctor
9	5.00				X			Doctor inspects injury and questions patient
10	2.00	200.0		X				Nurse takes patient to radiology
11	3.00		X					Technician x-rays patient
12	2.00	200.0		X				Return to bed in ER
13	3.00					X		Wait for doctor to return
14	2.00		X					Doctor provides diagnosis and advice
15	1.00	60.0		X				Return to emergency entrance area
16	4.00		X					Check out
17	2.00	180.0		X				Walk to pharmacy
18	4.00		X					Pick up prescription
19	1.00	20.0		X				Leave the building

Summary				
Activity		Number of Steps	Time (min)	Distance (ft)
Operation	●	5	23.00	
Transport	➡	9	11.00	815
Inspect	■	2	8.00	
Delay	◗	3	8.00	
Store	▼	—	—	

Figure 16. Process Chart for Emergency Room Admission (Krajewski et al., 2010, 150)

According to Slack et al. (2010, 99) one significant advantage of process documenting or mapping is that the acitivities can be systematically challenged in order to improve the process.

One definition for process management is “a structured approach to analyze and continually improve fundamental activities such as manufacturing, marketing, communications and other major elements of a company’s operation” (Psomas et al., 2011, 440).

In order to build links between supply chain members companies need to implement a standard set of supply chain processes (Croxton et.al, 2001, 13).

Lamb et al. (2014, 232) list eight critical business processes on which supply chain managers must focus: Customer relationship management, Customer service management, Demand management, Order fulfillment, Manufacturing flow management, Supplier relationship management, Product development and commercialization and Returns management.

In their article Croxton et al. (2001, 14) also list the same eight key processes, identified by The Global Supply Chain Forum , that make up the core of supply chain management. The eight key business processes run the length of the supply chain and cut across firms and functional silos within each firm.
Functional silos include Marketing&Sales, Research & Development, Finance, Production, Purchasing and Logistics. The following image (Figure 17) illustrates this complex entity.

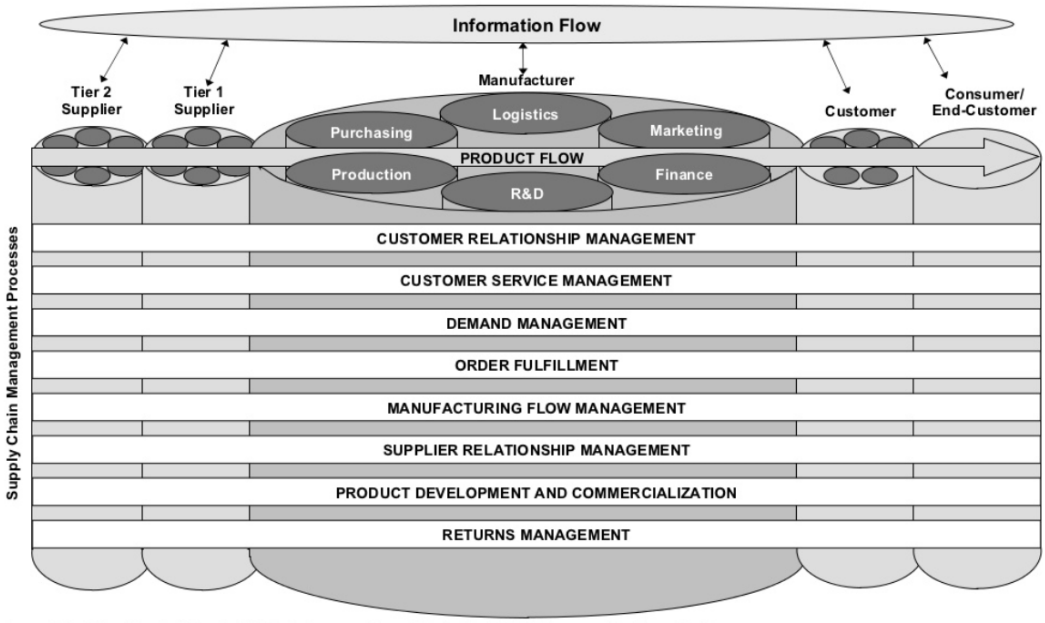


Figure 17. Supply Chain Management Processes (Croxton et al., 2001, 14)

The eight key business processes will be further explained in the following text. Each process includes strategic and operational sub-processes and interactions between processes, functions, and key members of the supply chain.

2.2.1 Customer Relationship Management

The customer relationship management process provides the structure for developing and maintaining the customer relationships (Croxton et al., 2001, 15). According to Krajewski et al. (2010, 392) “the purpose of the customer relationship process, which supports *customer relationship management (CRM)* programs, is to identify, attract, and build relationships with customers and to facilitate the transmission and tracking of orders”.

Croxton et al. (2001, 15) introduce the sub-processes as well as the process interfaces for the customer relationship management in their article (Figure 18).

The strategic sub-processes for customer relationship management include: 1. Review Corporate and Marketing Strategy, 2. Identify Criteria for Categorising the Customers, 3. Provide Guidelines for the Degree of Differentiation in the Product/Service Agreement, 4. Develop Framework of Metrics, and 5. Develop Guidelines for Sharing Process Improvement Benefits with Customers.

The operational sub-processes include: 1. Differentiate Customers, 2. Prepare the Account/Segment Management Team, 3. Internally Review the Accounts, 4. Identify Opportunities with the Accounts, 5. Develop the Product/Service Agreement, 6. Implement the Product/Service Agreement and 7. Measure Performance and Generate Profitability Reports.

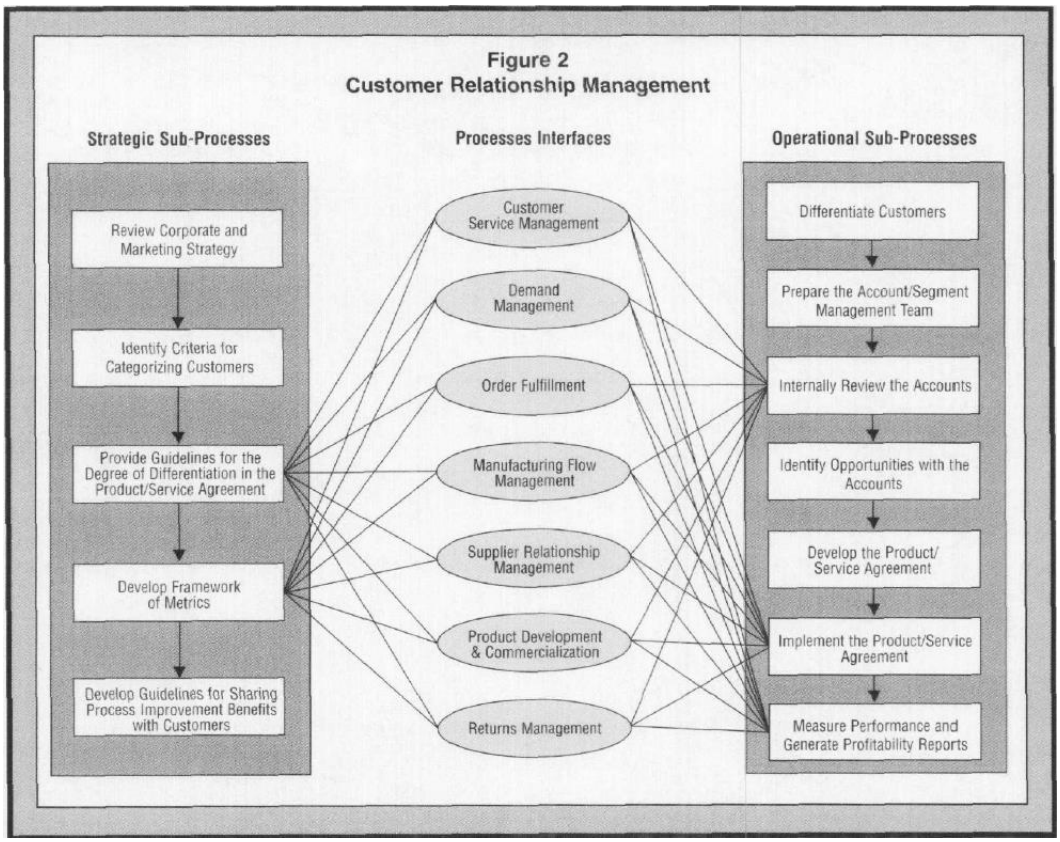


Figure 18. Customer Relationship Management Sub-Processes and the Processes Interfaces (Croxton et al., 2001, 15)

2.2.2 Customer Service Management

The customer service management process is the firm's face to the customer providing the customer information, such as product availability, shipping dates and order status – information which is provided to the customer through interfaces with the firm's functions, such as manufacturing and logistics (Croxton et al., 2001, 17).

The Figure 19 by Croxton et al. (2001, 17) illustrates the sub-processes as well as the process interfaces for customer service management.

The strategic sub-processes in customer service management include: 1. Develop Customer Service Strategy, 2. Develop Response Procedures. 3. Develop Infrastructure for Implementing Response Procedures, and 4. Develop Framework of Metrics.

The operational sub-processes include: 1. Recognize Event, 2. Evaluate Situation and Alternatives, 3. Implement Solution, and 4. Monitor and Report.
The customer service management process is responsible for responding to both internal and external events along the operational sub-processes (Croxton et al., 2001, 18).

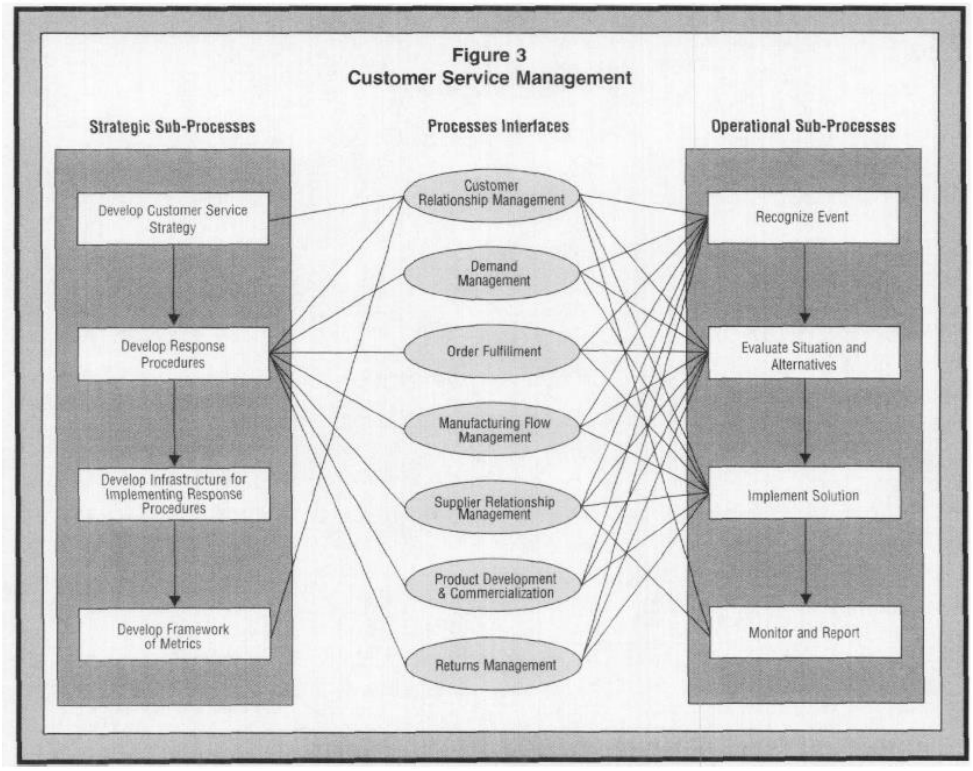


Figure 19 Customer Service Management Sub-Processes and the Processes Interfaces (Croxton et al., 2001, 17)

2.2.3 Demand Management

The demand management process balances the customers' requirements with the firm's supply capabilities including syncronizing the forecasting demand with production, procurement, and distribution (Croxton et al., 2001, 18). According to Burt et al. (2010, 530) “the demand management is used to estimate, control, smooth, coordinate, balance, and influence the demand and supply for a firm’s products and services in order to reduce total costs for the firm and its supply chain” and “the forecasts are developed at several points throughout the organization”. Forecast is an estimate or a calculated guess of future demand. The forecasts can be categorized in two: quantitative and qualitative. The quantitative (objective) methods use mathematical analysis of historical data like actual sales history data and time series data (trends, seasonality);

and the qualitative (subjective) methods use estimates from sources like market surveys, sales force estimations and expert opininons (Burt et al, 2010, 534 and Nahmias, 2001, 57-58).

Nahmias (2001, 57) has listed some characteristics of forecast as follows: 1. They are usually wrong – the planning system should be sufficiently robust to be able to react to unanticipated forecast errors, 2. A good forecast is more than a single number – a good forecast also includes some measure of the anticipated forecast error, 3. Aggregate forecasts are more accurate – the error made in forecasting sales for an entire product line is generally less than the error made in forecasting sales for an individual item, 4. The longer the forecast horizon, the less accurate the forecast will be, and 5. Forecasts should not be used to the exclusion of known information – there may be information available concerning the future demand that is not presented in the past history.

Croxton et al. (2001, 19) have listed the sub-processes as well as the process interfaces for demand management as can be seen on Figure 20.

The strategic sub-processes for demand management include: 1. Determine Forecasting Approaches, 2. Plan Information Flow, 3. Determine Synchronization Procedures, 4. Develop Contingency Management System, and 5. Develop Framework of Metrics.
The operational sub-processes include: 1. Collect Data/Information, 2. Forecast, 3. Synchronize, 4. Increase Flexibility and Reduce Variability, and 5. Measure Performance.

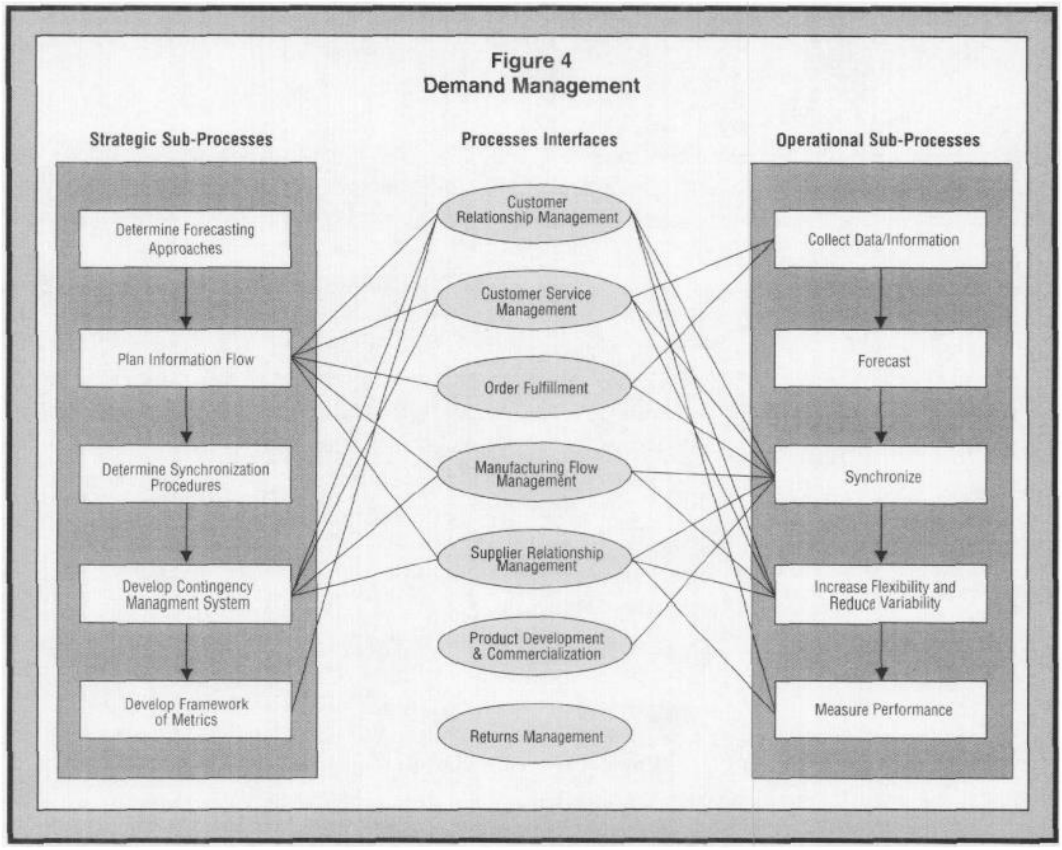


Figure 20. Demand Management Sub-Processes and the Processes Interfaces (Croxton et al., 2001, 19)

2.2.4 Order Fullfilment

Meeting the customer requirements in terms of effective order fulfillment requires integration of the firm's manufacturing, logistics and marketing plans and the partnerships with key members of the supply chain are necessary to meet customer requirements and reduce total delivered cost to customers (Croxton et al., 2001, 18).

Croxton et al. (2001, 21) have listed the sub-processes as well as the process interfaces for order fulfillment as can be seen on Figure 21.

The strategic sub-processes for order fulfillment include: 1. Review Marketing Strategy, Supply Chain Structure & Customer Service Goals, 2. Define Requirements for Order Fulfillment, 3. Evaluate Logistics Network, 4. Define Plan for Order Fulfillment, and 5. Develop Framework of Metrics.

The operational sub-processes include: 1. Generate & Communicate Order, 2. Enter Order, 3. Process Order, 4. Handle Documentation. 5. Pick Order, 6. Deliver Order, and 7. Perform Post Delivery Activities & Measure Performance.

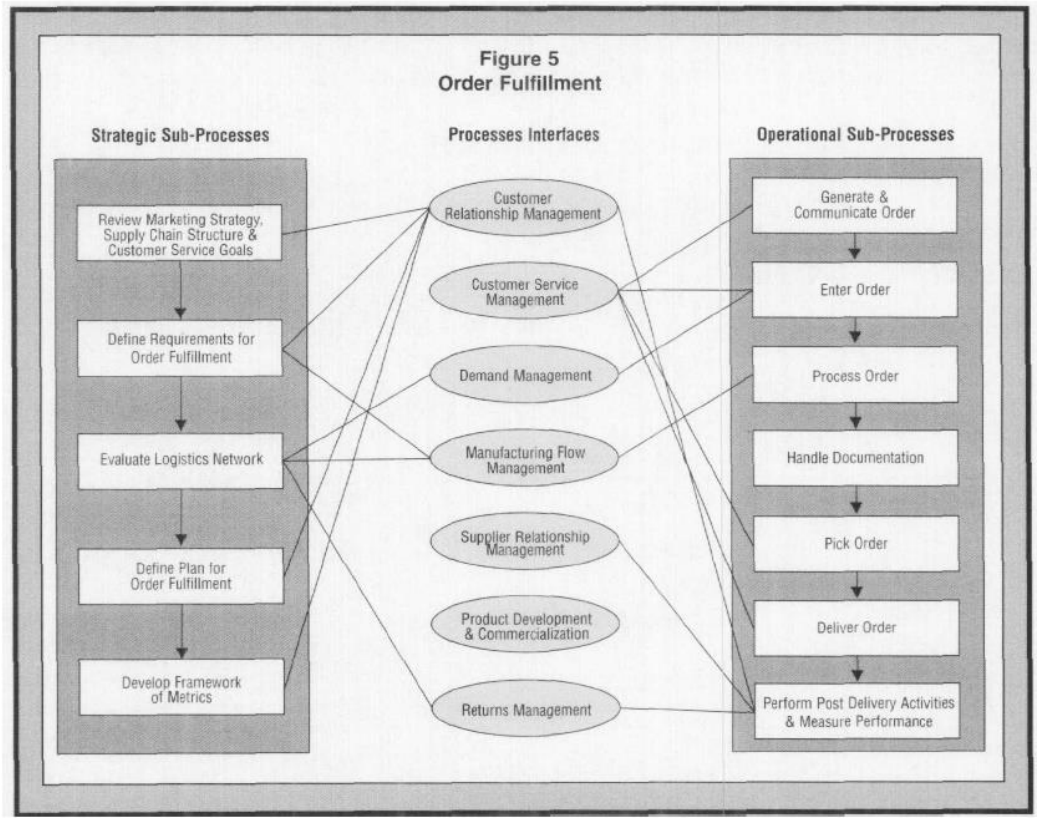


Figure 21. Order Fulfillment Sub-Processes and the Processes Interfaces (Croxton et al., 2001, 21)

2.2.5 Manufacturing Flow Management

According to Croxton et al. (2001, 22) “the manufacturing flow process deals with making the products and establishing the manufacturing flexibility needed to serve the target markets” and “the process includes all activities necessary for managing the product flow through the manufacturing facilities and for obtaining, implementing and managing flexibility”.

The sub-processes and the process interfaces for manufacturing flow management by Croxton et al. (2001, 22) have been illustrated on Figure 22.

The strategic sub-processes for manugacturing flow management include: 1. Review Manufacturing, Sourcing, Marketing & Logistics Strategies, 2. Determine Degree of Manufacturing Flexibility Requirement, 3. Determine Push/Pull Boundaries, 4. Identify Manufacturing Constraints and Requirements, 5. Determine Manufacturing Capabilities, and 6. Develop Framework of Metrics.

The operational sub-processes include: 1. Determine Routing & Velocity through Manufacturing, 2. Manufacturing & Material Planning, 3. Synchronize Capacity and Demand, and 4. Measure Performance.

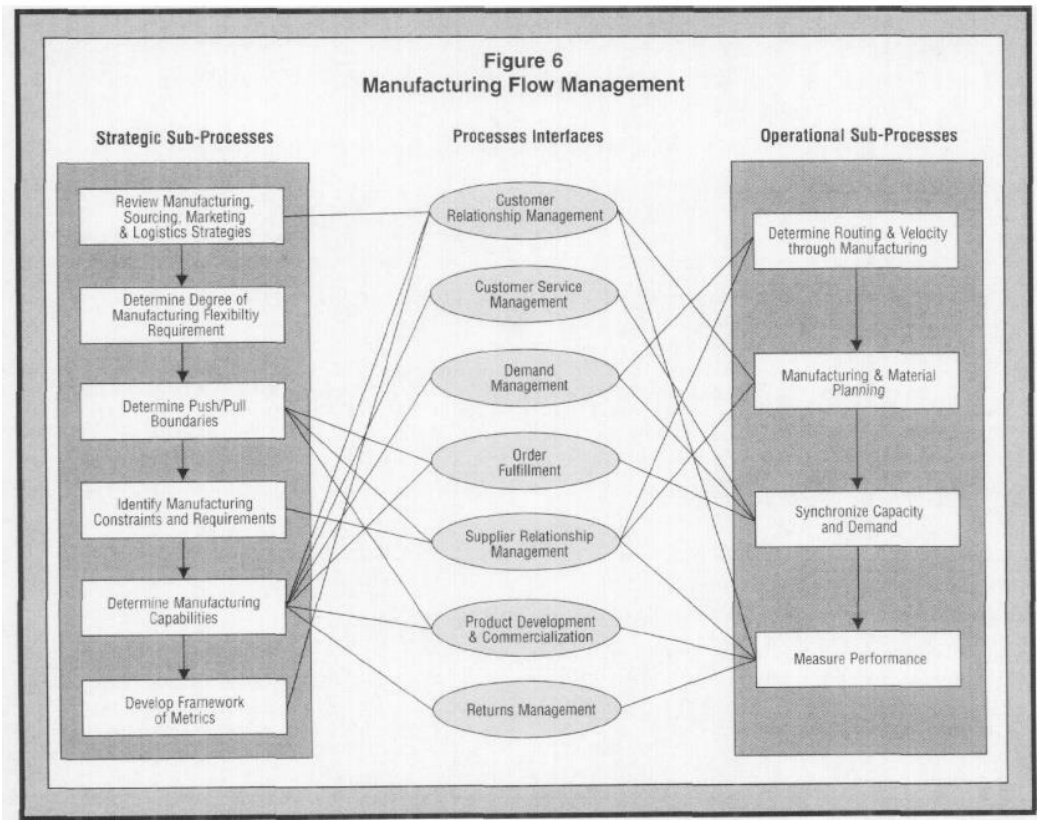


Figure 22. Manufacturing Flow Management Sub-Processes and the Processes Interfaces (Croxton et al., 2001, 22)

2.2.6 Supplier Relationship Management

The process of supplier relationship management defines company's interactions with its suppliers. Croxton et al. (2001, 24) state that "just as a company needs to develop relationships with its customers, it needs to foster relationships with its suppliers".

According to Burt et al. (2010, 261) "careful selection of suppliers and professional management of the relationships are essential as supplier performance has a significant impact on customer satisfaction".

The sub-processes and process interfaces for supplier relationship management can be seen on Figure 23 by Croxton et al. (2001, 25).

The strategic sub-processes for supplier relationship management include: 1. Review Corporate, Manufacturing and Sourcing Strategies, 2. Identify Criteria for Categorizing Suppliers, 3. Provide Guidelines for the Degree of Customization in the Product/Service Alignment, 4. Develop Framework of Metrics, and 5. Develop Guidelines for Sharing Process Improvement Benefits with Suppliers.

The operational sub-processes include: 1. Differentiate Suppliers, 2. Prepare the Supplier/Segment Management Team, 3. Internally Review the Supplier/Supplier Segment, 4. Identify Opportunities with the Suppliers, 5. Develop Product/Service Agreement and Communication Plan, 6. Implement the Product/Service Agreement, and 7. Measure Performance and Generate Supplier Cost/Profitability Reports.

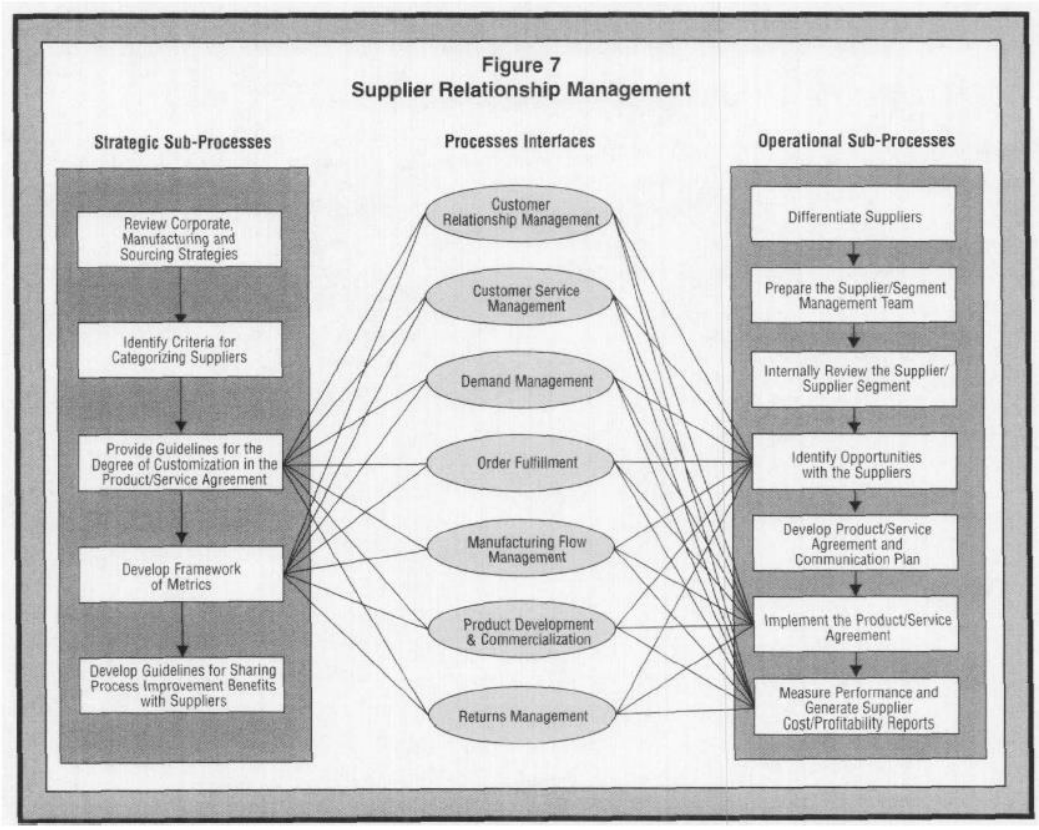


Figure 23. Supplier Relationship Management Sub-Processes and the Processes Interfaces (Croxton et al., 2001, 25)

2.2.7 Product Development and Commercialization

Product development is a critical function in the supply chain management processes and essential for continuing success of the firm. Croxton et al. (2001, 26) mention that “as product life cycles shorten, the right products must be developed and successfully launched in ever-shorter timeframes in order to remain competitive”.

According to Krajewski et al. (2010, 379) the “new service/product development process is an integral element in a firm’s supply chain because it defines the nature of the materials, services, and information flows the supply chain must support”.

The sub-processes and the process interfaces for product development and commercialization can be seen on Figure 24 by Croxton et al. (2001, 27).

The strategic sub-processes for product development and commercialization include: 1. Review Sourcing, Manufacturing & Marketing Strategies, 2. Develop Idea Generation and Screening Processes, 3. Establish Guidelines for Cross-functional Product Development Team Membership, 4. Develop Product Rollout Issues & Constraints, 5. Establish New Product Project Guidelines, and 6. Develop Framework of Metrics.

The operational sub-processes include: 1. Define New Products & Assess Fit, 2. Establish Cross-functional Product Development Team, 3. Formalize New Product Development Project, 4. Design & Build Prototypes, 5. Make/Buy Decision, 6. Determine Channels, 7. Product Rollout, and 8. Measure Process Performance.

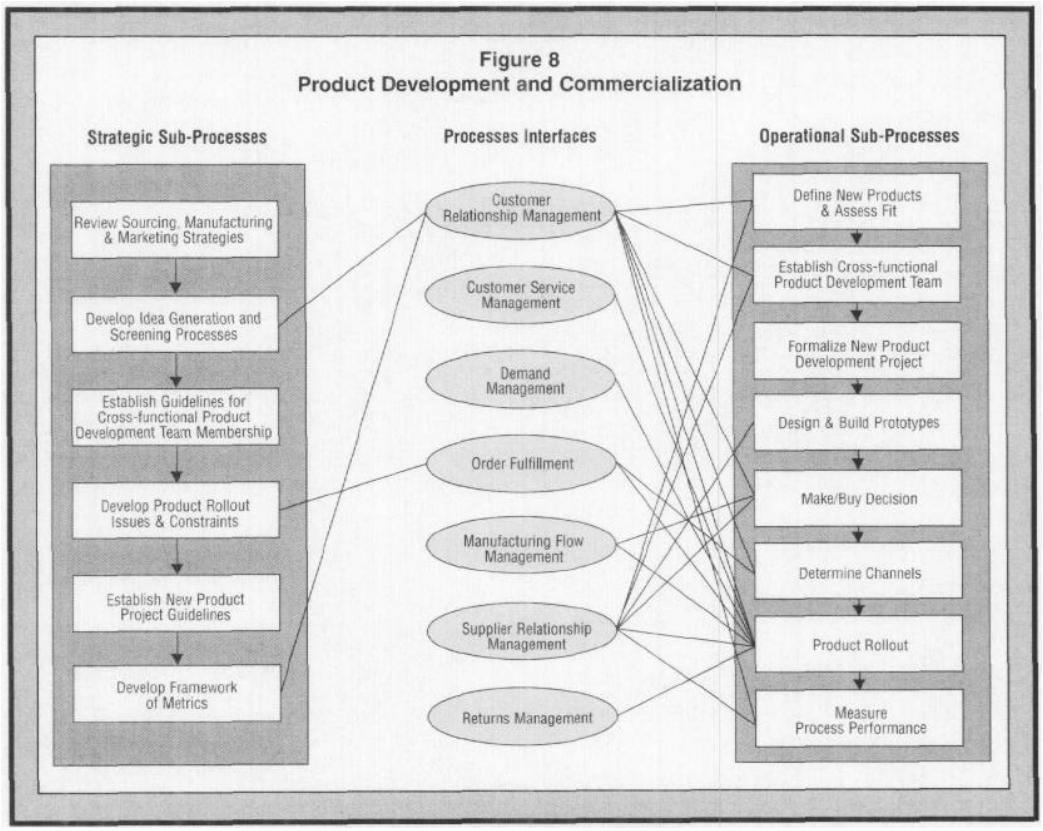


Figure 24. Product Development and Commercialization Sub-Processes and the Processes Interfaces (Croxton et al., 2001, 27)

2.2.8 Returns Management

Many firms neglect the critical process of returns management but according to Croxton et al. (2001, 28) this process can assist the firm in achieving a sustainable competitive advantage by stating: “effective management of the returns process enables the firm to identify productivity improvement opportunities and breakthrough projects”.

Croxton et al. (2001, 30) have listed the sub-processes and the process interfaces for returns management on Figure 25.

The strategic sub-processes for returns management include: 1. Review Environmental & Legal Compliance Guidelines, 2. Develop Avoidance, Gatekeeping & Disposition Guidelines, 3. Develop Return Network & Flow Options, 4. Develop Credit Rules, 5. Determine Secondary Markets, and 6. Develop Framework of Metrics.

The operational sub-processes include: 1. Receive Return Request, 2. Determine Routing, 3. Receive Returns, 4. Select Disposition, 5. Credit Consumer/Supplier, and 6. Analyze Returns and Measure Performance.

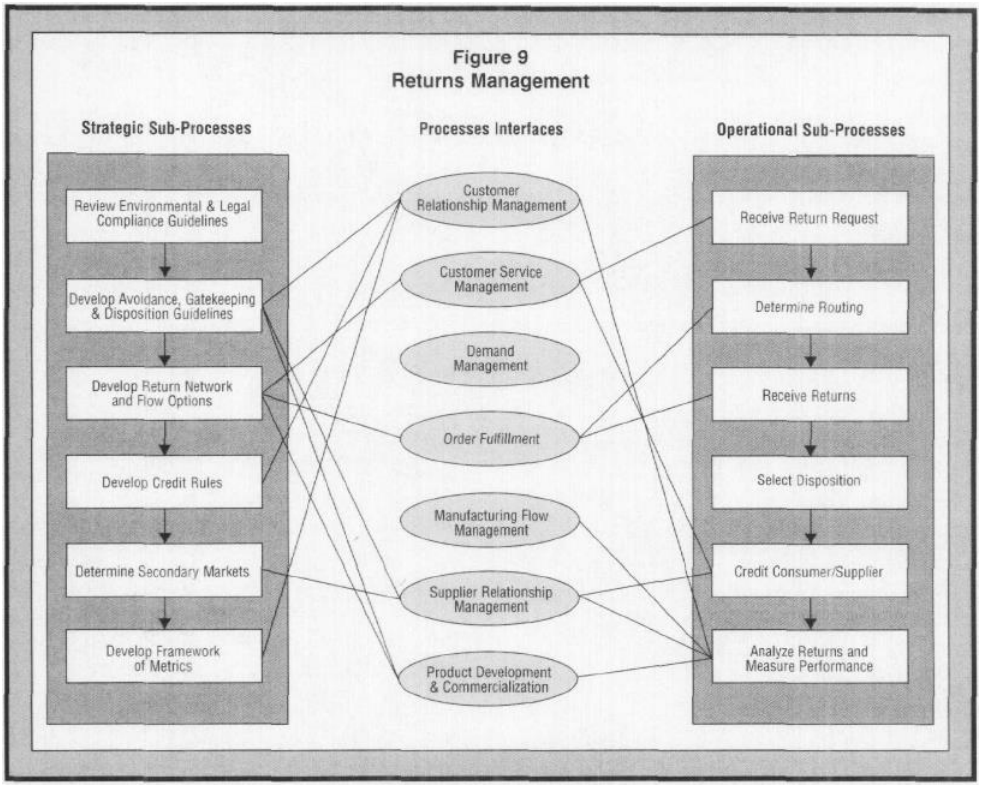


Figure 25. Returns Management Sub-Processes and the Processes Interfaces (Croxton et al., 2001, 30)

2.2.9 Successful Supply Chain Development

As Christopher (2011, 199) writes in his book, improving or developing the supply chain is all about simplification, improving process reliability, reducing process variability and reducing complexity. The business has also been traditionally organized around functions; in today's turbulent business environment it is now suggested that the emphasis in organisations should be upon the key business processes that create value to customers.

Schary and Skjott-Larsen (2003, 56-57) write that specialized activities that define a system of a product flow should only be included within the supply chain if they add value to the final product and that their specific function should not be duplicated within the supply chain.

According to Stevenson (2005; 704) creating an effective supply chain requires linking the market, distribution channels, processing and suppliers and it should enable the participants to (1) share forecasts, (2) determine the status of orders in real time, and (3) access inventory data of partners.

Also according to Stevenson (2005, 705), the successful supply chain management requires trust among trading partners, effective communication, supply chain visibility, event management capability in terms of ability to detect and respond to unplanned events and performance metrics.

Psomas et al. list in their article proposed steps to successfully apply process management following the ISO 9001 requirements:

1) identify macro-processes, their mutual relations, inputs, outputs, constraints and necessary resources;
2) specify, progressively, the single macro-processes to the activity level;
3) build complete flow charts for priority activities and successively for all activities;
4) define the gaps between the activities, the fixed targets and the norm and, if necessary, re-think (re-engineer) the activity;
5) check the effectiveness of the activities and of the process that subsumes them;
6) draft a document that describes the activity (instruction) or the process (procedure); and

7) document the quality management system globally, from process map to policies, to choices and activities (manual, procedures, instructions, indicators, plans, etc.).

(Psomas et al., 2011, 442)

2.3 Supply Chain Performance Measurement

Performance measurement is defined as “a metric to quantify the efficiency and effectiveness of operations” and most organizations tend to measure based on “hard” rather on “soft” data, ignoring non-financial measures such as quality, market share, customer satisfaction, human resources, innovation and learning (Suni et al. 2007, 53).

Supply Chain Performance Measures (SCPM) serve as an indicator of how well the SC system is functioning (Kazemkhanlou et al., 2014, 273). Kazemkhanlou et al. (2014, 282) also conclude in their article that “performance measurement is a power tool that assists firms or organizations to evaluate resource utilization so that they can strategically manage and continuously control to achieve their objectives and goals”.

According to Elrod et al. (2013, 40) “supply chain measurements are one key aspect of continuous improvement that has the potential to identify opportunities to cut costs, lean processes, and improve overall business functions”.

Performance Measurement System (PMS) can be defined as “a balanced and dynamic system that enables support of decision-making processes by gathering, elaborating and analyzing information” and the SCPMS is also defined as “the reporting process that gives feedback to employees on the outcome of actions” as well as “a set of metrics used to quantify the efficiency and effectiveness of action” (Kazemkhanlou et al., 2014, 274).

By selecting the right measurements the organization can:

- check its position, that it knows where it is and where it is going;
- communicate its position according to two perspectives, internal, i.e. organisation internally communicates in order to thank or spur individuals and teams, and external, organisation externally communicates in order to cope with legal requirements or market’s needs;
- confirm priorities, since by measuring it can identify how far it is from its goal; and

> • compel progress, that means it can use measurement as means of motivation and communicating priorities, and as a basis for reward.
>
> (Carlucci 2010, 67)

Desirable characteristics of SCPMS include the following:

> • Inclusiveness (measurement of all pertinent aspects)
> • Universality (allow for comparison under various operating conditions)
> • Measurability (data required are measurable) and
> • Consistency (measures consistent with organization goals)
>
> (Kazemkhanlou et al., 2014, 274)

A longer list is provided in the article mentioning that a firm's performance measures should:

> • Be simple and easy to use.
> • Have a clear purpose.
> • Provide fast feedback.
> • Relate to performance improvement, not just monitoring.
> • Reinforce the firm's strategy.
> • Relate to both long-term and short-term objectives of the organization.
> • Match the firm's organization culture.
> • Not conflict with one another.
> • Be integrated both horizontally and vertically in the corporate structure.
> • Be consistent with the firm's existing recognition and reward system.
> • Focus on what is important to customers.
> • Focus on what the competition is doing.
> • Lead to identification and elimination of waste.
> • Help accelerate organizational learning.
> • Evaluate groups not individuals for performance to schedule.
> • Establish specific numeric standards for most goals.
> • It must reflect relevant non-financial information based on key success factors of each business.
> • It must make a link to reward systems
> • The financial and non-financial measures must be aligned and fit within a strategic framework.
> • Minimum deviations should exist between the organizational goals and measurement goals
>
> (Kazemkhanlou et al., 2014, 274)

Performance measurement has roots in early accounting systems and it has evolved in two phases; the first phase was in the late 1880s and the second phase in the late 1980s (Kurien et al., 2011, 21). The growth of global business activities in the late 1980s changed the measurement from traditionally financially based, internally focused, backward looking and locally focused to a broader view of performance meas-

urement with the alignment of financial and non-financial measures (Kurien et al., 2011, 21). The structural evolution of business organizations along with globalization, automation processes and e-commerce also affected the development of better integrated performance measurement systems.

The evolution of performance measurement systems in an organizational context can be seen in the following image (Figure 26):

Table 1. Evolution of PMS in an organizational context (Gomes et al., 2004 and Morgan, 2007)

Period	Characteristics of business organisation	Characteristics of PMS
Before 1980	Systematic large organizations	(i). Cost Accounting orientation. (ii).Retroactive approach and results used to promote organizational efficiency, facilitate budgeting and attract capital from external entities (iii).Performance measurement dominated by transaction costs and profit determination
1980 - 1990	Business organizations became global	(i). Cost Accounting orientation (ii).Retroactive approach and results used to promote organizational efficiency. (iii).Enhanced to include operations and value adding perspectives.
1990 – 2000	Automation of business processes	(i).A mixed financial and non financial orientation. (ii).A mixed retroactive and proactive approach. (iii).Results are used to manage the entire organization. (iv).PMS enhanced to include process, quality & customer focus
2000 - 2010	e-Commerce and borderless business activities	(i).A balanced and integrated orientation. (ii).A more proactive approach. (iii).Results are used to enhance organizational responsiveness. (iv).Performance measurement enhanced to give a balanced view of the organization and included the SC & inter-process activities.

Figure 26. The evolution of performance measurement systems in an organizational context (Kurien et al., 2011, 21)

The main goal of SCPM models and frameworks is to support management by measuring business performance as well as analyzing and improving business operational efficiency (Kurien et al., 2011, 20) but with the little guidance available in the literature for the actual selection and implementation of Supply Chain Performance Measurement System the process of choosing appropriate performance measures is difficult (Kurien et al., 2011, 19). The hundreds of performance measures available for and used by different organizations in different industries can be broadly categorized into quality, financial, time, product flexibility, overall performance, and innovation (Elrod et al., 2013, 39). Examples provided by Elrod et al. (2013, 41) for cost measures are: Financial, Distribution, Information Processing, Inventory, Total, Manufacturing, Inventory Obsolence, Finished Goods Inventory, ROI, Warehouse, Incentive and Intangible Costs. The examples for quality measures are: Perceived Value of the Product, Buyer-Supplier Relationship, Shipment Errors, Accuracy, and Number of Faulty Notes Invoiced (Elrod et al., 2013, 44). Examples provided for time measures are: Order Lead

Time, Customer Order Path, Effectiveness of Scheduling the Techniques, Product Development Cycle Time, Product Lateness Time, Average Lateness Time, Average Earliness Time, and Manufacturing Lead Time (Elrod et al., 2013, 45). Flexibility measures listed by Elrod et al. (2013, 46) include: Range of Products and Services, Capazity Utilization, Volume Flexibility, Plant Volume Flexibility, Delivery Flexibility, Labor Flexibility, Modification Flexibility, and Expansion Flexibility.

Kazemkhanlou et al. (2014, 278-281) present 16 well-known supply chain performance measurement models and their particularities:

1 ABC: Activity-Based Costing
It has been created in the1980s. It aims to analyze costs and margin, but goes beyond the simple calculation of return costs. It necessitates a deep knowledge of the company. It groups activities by their process logic and interweaves accounting data into this concept.
2 FLR: Framework for Logistics Research
It has been developed in the 1990s. It describes dependency between the level of performance achieved, logistics organization and competitive strategy. It can be applied at organizational and strategic level. It structures logistics function into several dimensions (centralization, formalization, integration and areas of control).
3 BSC: Balanced Score Card
It has been developed in the 1990s. It seeks balanced measures to buttress company strategy. This principle proposes four analytical axes: customers, finance, internal processes and innovation-growth and it incorporates a human dimension for the performance measurement. It is specifically geared towards general management and can be applied from the strategic through the organizational level. It aims to establish causalities between the performance of each analytical axis.
4 SCOR: Supply Chain Operation Reference model
It has been developed in 1996 by the Supply Chain Council (SCC).It aims to analyse four dimensions: reliability of commercial performance, flexibility/ responsiveness, cost of supply chain and turnover of committed capital. It can be applied to all industrial and service sector companies, at tactical and operational level for an implementation of decisions relating to the company's strategic planning. Its indicators' definitions are explained using calculation modes and giving association of indicators for each process.
5 GSCF framework
It has been created by Ohio State University in 1994. It describes three levels (strategic, tactical and operational) and highlights links between supply chain process and structure. It focuses on seven processes: customer relationship management, customer service management, demand management, order fulfillment, manufacturing flow management, supplier relationship management, product development and commercialization, and returns management
6 ASLOG audit
It has been created in1997 by ASLOG, based on models used in the automobile sector. It assesses logistics procedures by analyzing strengths and weaknesses. It is a transversal tool, which aims to implement good practice

dedicated to companies with low or medium levels of maturity. It analyses the following areas: management, strategy and planning, design and projects, sourcing, production, transportation, stocks, sales, returns and after sales, piloting and permanent progress indicator.

7 SASC: Strategic Audit Supply Chain

It has been developed in 1999. It analyzes supply chain in terms of processes, information technologies and organization at an organizational level. Its principle is to break logistics chain down into six competencies: customer orientation, distribution, sales planning, lean production, supplier partnerships and integrated management of chain and to link competencies to information technology and organization of chain.

8 Global EVALOG (Global MMOG/LE)

It has been created in 1999 with Odette International Limited and Automobile Industry Action Group. It assesses partner site processes and performance, pursues continuous improvement approach. Although it has been developed for an automobile industry, it can be used for associated sectors (metal works, chemicals). It is structured in to six areas: strategy and improvement, work organization, production planning, customer interface, process control and supplier interface.

9 WCL: World Class Logistics model

It has been developed by Michigan State University in the 1990s. It evaluates the company's performance in terms of its ability to account for inter organizational relationships through a model comprised of 68 questions.

It can be applied at strategic and organizational level. It revolves around four areas of competency: positioning, integration, agility and performance measurement.

10 AFNOR FDX50-605

It has been developed in 2008.It offers general framework for strategic reflection and defines different logistics processes. It identifies performance levers associated with each process. Its model features six area: identification of needs and setting of objectives, logistics system design and development, production, sales and distribution, logistics support and control over global logistics process.

11 SCM/SME

It has been developed in 2007 within an SME context. It is composed by a questionnaire featuring 25 modules: corporate strategy, organization and logistic competencies development, performance processes and measurements, information system. Its targets are mainly industrial SMEs in fast moving consumer goods sector. It is structured around demand management, distribution, import/export flows, stocks, production, sourcing, returns, after sales support and traceability.

12 APICS: Association for Operations Management

It has been developed by professional association APICS in 2000. It analyzes innovation and customer service management, efficiency drivers, agility, risk control and sustainability. It mainly applies to industrial firms. Its processes are structured via model that is mainly geared towards production planning.

13 ECR: Efficient Customer Response

It has been created in 1994 by an ECR Association of manufacturers and retailers. It evaluates good interorganizational practices and uses maturity based evaluation tool: global mapping. It focuses on collaboration between industrialists and distributors in fast moving consumer goods sector. It establishes common language based on joint evaluation of performance by act or sin the chain. It is based on 45 criteria structured into four areas:

consumer demand management, supply chain management, technological platforms and integration.

14 EFQM: Excellence model

It has been in traduced in 1992. It starts by a questionnaire with 50 questions; respondents positioned along the scale of excellence. It covers areas relating to process efficiency, continuous improvement in products and services, personnel management and progression. It is suitable for all types of companies. It is based on eight principles: customer focus, leadership, definition of objectives, process-based management, staff involvement, continuous innovation process, development of partnerships and civic responsibility.

15 SCALE: Supply Chain Advisor Level Evaluation

It has been created in the early 2000s by the Institute for Supply Chain Excellence (ISLI) for all sectors of activity. It revolves around questionnaire that assesses strategic and tactical dimensions, elements of value creation. It is based on 58 processes classified into seven categories of activities: definition of strategic objectives, establishment of procedures, needs planning, coordination of phases, performance evaluation and monitoring and supply chain optimization.

16 SPM: Strategic Profit Model

It has been created in 2002, derived from the DuPont model. It displays existing interactions between strategic and operational levels by means of financial ratios. It proposes strategic and financial implementation based on cost drivers using returns on asset or returns on net value measurements.

The well known models SCOR and Balanced Scorecard as well as benchmarking will be discussed in the following text.

2.3.1 SCOR – The Supply Chain Operations Reference

According to Supply Chain Council (2012) the Supply Chain Operations Reference model (SCOR®) was established for evaluating and comparing supply chain activities and performance and it provides “a unique framework that links business process, metrics, best practices and technology into a unified structure to support communication among supply chain partners and to improve the effectiveness of supply chain management and related supply chain improvement activities” (Supply Chain Council/SCC, 2012, i1). The 976 pages SCOR document of the Supply Chain Council (SCC) describes the business activities associated with all phases of satisfying a customer's demand. The SCOR model has several sections and six primary management processes of Plan, Source, Make, Deliver, Return and Enable as seen on the following image (Figure 27):

Figure 27. SCOR is organized around six major management processes (Supply Chain Council/SCC, 2012, i.2)

These process building blocks can be used in describing the supply chains that are very simple or very complex using a common set of definitions and according to the SCC (2012, i.2) the model spans “all customer interactions (order entry through paid invoice), all physical material transactions (supplier's supplier to customer's customer, including equipment, supplies, spare parts, bulk product, software, etc.) and all market interactions (from the understanding of aggregate demand to the fulfillment of each order)”. However, “the model does not address: sales and marketing (demand generation), product development, research and development, and some elements of post-delivery customer support”.

The SCOR model is focused on the top three industry neutral process levels and the organization that implement supply chain improvements with the SCOR model has to extend the model, at least to Level-4 (industry-, organization- and/or location-specific processes, systems, and practices) (SCC, 2012, i.2). The illustration of the SCOR as a hierarchical process model can be seen in the following image (Figure 28):

	Level		Examples	Comments
	#	Description		
Within scope of SCOR	1 	Process Types (Scope)	Plan, Source, Make, Deliver, Return and Enable	Level-1 defines scope and content of a supply chain. At level-1 the basis-of-competition performance targets for a supply chain are set.
	2 	Process Categories (Configuration)	Make-to-Stock, Make-to-Order, Engineer-to-Order Defective Products, MRO Products, Excess Products	Level-2 defines the operations strategy. At level-2 the process capabilities for a supply chain are set. (Make-to-Stock, Make-to-Order)
	3 	Process Elements (Steps)	• Schedule Deliveries • Receive Product • Verify Product • Transfer Product • Authorize Payment	Level-3 defines the configuration of individual processes. At level-3 the ability to execute is set. At level-3 the focus is on the right: • Processes • Inputs and Outputs • Process performance • Practices • Technology capabilities • Skills of staff
Not in scope	4 	Activities (Implementation)	Industry-, company-, location- and/or technology specific steps	Level-4 describes the activities performed within the supply chain. Companies implement industry-, company-, and/or location-specific processes and practices to achieve required performance

Figure 28. SCOR is a hierarchical process model (SCC, 2012, i.3)

The SCOR reference model consists of 4 major sections:

> • Performance: Standard metrics to describe process performance and define strategic goals
> • Processes: Standard descriptions of management processes and process relationships
> • Practices: Management practices that produce significant better process performance
> • People: Standard definitions for skills required to perform supply chain processes.
>
> (SCC, 2012, i.3)

The first SCOR section of Performance/Metrics focuses on Performance Attributes and Metrics. SCOR recognizes 5 performance attributes:

> **Reliability**
> The Reliability attribute addresses the ability to perform tasks as required. Reliability focuses on the predictability of the outcome of a process. Typical metrics for the reliability attribute include: On-time, the right quantity, the right quality. The SCOR key performance indicator (level-1 metric) is Perfect Order Fulfillment. Reliability is a customer focused attribute.
> **Responsiveness**
> The Responsiveness attribute describes the speed at which tasks are performed. Responsiveness addresses repeated speed of doing business. Example Responsiveness metrics are cycle time metrics. The SCOR key performance indicator for Responsiveness is Order Fulfillment Cycle Time.
> Responsiveness is a customer focused attribute.
> **Agility**
> The Agility attribute describes the ability to respond to external influences; the ability to and speed of change. External influences include: Non-forecastable increases or decreases in demand, suppliers or partners going out of business, natural disasters, acts of (cyber) terrorism, availability of financial resources (the economy), labor issues. The SCOR key performance indicators include Flexibility, Adaptability and Value-at-Risk. Agility is a customer focused attribute.
> **Cost**
> The Cost attribute describes the cost of operating the process. Typical costs include labor cost, material cost, transportation cost. The SCOR key performance indicators for Cost is Total Cost to Serve. Cost is an internal focused attribute.
> **Assets**
> The Asset Management Efficiency ('Assets') attribute describes the ability to efficiently utilize assets. Asset management strategies in supply chain include inventory reduction and in-source vs. outsource. Example metrics include: Inventory days of supply, capacity utilization. The SCOR key performance indicators include: Cash-to-Cash Cycle Time, Return on Fixed Assets. Asset Management Efficiency is an internal focused attribute.
>
> (SCC, 2012, 1.0.1)

There are three levels of metrics in SCOR model:

> • Level-1 metrics are diagnostics for the overall health of the supply chain. These metrics are also known as strategic metrics and key performance indicators (KPI). ***Benchmarking level-1 metrics helps establishing realistic targets to support the strategic directions***.
> • Level-2 metrics serve as diagnostics for the level-1 metrics. The diagnostic relationship helps to identify the root cause or causes of a performance gap for a level-1 metric.
> • Level-3 metrics serve as diagnostics for level-2 metrics.
>
> (SCC, 2012, 1.0.2)

The level 1 metrics for the performance attributes as follows (Figure 29):

Attribute	Level-1 Metric
Reliability	Perfect Order Fulfillment
Responsiveness	Order Fulfillment Cycle Time
Agility	Upside Flexibility
	Upside Adaptability
	Downside Adaptability
	Overall Value-at-Risk
Cost	Total Cost to Serve
Asset Management Efficiency	Cash-to-Cash Cycle Time
	Return on Fixed Assets
	Return on Working Capital

Figure 29. The 10 strategic level-1 metrics (SCC, 2012, 1.0.2)

Each level-1 metric expand to level-2 and level-3. In all, there are over 200 level-1 metrics, as well as more focused metrics to improve specific processes (level-2 and level-3 metrics).

In the second SCOR section of Processes the six major processes (level-1 processes) are each explained in detail, the main objectives of the processes are as follows:

Plan
The Plan processes describe the activities associated with developing plans to operate the supply chain. The Plan processes include the gathering of requirements, gathering of information on available resources, balancing requirements and resources to determine planned capabilities and gaps in demand or resources and identify actions to correct these gaps.

Source
The Source processes describe the ordering (or scheduling of deliveries) and receipt of goods and services. The Source process embodies the issuance of purchase orders or scheduling deliveries, receiving, validation and storage of goods and accepting the invoice from the supplier.

Make
The Make processes describe the activities associated with the conversion of materials or creation of the content for services. Conversion of materials is used rather than ‘production’ or ‘manufacturing’ as Make represents all types of material conversions: Assembly, Chemical processing, Maintenance, Repair, Overhaul, Recycling, Refurbishment, Remanufacturing and other common names for material conversion processes. As a general guideline: These processes are recognized by the fact that 1 or more item numbers go in and 1 or more different item numbers come out of this process.

Deliver
The Deliver processes describe the activities associated with the creation, maintenance and fulfillment of customer orders. The Deliver process embodies the receipt, validation and creation of customer orders, scheduling order delivery, pick, pack and shipment and invoicing the customer.

Return
The Return processes describe the activities associated with the reverse flow of goods. The Return process embodies the identification of the need to return, the disposition decision making, the scheduling of the return and the shipment and receipt of the returned goods. Repair, recycling, refurbishment and remanufacturing processes are not described using Return process elements.

Enable
The Enable processes describe the associated with the management of the supply chain. Enable processes include management of business rules, performance management, data management, resource management, facilities management, contract management, supply chain network management, managing regulatory compliance and risk management.

(SCC, 2012, 2.0.1-2)

In the third SCOR section of Practices the SCC has listed the best practices based on input from practitioners and experts from a diverse range of industries. According to SCC the "practices listed in SCOR are for identification purposes only. Further research and analysis is generally required to fully understand how to implement a practice" (SCC, 2012, 3.0.2). The classification categories for the SCOR practices are listed as follows (Figure 30):

Categories	
Business Process Analysis/Improvement	Planning and Forecasting
Customer Support	Product Lifecycle Management
Distribution Management	Production Execution
Information/Data Management	Purchasing/Procurement
Inventory Management	Reverse Logistics
Material Handling	Risk/Security Management
New Product Introduction	Sustainable Supply Chain Management
Order Engineering (ETO)	Transportation Management
Order Management	Warehousing
People Management (Training)	

Figure 30. The classification categories for the SCOR practices (SCC, 2012, 3.0.2)

Close to 200 best practices have been listed under the main categories.

In the fourth SCOR section of People the standards for managing talent in the supply chain are introduced. The key elements of the People section are Skills, Experiences, Aptitudes and Trainings:

> **Skill**
> Skill is the capacity to deliver pre-determined results with minimal input of time and energy. Skills are further defined by Experiences, Aptitudes, Trainings and Competency levels. Examples of supply chain skills include: Master Scheduling, Import/Export Regulations, Production Planning, and Risk Mitigation.
> **Experience**
> Experience is the knowledge or ability acquired by observation or active participation. Experience is obtained by doing the work in a real life environment and undergoing different situations that require different actions. Example experiences include: Cycle Counting, Cross Docking, and Hazardous Materials Handling.
> **Aptitude**
> Aptitude is a natural, acquired, learned or developed ability to perform a certain kind of work at a certain level. Example aptitudes include: Accuracy, Analytical, and Natural leadership.
> **Training**
> Training develops a skill or type of behavior through instruction. Examples of training includes formal trainings such as SCOR-S certification, but also includes courses and on-the-job training.
>
> (SCC, 2012, 4.0.1)

The total of 161 skills have been listed along with the Processes, Experiences, Aptitudes, Trainings and Practices for each of them.

An example of the standards for Customer Order Management as follows (Figure 31):

HS.0028	Customer Order Management

The process or the work flow associated with the identification, receipt, acceptance, picking, packing, delivery and of the packed item(s) to a shipping carrier.

Processes	
sD1.2	Receive, Enter, and Validate Order
sD1.11	Load Vehicle and Generate Shipping Documents
sD2.2	Receive, Configure, Enter and Validate Order
sD2.11	Load Product & Generate Shipping Docs
sD3.11	Load Product & Generate Shipping Docs
Experiences	
HE.0031	Company terms and conditions
HE.0053	CRM Methods and Tools
HE.0078	Electronic Data Interchange (EDI) Systems
HE.0131	Inventory Management
Aptitudes	
HA.0002	Accurate
HA.0008	Business minded
HA.0014	Computer Literate
HA.0019	Customer Oriented
HA.0026	Diversity Recogntion/Respect
HA.0072	Written/Verbal Communication
Trainings	
HT.0006	APICS CPIM
HT.0046	Engineering
HT.0080	ISO Certification
Practices	
BP.090	Days of Supply Based MRP Proposal Management
BP.168	Rotable Spares Pool

Figure 31. The Customer Order Management standards (SCC, 2012, 4.1.32)

The fifth section of GreenSCOR is proposing a set of strategic environmental metrics that can be added to the SCOR Model (Figure 32):

Metric	Units	Basis
Carbon Emissions	Tons CO2 Equivalent	This is the unit of measure currently used for green house gas emissions and is a measure of the climate impact from CO2 and other global warming air emissions.
Air Pollutant Emissions	Tons or kg	This would include emissions of major air pollutants (COx, NOx, SOx, Volatile Organic Compounds (VOC) and Particulate). These are the major emissions that U.S. EPA tracks.
Liquid Waste Generated	Tons or kg	This includes liquid waste that is either disposed of or released to open water or sewer systems (these emissions are generally listed on water emissions permits).
Solid Waste Generated	Tons or kg	The total solid waste generated by the process.
% Recycled waste	Per cent	The per cent of the solid waste that is recycled.

Figure 32. GreenSCOR metrics (SCC, 2012, 5.1.1)

The GreenSCOR include 33 metrics under the five main categories.

Lambert et al. (2005, 38) mention that the weakness of the SCOR-model is the fact that it focuses on activities in the purchasing, logistics, and manufacturing functional areas leaving the management attempting to manage the supply chain without input from marketing, finance, and research and development. The perceived strength is the benchmarking tools offered (Lambert et al., 2005, 39). It is highlighted that the SCOR best-practice analysis focuses on process benchmarking rather than performance benchmarking (Lambert et al., 2005, 39). Further, the SCOR has been recognized as "a useful tool for identifying areas of improvement to achieve quick pay-back opportunities and satisfy top-management's desire for cost reductions and asset efficiency" (Lambert et al., 2005, 40).

2.3.2 BSC - The Balanced Scorecard

The BSC was first created by Robert S. Kaplan and David P. Norton in 1992 and they describe the measures as follows:

> The balanced scorecard includes financial measures that tell the results of actions already taken. And it complements the financial measures with operational measures on customer satisfaction, internal processes, and the organization's innovation and improvement activities -- operational measures that are the drivers of future financial performance.
>
> (Kaplan et al., 1992, 71)

According to Kurien et al. (2011, 24) “BSC proposes that a company should use a balanced set of measures that allows top managers to take a quick but comprehensive view of the business from four important perspectives” The four perspectives answer the following questions:

> (i). How do we look to our shareholders (financial perspective)? (ii).
> What must we excel at (internal business perspective)? (iii). How do our customers see us (the customer perspective)? (iv). How
> can we continue to improve and create value (innovation and learning perspective)?
>
> Kurien et al., 2011, 25

Elrod et al. (2013, 40) state that the measures – financial, internal process, customers and innovation – are used to define the implementation of the company’s strategy.

Kaplan et al. (1992, 72-73) claim that the BSC minimizes the information overload by limiting the number of measures used and that “the balanced scorecard forces managers to focus on the handful of measures that are most crucial”. Kurien et al. (2011, 25) however list the following critics to the BSC framework: it is “primarily designed to provide senior managers with an overall view of performance” and “not intended for the factory operations level”, it is “constructed as a monitoring and controlling tool rather than improvement tool”, it “provides little guidance on how the appropriate measures can be identified, introduced and ultimately used to manage business”, it “does not consider the competitor perspective at all” making it “difficult to make comparisons within and across firms using BSC”, and it “is more like a strategic managment tool, rather than a true complete PMS”. Perkins et al. (2014, 151) state in their article that “It is surprising that considering the large body of literature regarding the BSC, there is

relatively little evidence showing whether an implementation of the BSC leads to an increase in performance".

The BSC tool illustrated as follows (Figure 33):

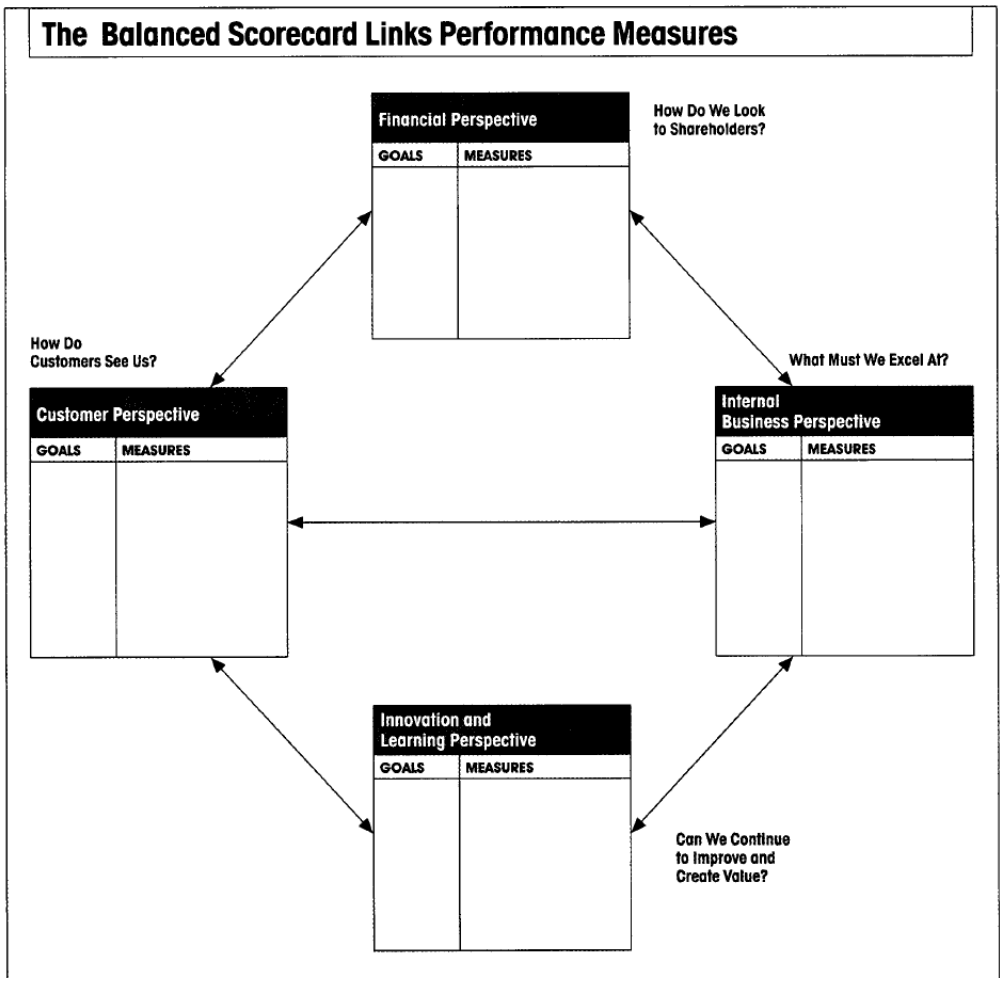


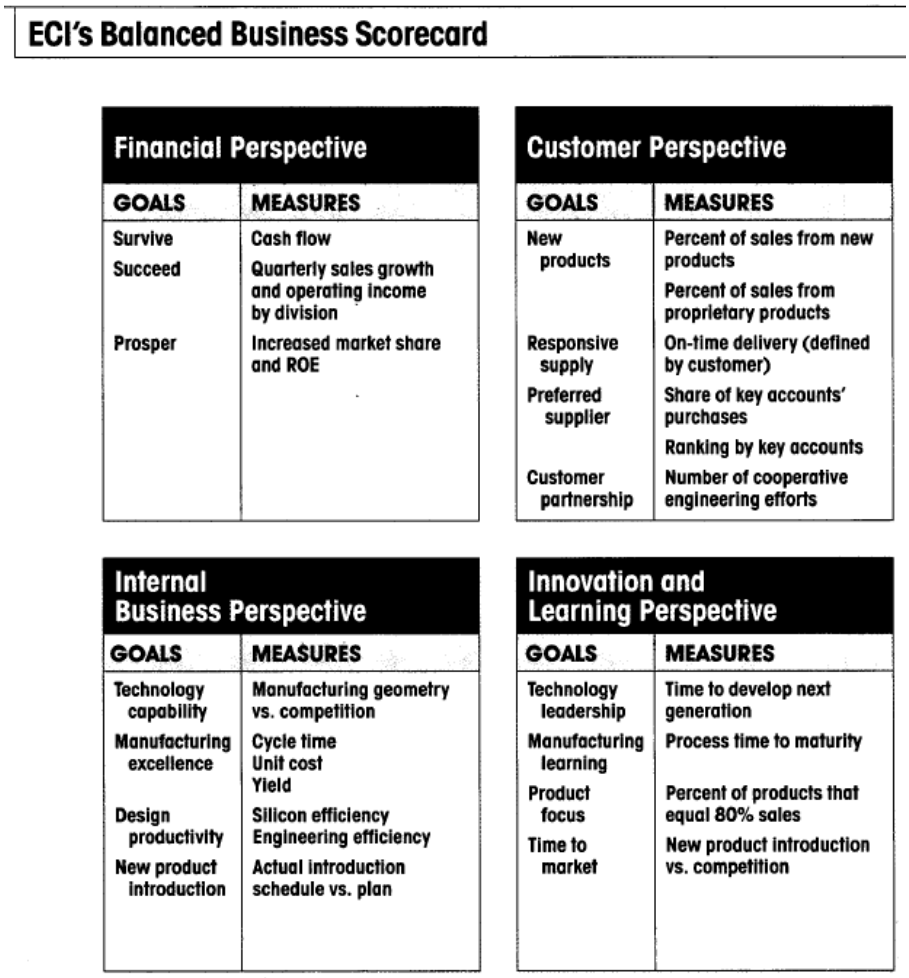
Figure 33. Balanced Score Card Links Performance Measures
(Kaplan et al., 1992, 72)

The customer perspective mentions four categories for measurement: time, quality, performance and service including measures such as lead-time, (quality) defect level, and on-time delivery (Kaplan et al., 1992, 73).

The internal business perspective measures concentrate on factors that affect cycle-time, quality, employee skills, and productivity for example (Kaplan et al., 1992, 75).
The innovation measures focus on the continual improvements in existing products and processes and the ability to introduce new products with expanded capabilities (Kaplan et al., 1992, 76).

The financial performance measures “indicate whether the company’s strategy, implementation, and execution are contributing to bottom-line improvement” and include goals that have to do with profitability, growth and shareholder value (Kaplan et al., 1992, 77).

An example of a BSC can be seen as follows (Figure 34):



ECI's Balanced Business Scorecard

Financial Perspective

GOALS	MEASURES
Survive	Cash flow
Succeed	Quarterly sales growth and operating income by division
Prosper	Increased market share and ROE

Customer Perspective

GOALS	MEASURES
New products	Percent of sales from new products
	Percent of sales from proprietary products
Responsive supply	On-time delivery (defined by customer)
Preferred supplier	Share of key accounts' purchases
	Ranking by key accounts
Customer partnership	Number of cooperative engineering efforts

Internal Business Perspective

GOALS	MEASURES
Technology capability	Manufacturing geometry vs. competition
Manufacturing excellence	Cycle time Unit cost Yield
Design productivity	Silicon efficiency Engineering efficiency
New product introduction	Actual introduction schedule vs. plan

Innovation and Learning Perspective

GOALS	MEASURES
Technology leadership	Time to develop next generation
Manufacturing learning	Process time to maturity
Product focus	Percent of products that equal 80% sales
Time to market	New product introduction vs. competition

Figure 34. ECI’s Balanced Business Scorecard (Kaplan et al., 1992, 76)

Perkins et al. (2012, 149) write in their article that “the scorecard concept has evolved over a number of years through a series of papersand books by Kaplan and Norton (Kaplan and Norton, 1992, 1993, 1996a,b, 2000, 2004a,b, 2006) transforming the scorecard concept from an innovative, but relatively simple performance measurement tool, through to a complex PMS”. Further developers of the concept have been Gavin Lawrie and Ian Cobbold. Perkins et al. have divided the evolution of BSC to first-, sec-

ond- and third-generation BSCs and further to different versions of them as can be seen on the following image (Figure 35):

	First-generation balanced scorecard				Second-generation balanced scorecard		Third-generation balanced scorecard	
	Balanced scorecard 1.0	Balanced scorecard 1.0.1	Balanced scorecard 1.1	Balanced scorecard 1.2	Balanced scorecard 2.0	Balanced scorecard 2.1	Balanced scorecard 3.0	Balanced scorecard 3.1
Developed in […]	Kaplan and Norton (1992)	Kaplan and Norton (1993)	Kaplan and Norton (1996a)	Kaplan and Norton (1996b)	Kaplan and Norton (2000)	Kaplan and Norton (2004a, b)	Lawrie and Cobbold (2004)	Cobbold and Lawrie (2002)
Characterised by […]	Mixture of financial and non-financial measures	Beginning to focus on strategy	More weight given to specific targets and time to reach them	Strategic linkages between strategic objectives	Introduction of strategy maps	Further development of strategy maps	Addition of destination statements	Reduction in number of perspectives used
	Interactions between four different perspectives of organisational performance	Shows an early "how to" guide for building a BSC	Focus on strategy: the four processes of managing strategy	BSC as part of a core Performance management system	How organisational assets can be converted into performance outcomes	How intangible assets can determine the performance of critical internal processes	More focus on strategic linkage model, less on specific measures	
	Number of measures balanced	Introduction of strategic objectives	Introduction of causality		Introduction of intangible assets	Bottom-up approach		
			Strategic linkages between measures		Cascading top-down approach			

Figure 35. The evolution of balanced scorecards (Perkins et al.,2014, 155)

In order to make any version of the BSC to work, the BSC requires that a company strategy is defined. According to Gautreau et al. (2001, 156) "no system can do that; it is senior management's responsibility and vision" and also "the scorecard cannot select the best measurements of strategy". Management must also communicate the strategy to employees and express their expectations on employee performance in order to achieve the corporate goals (Gautreau et al., 2001, 154).

2.3.3 Benchmarking

The supply chain performance measures have an important role in evaluating performance and the benchmarking measures the results against similar organizations.
Benchmarking is defined as "the continuous process of measuring the company's products, services, costs, and practices against those of competitors or firms that display the "best in class" achievements" (Soni et al.,2007, 48).

The Supply Chain Council defines benchmarking as follows:

> Working knowledge of the process of capturing and comparing one's own business processes and performance metrics to industry peers and/or best practices from other industries. Typical measures include quality, time, and cost, with the goal of closing performance gaps and doing things better, faster, and cheaper.
> Supply Chain Council (2012, 751)

Benchmarking is a valuable tool that provides an opportunity to learn from other organizations and more than 70 percent of managers worldwide reported using this tool in their companies (Soni et al., 2010, 44). It provides a mechanism to make organizations more competitive, implement industry best practice, and develop measures of productivity. In the article of Soni et al. (2010, 46) the drivers of SCM, such as facilities, transportation, inventory, sourcing, information and pricing have been considered as significant categories of measurement.

Most benchmarking is focussed on external environment and not on the importance of harnessing the internal competencies. The internal benchmarking is defined in the article of Soni et al. (2007, 49) as “the process of identifying, sharing and using the knowledge and practices inside one’s own organization”.

Internal benchmarking provides following advantages specifically:

- easy assess of data and information required;
- transferability of practices from one organization/supply chain to another; and
- provides a stepping stone towards external benchmarking.

Soni et al. (2007, 49)

According to Soni et al. for carrying out internal benchmarking, the tool/technique must have following capabilities:

- able to handle qualitative and quantitative data;
- provide an aggregate measure to compare overall performance;
- provide disaggregated measure to compare performance of supply chains in each field;
- able to establish mathematical logic to benchmarking process;
- able to analyze multiple outputs at a time;
- able to reduce subjectivity; and
- able to work on best value rather than average value

Soni et al. (2007, 53)

2.3.4 ABC Analysis

Only small percentage of the stock-keeping-units (SKU) deserve closer attention and tightest control (Krajewski et al., 2010, 436). One way of identifying the products or items that the managers should mostly focus on is using the ABC analysis.

The ABC-analysis typically divides the SKUs into three classes according to their monetary usage/value as follows (Figure 36) : the class A items typically represent only about 20 percent of the SKUs but account for 80 percent of the value, the class B items represent about 30 percent of the SKUs but only 15 percent of the value, and the class C items represent roughly 50 percent of the SKUs and 5 percent of the value (Krajewski et al., 2010, 436).

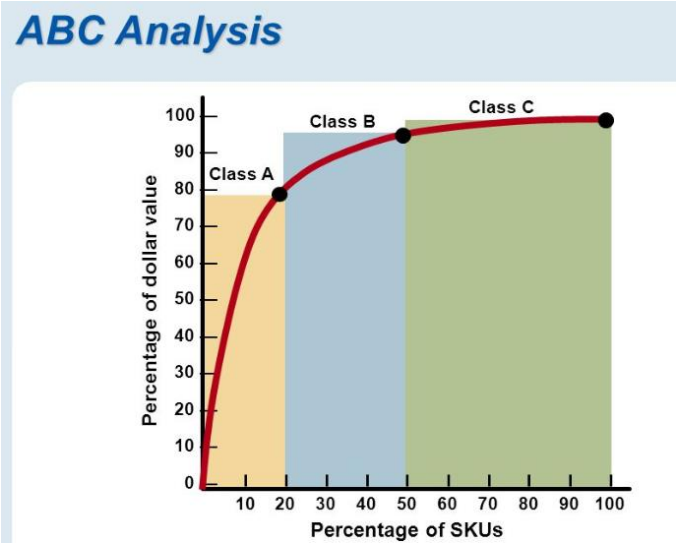


Figure 36. Typical chart using ABC analysis (Krajewski et al., 2010, 436)

2.3.5 Designing Performance Measurement

Chen et al. (2007, 15) write that supply chain performance measures should take a process perspective and that “the process-oriented metrics can contribute to better coordination and integration among various departments”. They also state that “if initiatives encouraging integration come from the top levels of the organization, they are more likely to succeed”.

According to Kurien et al. (2011, 23) there is a challenge in choosing the right “Measurement system design” and “identifying what you need to measure so as to concentrate on what is absolutely vital”. Further, according to Kurien et al. (2011, 28) “a PMS should be derived from the company’s objectives” and “a PMS should be appropriately focused on short- and long-term results, different types of performances (e.g. cost, quality, delivery, flexibility and dependability), various perspectives (e.g. the customer, the shareholder, the competitor, the internal and the innovativeness perspective), and various organisational levels (e.g. global and local performance)”.

Gautreau et al. (2001, 156) have a list for managers to consider when implementing PMS: “1. *Focus on a few key measures*. Too many measures may blur the strategy/goal. 2. *Use measures that employees can control*. If they cannot control the measures, employees will feel alienated and disgruntled. 3. *Keep the lines of communication open and revise the programme often with changes in corporate structure and strategy*”.

According to Elrod et al. (2013, 48) “the supply chain should be measured to evaluate performance” and that the “measures most important to the performance of the organization should be selected”.

According to Carlucci (2010, 67) in order to prevent information overload “it is reasonable that any effective PMS has to include a limited number of indicators, i.e. key performance indicators (KPIs)”.

Bai et al. (2014) write in their article that with the large set of potential sustainable supply chain performance measures, “identifying key performance indicators (KPI) is thus the best practice policy for operations and supply chain management”.

Slack et al. (2010, 607) stress that there should be “a clear link between the operation’s overall strategy, the most important (or **‘key’**) **performance indicators** (KPIs) that reflect strategic objectives, and the bundle of detailed measures that are used to ‘flesh out’ each key performance indicator”.

2.4 Conclusions of the Literature Review

In research for the theoretical framework it soon became clear that the supply chain management is both a very popular and a wide topic and data written and researched keeps adding up all the time. The benefits of the effective supply chain management are however clear: lower inventories, lower costs, higher productivity, higher profits and greater customer loyalty to name a few.

In the wide concept of supply chain management a good question is: who has the responsibility of the supply chain's effectivity? Today's supply chains that often span to supply networks also on global level require co-operation, defined processes and responsibilities as well as measurements to follow and improve the implementation. The chain or network can not be operated by one person and thus it is essential to learn co-operative, cross-functional and team-oriented approach for managing the operations with the customer satisfaction in the main focus. The effective cross-functional teams approach on intra-organisational level enables effective inter-organisational co-operation. In the management point of view a wide set of cross-functional skills are required; for example demand forecasting and supply planning, sourcing and supplier management, customer and distribution channel management along with the inter-organisational skills that are needed for cross-functional co-operation.

In addition to effective communication, an effective supply chain needs shared forecasts and visibility to order status in real time as well as access to inventory data of all partners. As the structure of supply chain or network by nature is complicated, the development should focus on simplification, process reliability improvement, process variability reduction and complexity reduction. Process documenting enables the monitoring and improving the process functions as well as helps standardizing the processes between supply chain member companies. Supply chain's eight business processes should all be equally focused on strategic level since measuring the actual process performance should have strategic basis.

There are overwhelming pool of actual performance measures to choose from but in the supply chain performance measurement a process perspective should be chosen and focus should be on few key measures or KPIs that have clear link to strategic goals such as case company's customer satisfaction, inventory goals and forecasting accuracy.

3 Project Progress

As stated in the introduction, the project was divided into two subprojects and main objectives:

1. Creating the internal production and supply chain process description and measurement tools for the process
2. Developing the production planning system by transferring the internal sales forecasts straight to the system without manual processing in between systems

The project group worked mainly with the process description and measurement tools and the development of the production planning system was done by a smaller group led by the production management.

3.1 Developing the Process and Process Performance Measurement Tools

In the case company, the ISO 9001 quality management system was already in use. The documentation was more or less up to date on departmental level ("subprocesses), but no macro-level or so called "main process" for the internal supply chain was documented. The goal of the project group was to create a process description including the process performance measurement tools description.

The main process description creation within the project was divided into three parts:

1. The collecting of the existing process descriptions and measurement systems following with development suggestions
2. Documenting the process description and measurement systems/meters to the quality system and defining the responsibilities
3. Identifying the key persons in the process and organizing the process introduction/training and starting of the measuring/reporting

To start with the work, the project group proposed an initial main process model based on the own manufactured product's life cycle or its flow in the internal supply chain and it was further modified with the steering group as follows.

3.1.1 Product in an Internal Supply Chain

The product's flow in the internal supply chain is only a part of the complete supply chain as can be seen on Figure 37. The processes within the internal supply chain exclude the raw materials procurement and processes after the product leaves the case company's own logistics centre.

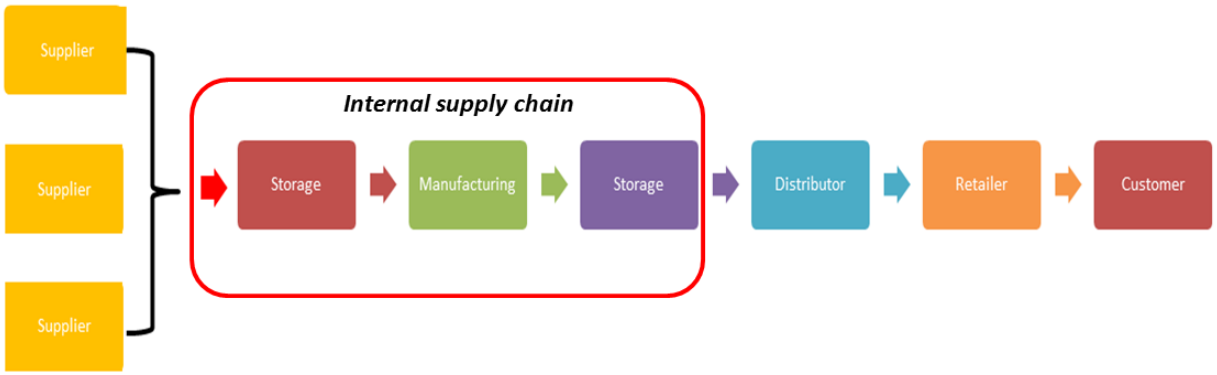


Figure 37. Internal supply chain in supply chain adapted from Stevenson (2005, 694)

The proposed model for a product in the case company's internal manufacturing and supply chain was modified first by project group and the steering group and resulted as can be seen on Figure 38. The model utilizes the company specific functions around the basic functions of "plan, source, make and deliver (return/enable)" of the SCOR-model and an example on Figure 10 (p.17). As it can be seen, the Product development process and the Customer management related processes were left out from the main process description with the steering group's decision and were only functioning as input functions for the subprocesses.

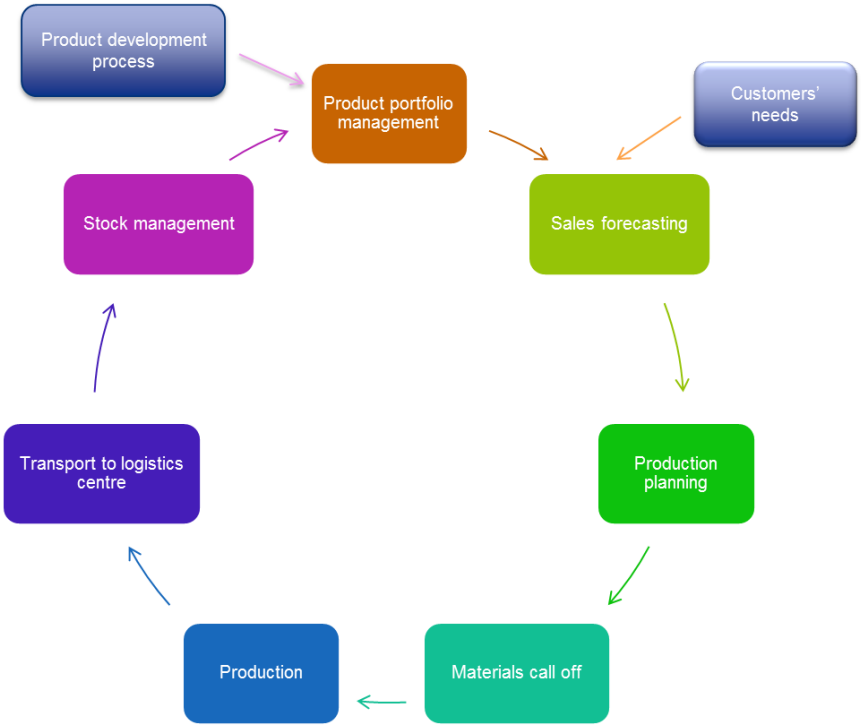


Figure 38. Product in the case company's internal manufacturing and supply chain

This initial main process model functioned as a base for the final main process description.

Very soon after the project group had started the three main focus areas arose: out-of-stock situations, unclear responsibilities within the internal production and supply chain and the measurement tools needed.

Two main reasons for occuring out-of-stock situations were identified early on in the project. First, the changed forecasting system had not been perfectly communicated and that had resulted in misunderstanding in the production timing. Previous system required production in forecasted month and the new system required delivery of ready products in the forecasted month. This created roughly a one month gap in production being behind from the forecasted sales. Secondly, even though the forecasts tended to be optimistic; the simultaneous focus in optimizing stock levels together with the one month production gap resulted in out-of-stock situations or close calls in best moving items.

Even though the one month gap was eventually closed the question of follow-up responsibilities rose up. Who is responsible for making sure the out-of-stock situations will not occur? The answer to this question should be in the process description.

Unclear responsibilities is a wide term and should be examined on many levels in the process. First of all, the ownership of the main process was discussed with the steering group and it was decided that the owner of the internal supply chain process of own manufactured goods is the manufacturing department which is responsible for right-time producing and delivering the goods based on internal forecasts. This ownership also means that the manufacturing department has the right to expect other departments or sales divisions to fulfill their responsibilities in the process in order to enable efficient and smooth production planning.
Clearing up the main responsibility of the functionality of the main process as a whole, the unclear and overlapping tasks had to be agreed upon. The basic input and output functions along the progressing process were good place to identify the essential and relevant fucntions that had to be completed by someone in order for the process to go on smoothly. The responsibilities along the internal supply chain should be described in the process description and they should be communicatied to the relevant persons working within the chain.

One of the seven main goals of the steering group was “Developing the supply chain measurement tools and practices for own production”. The measurement system was not created only for the measurement’s sake but to guide the process and for setting targets for the performance.

3.1.2 Existing Processes and Measurement Tools

The following existing processes and process descriptions were identified as the sub-processes for the main processes:

- **Portfolio management related processes:** Description of the Product Portfolio Management: Input fucntions from Innovation-/Product Development process, New Product Opening to the Production Plants , MDM Update Process New Product Opening, Product Ending Process
- **Sales forecasting related processes**: Description of the Sales Forecasting: The customers' needs function as input/guidance in the process
- **Production planning related processes:** Own production's production planning and Own Production Forecasting Description and Instructions
- **Materials (raw materials & packaking & labelling) procurement and call off related processes:** Materials Procurement, Materials Receiving and Quality Control , Printed Materials and Labels Control
- **Production related processes:** Defining Standard Pricing, Production Process/ Main Process, Product Production, Vinegar Production and White Vinegar Production
- **Finished products handling/transporting related process:** Stockremoval Instructions
- **Stock management related processes:** Arrivals Process and Departing Goods Process, Procurement Planning Description–document's Monthly Discussions about Sales Forecasts and Meters

The following topics were brought to special attention in the main process:

- The role of the production management is emphasized as the process owner and the timely executor of the sales forecasts ("minimum reaches follow up")
- The product portfolio management and the sales forecasting have to support the own production's efficient operation
- The new items and changes communication among R&D/sales divisions/production/MDM/logistics should be more efficient – one suggestion was to move the product cards from word/excel to the MDM system and its automated workflow

- The visibility to the production was to be increased with the weekly availability reporting and monthly updated production plan for the sales/customer service use
- The overall visibility to the production plants were to be added by adding intra-net activity (“news”)

The following existing meters and reports were identified in the sub-processes:

- Delivery accuracy to the customer (from the logistics centre)
- Forecasting accuracy
- Non-marketable items measurement (production materials)
- Standardpricing development, New items launch follow-up
- Production successrate%(lead time/efficiency)
- Production line utilization rate, Production loss reporting (max 1,5% / product)
- Factory defect notices, Batch exceptions / Utilization decisions (quality)
- Environmental meters, Waste statistics (The waste quantity compared to the production quantity does not exceed 0,5 %)
- Quality-, environment- and safety exeptions
- Logistics operations: volyms, efficiency, profitability, accuracy, lead time
- Stock reaches and values follow-up (Procurement department’s KPI-reporting & monthly meetings with Product managers)

No actual performance measurement model seemed to be followed but individual processes are measured for example by the SCOR performance categories of reliability, responsiveness, agility, cost and assets management (p.46).

The control points which ensure the process execution and flow but do not in practice measure the development were identified and added along the project as follows:

- Product Portfolio Management – monthly follow up by procurement department
- Sales Forecasting – monthly follow up by procurement department
- Monthly Discussions about Portfolios, Forecasts, Production Plans and Meters - monthly follow up by procurement department
- Updating of the Own Production Availability Report (*New/added during the project*) - monthly follow up by procurement department

- Updating the Production Plan (*New/added during the project*) - monthly follow up by procurement department
- Slowly Moving Items Reporting – quarterly follow up by procurement department

3.1.3 New Measurement Tools for the Main Process

The measurement tools in the project were aimed to have following qualities:

- Guide the process and measure change/development
- Be connected to the strategy (only the best! / company as a whole first!)
- Focus on the relevant, no excessive meters, meters that clear up the organization's targets (ensuring availability, stock values, quality, efficiency, cost savings)
- Personnel has to be able to understand the purpose of measuring – personnel training
- Measuring is done for reaching targets – the measurer has responsibility/authority to take actions on undesirable development
- The measurement system has to be reliable

The main KPIs chosen in order to prevent information overload and to quide, develop, ensure quality and measure performance in the main process of the own manufactured items supply chain were the following:

Forecasting Accuracy

As it has been emphasized, the production planning and demand management are based on sales forecasts. In was also agreed in the project that in order to enable efficient and smooth production planning and timely deliveries to the logistic centre, the production management must be able to trust the sales forecasts. The Forecasting Accuracy is reported on sales division and brand level. Forecasting Accuracy compares the chosen forecast month's QTY of the 2nd and 3rd month to the actual sales QTY and qives the accuracy percentage according to that. The target for A-products is between 80%-120% allowing maximum -/+ 20% deviation and the rest is given more variation between 50%-150% allowing maximum -/+ 50% deviation. Focus in the forecasting is thus guided to the A-products. The company level KPI reporting is given in total accuracy percentages as can be seen on Figure 39.

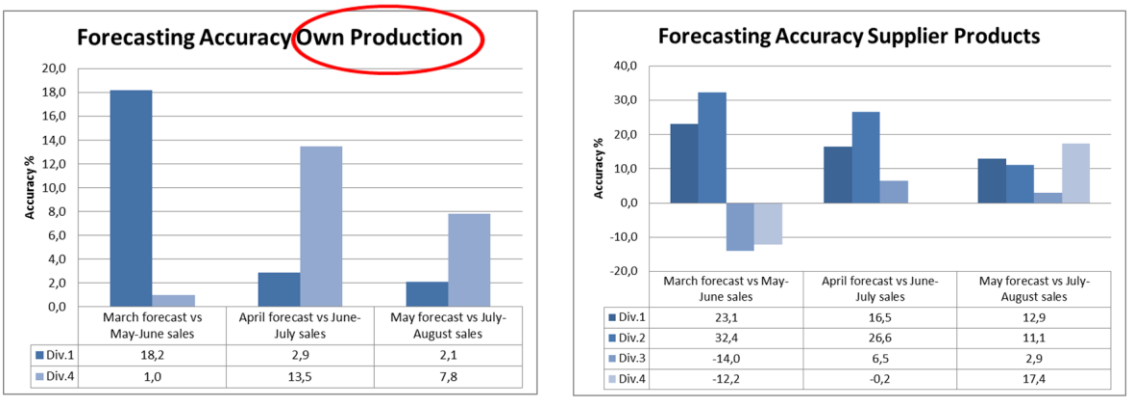


Figure 39. KPI reporting for Forecasting Accuracy

Internal Delivery Accuracy

A report measuring the production according to the forecast was needed. The existing report of Internal Delivery Accuracy used for measuring procurement planners' performance was adopted for this use. With this tool it can be compared on what accuracy the QTY forecasted for a certain month is in stock on the last day of the previous month. For example when the QTY forecasted for January is 5000 and the stock QTY on 31st of December is 6000 the accuracy is 120%. The targets for the Internal Delivery Accuracy are set based on ABC-classification: A=100%, B=95%, C=90% and is subject to change if needed. Internal Delivery Accuracy is reported monthly on sales division level (Figure 40) and can be brought to ABC, brand and individual item level when needed.

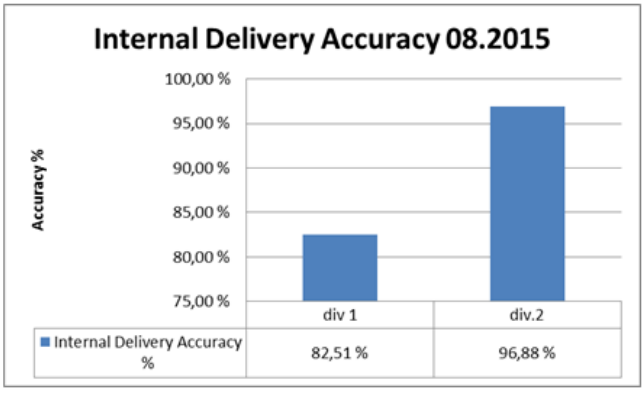


Figure 40. KPI reporting for Internal Delivery Accuracy

Stock Reach Follow Up

The Stock Reach Follow Up rose as an important topic in the project. The “minimum reaches” responsibility falls to the production management but is based on the sales forecasts. In addition to producing according to the sales forecasts, the production management updates weekly availability report for items with reach 14 days or under. The actual measurement tool however follows and reports the “maximum reaches”. The targets for the maximum reaches (own production) and the Stock Reach Follow up measurement are also set based on ABC-classification: A=60days, B=180days, C=360days, D=360days and U=360days (U=new item, under 6 months sales history). Supplier product maximum target reaches remain A=60days, B=90 days and C=120 days. The Stock Reaches are reported on sales division (Figure 41) and brand level. The most visible change to the previous reporting is that the own production items are now separated from outside suppliers and so the two different kind of “supplier” management can be clearly compared.

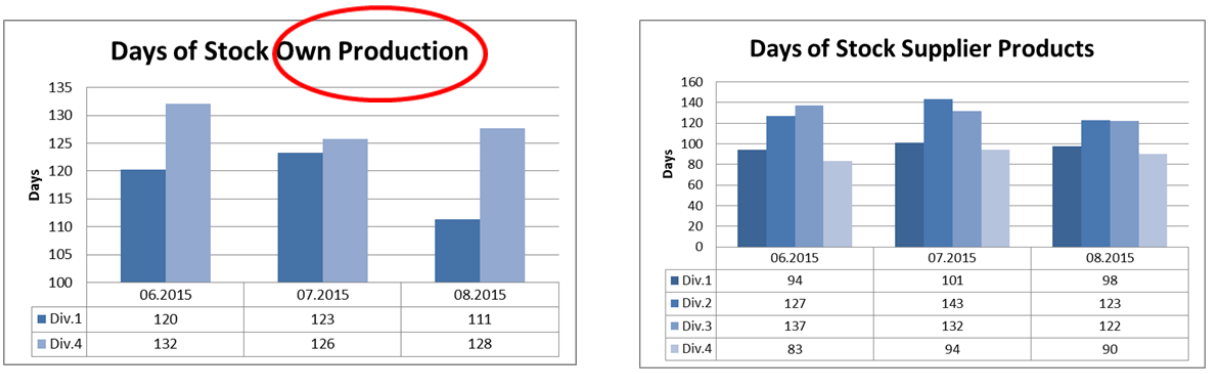


Figure 41. KPI Reporting for Stock Reach / Days of Stock

Stock Value Follow Up

The Stock Value Follow Up had already been in focus along with the new procurement department. The change in this measuring and reporting was the same as for the reach days; the own production items are now separated from outside suppliers and two total stock values are followed on sales division and brand level. The target values are set on brand level and by ABC-classification based on the on target reaches and actual sales history data (external deliveries stock value). The stock development reporting is given on company level and the stock value target reporting on sales division level as can be seen on images on Figure 42.

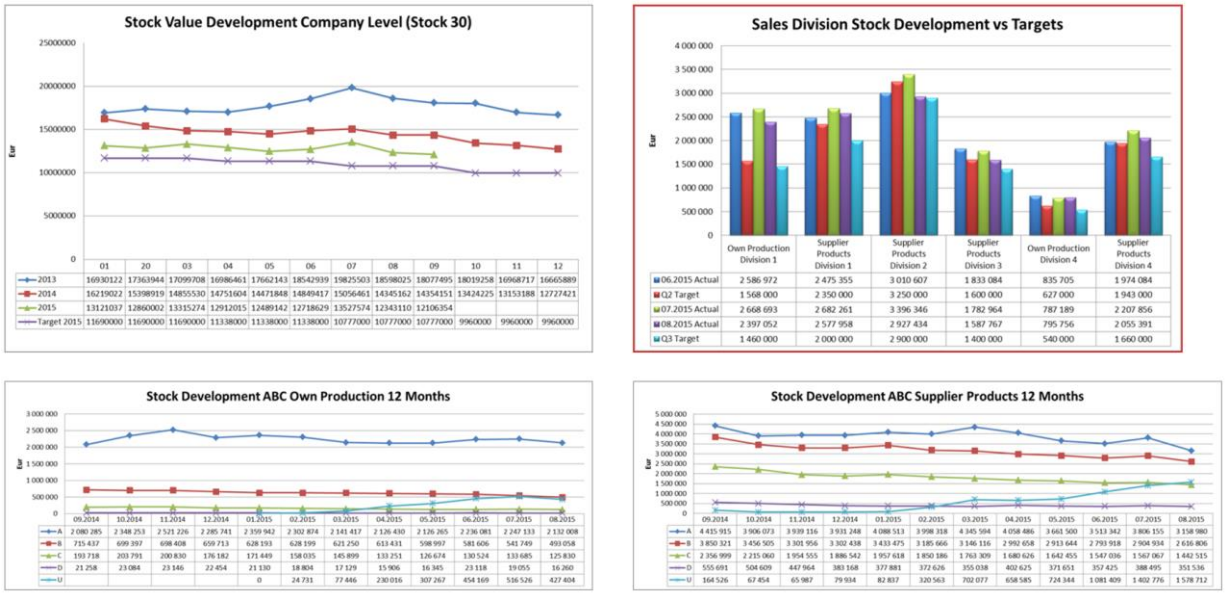


Figure 42. KPI Reporting for Stock Value Follow-Up

Customer Delivery Accuracy

The ultimate goal for the smooth and efficient cooperation along the internal supply chain is securing the customer satisfaction. The measurement tool for this is the Customer Delivery Accuracy. The Customer Delivery Accuracy from the logistics centre is measured based on the customer's requested delivery date and the target accuracy percentage is 98%. The reporting for own production and supplier products on sales division level can be seen on Figure 43.

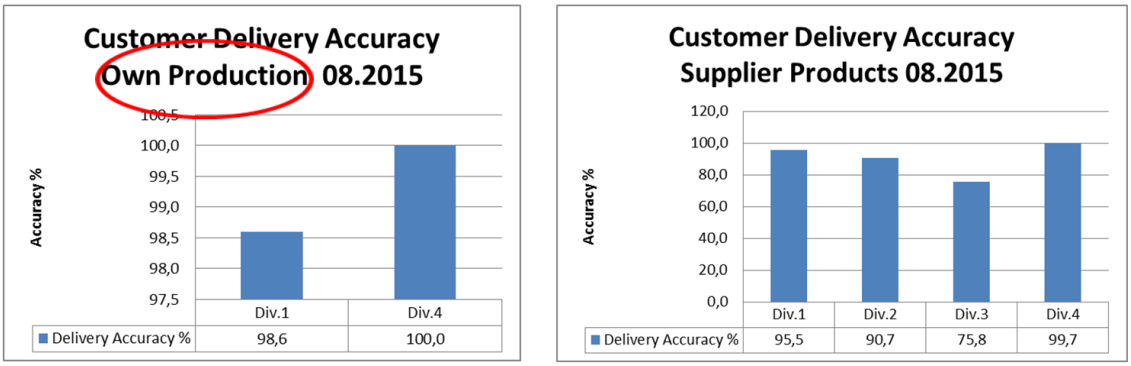


Figure 43. KPI Reporting for Customer Delivery Accuracy

The measurement tools used in the subprocesses were decided to continue as before. The main process measurement tools, responsibilities and distribution are described in the process description in the quality system (Appendix 1). To add the visibility of the measurement the own production's stock targets and development are montly updated alongside the supplier products on the intranet's front page. The development compared to the targets is shown with index numbers on sales division level (Figure 44) . The KPIs chosen to the main process are monthly reported on sales division level to top management and the brand level reports are given to the product managers or the persons responsible for the brand in question.

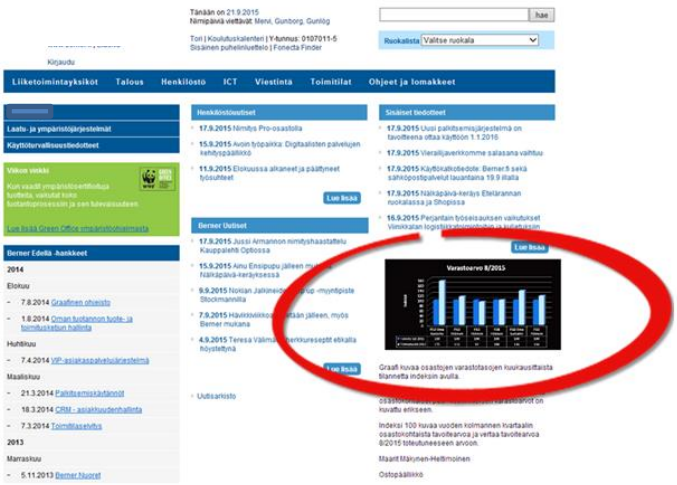


Figure 44. Stock Targets Development Reporting on the Intranet Front Page

3.1.4 Final Process Description

The final process flowchart for the main level process accepted by the steering group and translated from Finnish can be seen as follows (Figure 45):

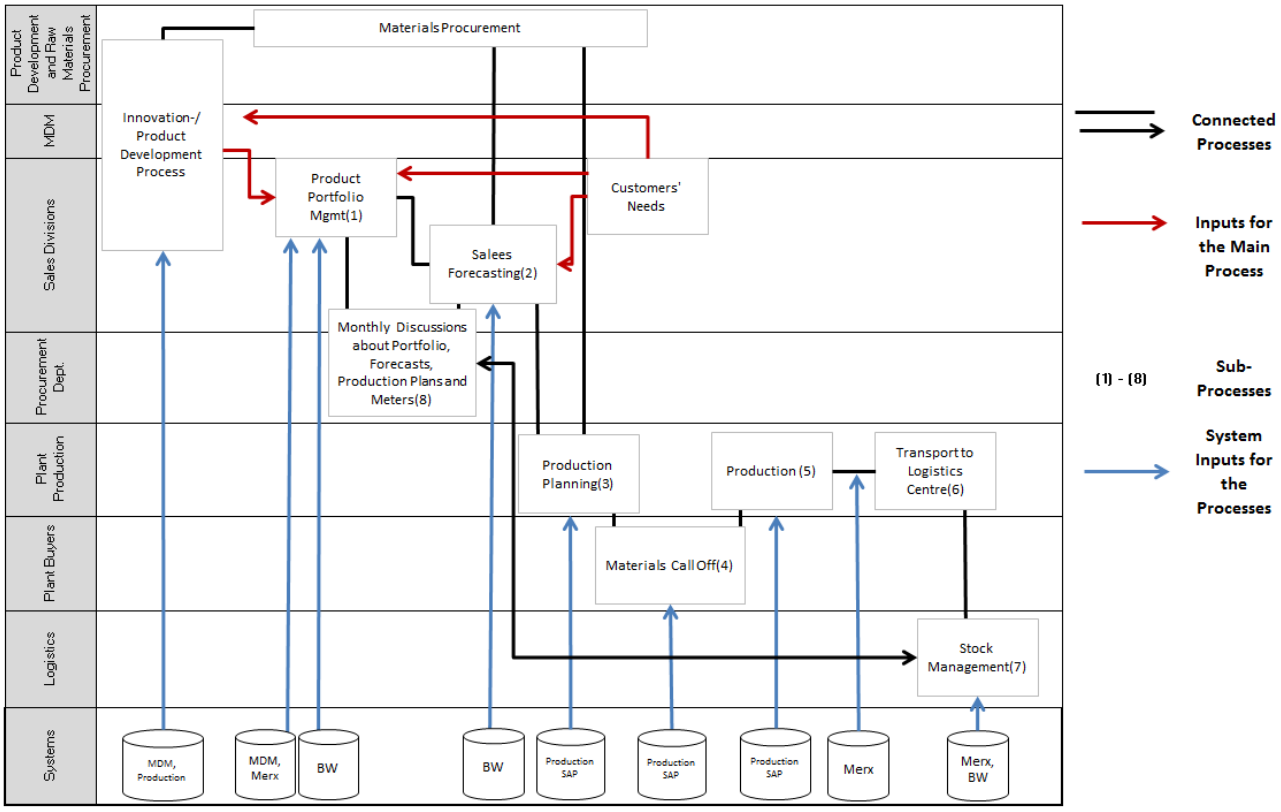


Figure 45. Main Process for the Own Production Product- and Supply Chain

The final main process description (Appendix 1) is also translated from Finnish and the actual description in the quality system has links to the subprocesses in question as can be seen on Figure 46. Main reason for using the links is to keep the main description as clear as possible and also have always the updated versions of the subprocesses in the main process description also.

Prosessivaihe (#)	Sisältö	Kierto / määräaika	Toimija/ Vastuu	Järjestelmä
Valikoiman hallinta (1)	Valikoiman hallintaa tehdään prosessikuvauksen Valikoimanhallinnan kuvaus 02287 mukaisesti, syöttönä valikoiman hallinnalle toimivat seuraavat prosessit: Innovaatio-/ ja tuotekehitysprosessi 02303, 01047, Uuden tuotteen perustaminen tehtaalle 01746, MDM Ylläpitoprosessi tuotteen Avaus 02380. Lisäksi valikoiman hallintaa ohjaa Asiakastarve. Valikoimanhallinnan tuotteen lopetuspäätöstä seuraa Tuotteen lopetusprosessi 02382.	Kuukausittain	Tuotepäällikkö	SAP BW

Figure 46. Main process description has straight links to the subprocesses

The measurements chosen are also described in the process description.

3.2 Developing the Production Planning System

The development of the production planning system was also divided in three parts:

1. Defining the development needs for the production planning system
2. Mapping the development possibilities and budgeting with a cooperation partner (Solteq)
3. Approval for the changes/development, testing, training and launch

After defining the development needs three alternative development options were received from the software partner and two of them were tested. The estimated budgets for the two were about the same. The actual system update was delayed due to version updates, holidays and maintenance breaks at the production plants. The final changes to the system were to be accepted by the production management which was also responsible for the testing, training and launch arrangements. The temporary manual forecasting excel or “factory order” and its updating was removed from procurement department to the production management in June/July 2015 before the actual implementation of the system development in the fall 2015. In all, this part of the project went along quite separately from other steering group’s goals and had least control by the actual project group.

4 Analysis and Conclusions

The actual project was finished within the time frame given by the steering group. The results of the project as well as the practical impacts of the project are described as follows. Even though the actual project was closed, the development work will continue along with the agreed goals for measurement and regular meetings.

4.1 Project Results

The project results are viewed based on the steering group's original goals as follows.

Securing stock availability and customer satisfaction with optimal stock levels is achieved on the sales forecast based production and stock targets. The production plants' management is responsible for the timely producing of the forecasted products ("minimum reach") and the "maximum reach" targets are followed on KPI-reports and the monthly meetings between the product managers and the procurement planners.
The maximum reach targets for the own production were set based on ABC-classification: A=60days, B=180days, C=360days, D=360days and U=360days (U=new item, under 6 months sales history).

Improving the quality and efficiency of the internal supply chain and minimizing the overlapping work tasks was the main goal in creating the main process description crossing the individual departments and functions within the company. The process description is documented in the quality system and the personnel informed. Along the project the visibility to the production and thus the flow of information was increased with the stock availability reporting as well as with the production plan reporting. The forecasting accuracy, internal delivery accuracy, customer delivery accuracy and stock development compared to targets is reported monthly on the top management's KPI-reporting separately from the supplier products.

Developing the supply chain measurement tools and practices for own production main process was aimed to quide, develop, ensure quality and measure performance in the process crossing the different departments and functions. In addition to choosing the measurement tools and setting targets as can be seen in chapter 3.1.3, the measuring and reporting of the standard prices in the production SAP-system was decided to take

under further development during the year 2015. More detailed data was wanted with less manual work.

Transferring the Sales Forecasts straight to the production planning system (SAP – separate module) did not progress as fast as the rest of the project. There were delays caused by version updates, holidays and maintenance breaks at the production plants. However, the final plan was to take the updated module in use around September 2015. The production is planned purely based on the sales forecast, stock data and minimum batch quantities. The forecast numbers will not be further interpreted by the production management.

Cost savings achieved by the project can be measured most concretely with the development of the stock values. It was counted that if the stock value targets based on the reach targets and sales history data would be accomplished during 2015, the savings created by the released stock equity and warehouse costs would be around 1,3M€. The long-sighted production planning based on quality sales forecasting enables more efficient use of resources and hopefully is seen as positive development in the production measurement tools such as standard prices, production and materials loss and production line utilization rate. With minimizing the overlapping worktasks for example in the communication of the out-of-stock situations the working is more time efficient.

For ensuring the good internal co-operation it was recommended that the sales division level regular production meetings would be organized with the production management at least 1-2 times a year, possibly quarterly. There were also discussions about the company level own production related meetings once in 1-2 years but nothing was decided. Good internal communications are essential in product development and updates. The suggestion to move the product cards from word/excel to the MDM system and it's automated workflow was to be considered after SYNKKA-updates in the spring 2015 but the development question remains open. In all, the ensuring of the good internal co-operation is the responsibility of the all actors in the process and can not be forced by creating a process description and instructions alone.

The actual measurement on project's results and impact on all KPI-measures can be seen with some delay by the end of the year 2015. The stock development from the beginning of the year has not been on target as hoped for several reasons. Although the total stock value and reach had started to go down by the beginning of April by 4%,

the development started to turn to the opposite direction during the spring and summer. One reason for this was the new regulation on classification, labelling and packaging ("CLP Regulation") that can be seen in the rise of new products (ABC-classification letter U). All the existing products that are kept in the portfolios have stock with new and old packaking for a while. Another reason affecting all brands was the one month summer break at the production plant 1 during ventilation renovation and holidays. Due to these two reasons only, the production was made ahead of schedule according to sales forecasting in order to avoid the out-of-stock situations after summer holidays. At the same time the consumer behaviour is not very constant and predictable due to the tough economic times and overstock can grow fast. Towards the end of the year (Oct – Dec), more target oriented development should be seen or careful analysis will be needed for the product portfolios, sales forecasts and markets. The stock development on ABC-level for all own production items during 01.2015 – 09.2015 can be seen on Figure 47.

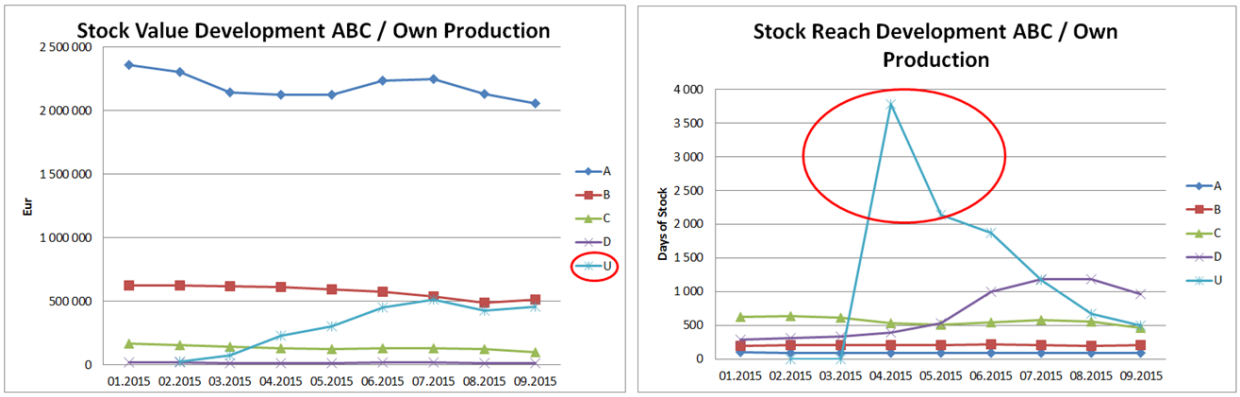


Figure 47. The Stock Development for Own Production 01.2015 – 09.2015

4.2 Practical Impacts of the Project

A few post-project practical impacts of the project are worth mentioning.

First, the production plant's availability reporting that was started already during the first full month of the project has become a time saving tool for the sales and customer service. Although in the future the systems should be developed to provide the visibility, the reporting has brought more efficiency to the process as it is today.

The process description updated to the quality system received positive feedback on DNV auditing the main process description in February 2015.

The separation of own production KPI measurement from outside suppliers has been an "eye-opener". While the outside supplier KPIs have developed to the target direction, own production has stayed quite stable. This means that the own production has not evolved and there is still room for development and optimization.

In the literature review it became clear that the strength of the supply chain is in inter-organizational relationships. The regular production meetings have been started with one sales division and will be started with another as soon as the organizational changes have been completed. The production minimum quantities have been discussed on each SKU-level and have also been already optimized anew in all possible items.

In all, the existing process description is a good tool to teach new employees and return to whenever there is a need.

4.3 Conclusions and Further Development

The project was successful considering the time-frame given and results achieved. The development will not stop after the official project but rather was given a base to grow on. The success of the future depends on the actors in the process, continuous measurement follow up and the co-operation on all cross-functional levels. The focus on quality product portfolio management and sales forecasting will lead to efficient production planning and ultimate customer satisfaction.

The actual development suggestions by the project group were the following two: the unification or centralizing the procurement of the packaking materials and development of or process descriptions for the subcontracting processes of the own brand items possibly along with the supplier management development project.

After the project and outside of the final report the following suggestions could also be added: the supply chain process functions and its measurement could be benchmarked on internal and external level for the continuous improvement and the KPIs and some individual subprocess measures could be displayed on some kind of visual dashboard for management’s use instead of monthly powerpoint reporting.

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Main Process Description for Own Production Product- and Supply Chain

Purpose of the Process

The purpose of the Main Process Description for Own Production Product- and Supply Chain is to ensure that the forecasted sales can be fulfilled ensuring good availability and stock turnover.

The process defines the communication between the production, sales divisons and other internal stakeholders, and based on that communication the forecasted items are produced at the production plants.

With the quality product portfolio management and sales forecasting the efficient production planning is possible and thus the accurate delivery of the forecasted items.

Innovation-/ Product Development Process and Customers' Needs function as input for the main process.

Process Scope

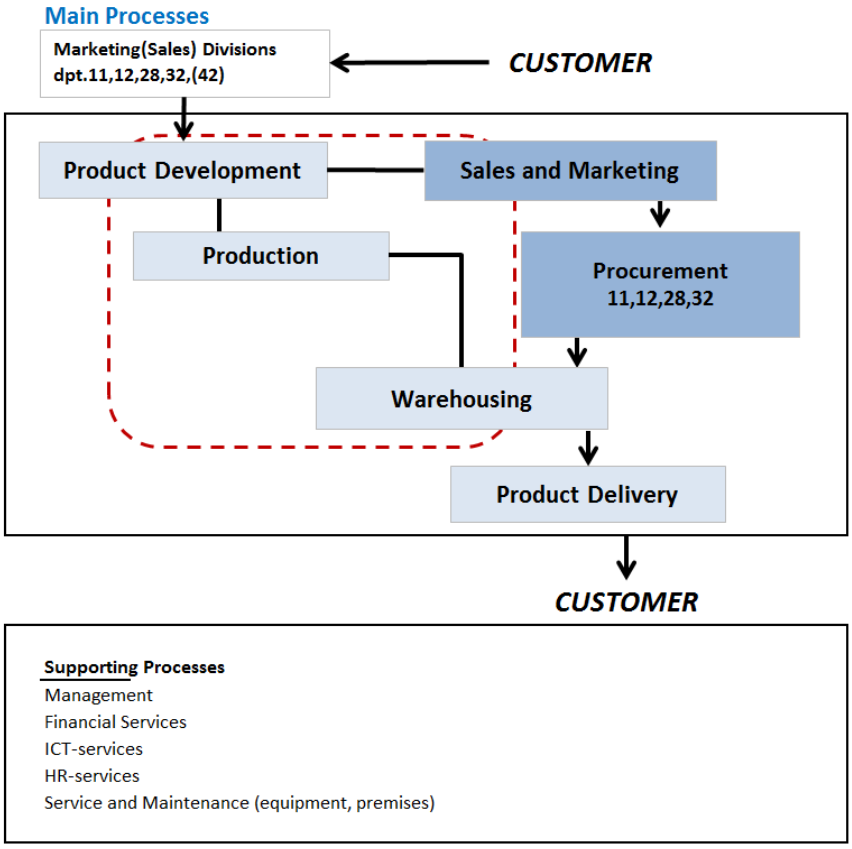

Figure 1 Process in the company's operating model document no 01646

The process follows the product development process in the operating model.
The purpose of the process is to produce company's brand products for consumers and professionals based on the sales forecasts created by the sales divisions. The finished products are stored at the company's logistics centre before delivering to the customer.
The management of the production plants owns the process.
The product managers are responsible for product portfolio management and sales forecasting.
Product manager in this concept is the person responsible for the portfolio management and sales forecasting, for example product-, category-, sales- or key account manager.

Process stakeholders

The stakeholders of the process include customers, materials suppliers, transport companies and public authorities. The outcomes of the process have straight impact on customer satisfaction and competitiveness.

Process Functions

Process Description

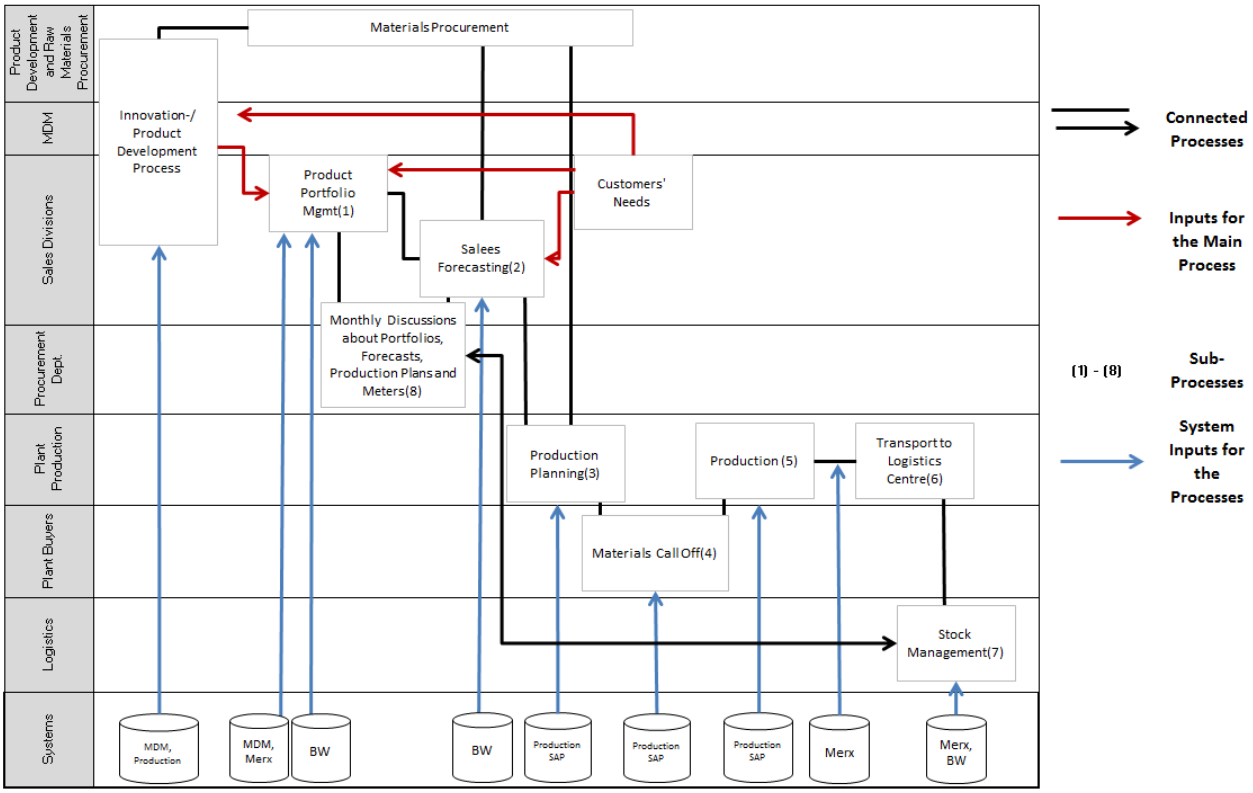

Figure 2 Process Flowchart

Roles, Responsibilities and Functions

The chart below takes the process to the level of functions. Each stage of the process will explain what is done, when, by whom and what is the role of the systems. The stage numbers can be seen both on the flowchart and the description chart.

Stage number (#)	Contents	Cycle / deadline	Actor/ Responsibility[1]	System
Product Portfolio Management (1)	The product portfolio management is done following the *Description of the Product Portfolio Management 02287*, the following processes function as inputs for this process: *Innovation-/Product Development Process 02303/01647*, *New Product Opening to the Production Plants 01746*,*MDM Update Process New Product Opening 02380*. The Product Portfolio Management is also guided by customers' needs. The decision for stopping the sales forecasting in Product Portfolio Management is followed by the *Product Ending Process 02382*.	Monthly	Product Manager	SAP BW
Sales Forecasting (2)	The sales forecasting is done following the *Description of the Sales Forecasting 02295*. The customers' needs function as input/guidance in the process.	Monthly	Product Manager	SAP BW
Production Planning (3)	The production planning is done following the *Own production's production planning 02372*. The 'Factory Order' will be replaced during 2015 by the straight importing of the sales forecasts to the production planning system. Until then the process of *Own Production Forecasting Description and Instructions 02300 and 02310* will be followed.	Monthly	Factory Manager	Production SAP
Materials Call Off (4)	The materials call off is done following the processes: *Materials Procurement 01747, Materials Receiving and Quality Control 02374 , Printed Materials and Labels Control (02189)*.	Daily, When Needed	The Responsibilities in the Processes	Production SAP
Production (5)	The process of *Defining Standard Pricing 02371* proceeds the production process itself. The main process of the production is described in the document *Production Process, Main Process*	Daily	The Responsibilities in the Processes	Production SAP, Merx (finished products)

[1] Person, who is responsible for following the process

	01754, more detailed description is found in the document *Product Production 01748*. Separate descriptions are found for *Vinegar Production 02409* and *White Vinegar Production 02135.* Finished and quality controlled products are moved from factory SAP to factory Merx area warehouses. The transporting functions will check out the products from factory Merx stock balance to Logistics centre Merx stock balance.			
Transport to the Logistics Centre(6)	The finished and quality checked products will be moved to the main warehouse at logistics centre following the *Stockremoval Instructions 02477*.	Daily, When Needed	Factory Management	Factory SAP, Merx
Stock Management (7)	The relevent processes for stock management are *Arrivals Process* and *Departing Goods Process Description* (can be found at K:\Kesvar), and *Procurement Planning Description 02292* – document's *Monthly Discussions about Sales Forecasts and Meters (5)*	Daily, Monthly, When Needed	The Responsibilities in the Processes	Merx, SAP BW
Monthly Discussions about Portfolios, Forecasts, Production Plans and Meters (8)	Product manager and procurement planner discuss the product portfolio, sales forecasts, production plans and brand specific meters in their monthly meetings.	Monthly	Procurement planner	SAP BW /Excel /Memos

Process Control

Is the Process Followed (control points)?

Control object	**The Control Question**	**Control Frequency**	**Responsibility**[2]	**Data Source**
Product Portfolio Management	How many portfolio decisions are updated and accepted in time?	Monthly	Procurement Planner	Excel / Memos
Sales Forecasting	How many sales forecasts are updated and accepted in time?	Monthly	Procurement Planner	Excel / Memos

[2] Person, who is responsible for following the process

Monthly Discussions about Portfolios, Forecasts, Production Plans and Meters	How many of the monthly meetings and discussions about portfolios, forecasts, production plans and meters with the responsible product manager have been completed in time?	Monthly	Procurement Planner	Excel / Memos
Updating of the Own Production Availability Report	The managment of the production plants updates the weekly availability report on own production items that have 14 days or less stock based on actual sales history data.	Weekly	Procurement Planner	Production SAP / Excel
Updating the Production Plan	The management of the production plants updates monthly (by 25th-30th) the 3 month production plan to the J-drive of the company.	Monthly	Procurement Planner	Production SAP / Excel
Slowly Moving Items Reporting	The slowly moving items report is updated with sales plans and actions by the responsible product managers.	Quarterly	Procurement Planner	SAP BW /Excel / Memos

What is the Effect of the Process (meters)?

Meter in Use	Measurement Object and Definition	Measurement Frequency	Responsibility	Data Source	Distribution
Customer Delivery Accuracy	The delivery accuracy to customer from the logistics centre based on the requested delivery date (Early&intime%, Late,not delivered&deleted%)	Monthly	Procurement Manager	SAP BW Supply chain KPI-reports	Top management KPI-reporting
Forecasting Accuracy	Forecasting Accuracy compares the chosen forecast month's QTY of the 2nd and 3rd month to the actual sales QTY and qives the accuracy % according to that. Sales division level accuracy is reported to the top management's monthly KPI-report. Brand level accuracy is reported	Monthly	Procurement Manager, Procurement Planner	SAP BW Forecasting Accuracy Analysis	Top management KPI-reporting, Product manager's and Procurement planner's meetings

	to the product managers in monthly meetings.				
Stock Reach Follow Up	Minimum reach targets of 2,5 months reach from the months beginning sales forecast is followed by *Internal Delivery Accuracy – meter* (SAP BW; Internal delivery accuracy). The meter is reported by ABC-classes on the top management's monthly KPI-report. Maximum reach targets are followed by SAP BW stock reports and are reported by ABC-classes on sales division level on the top management's monthly KPI-report and on brand level to the product managers in monthly meetings. In addition the slowly moving items are commented quarterly by brand responsible product managers on the files sent by accounting manager. The comments are sent to division managers, procurement planner and procurement manager. Exceptions: The production management is responsible for producing the minimum reach targets and updates weekly availability report on own production items that have 14 days or less stock based on ac-	Weekly, Monthly, Quarterly	Procurement manager, Procurement Planner, Accounting Manager, Product Manager	SAP BW, Excel / Memos	Top management KPI-reporting, Product manager's and Procurement planner's meetings

	tual sales history data. In out-of-tock or other exceptional situations the production management will contact the brand responsible product manager(s). The items exceeding the maximum reaches are followed and action plans are updated on quartetly slowly moving item's report as well as going through the stock reports in product manager's and procurement planner's monthly meetings.				
Stock Value Follow Up	The SKUs have been set target values by ABC-classes on brand level based on target reaches and actual sales (external deliveries stock value). The sales division level targets are followed on the top management's monthly KPI-report and brand level targets are discussed in product manager's and procurement planner's monthly meetings.	Monthly	Procurement manager, Procurement Planner, Product Manager	SAP BW, Excel / Memos	Top management KPI-reporting, Product manager's and Procurement planner's meetings

Reporting

Report	Time	Actor/ Responsibility	Data Source	Distribution/ Handling Responsibility
KPI-reporting: Stock Value Development, Stock Reaches Development, Internal Delivery Accuracy, Sales Forecasting Accuracy, Customer Delivery Accuracy	Monthly	Procurement Manager	SAP BW	Factory Management, Sales Divisions' Management, Executive Board, Head Of R&D and Sourcing; and Laboratory Manager
Availability Report: delivery-time for items with reach < 14pv	Weekly (Wed)	Factory Manager	Production SAP	J-Drive, Sales and Customer Service
Production Plan Update: 3 months production plan on month-level	Monthly 25.-30.th	Factory Manager	Production SAP	J-Drive, Sales and Customer Service