# Implementing Operational Excellence in different product groups at Nedap N.V.

## Operational Excellence

**John Bruns**

**11/21/2012**


## Public version

**Master thesis by:**
John Bruns
S1022296
University of Twente
Master Business Administration
Specialization Innovation & Entrepreneurship

**Supervisor from Nedap**
P. Bolwerk
Operations Manager

**Supervisors University of Twente**
Dr. P.C. Schuur
Prof.dr.ir. O.A.M. Fisscher

# Management Summary

In the beginning of 2009 a new board of management made a new strategy plan for Nedap. The main principle of this strategy plan is to turn the potential of Nedap into more concrete results. Central target of this program is the improvement of scalability of the organization. The scalability of the organization determines how supply volume of trade growth can be processed. The Road to Excellence program is a five year program with six different parts: Development Excellence, Marketing Excellence, Sales Excellence, Operational Excellence (OE), Support Excellence en People Excellence (CEO, Ruben Wegman, 2012). My research is about the implementation of OE. This addresses the whole order trajectory. The processes need to be organized efficiently from sales planning till delivery, so that they fulfill the demands of the customers with low process costs, low stock levels but the right products that serve commercial purposes. The aims of OE are to realize a continuous improvement process of the supply chain.

The goal of this research is to develop a standard way of implementing OE within different product groups. This thesis contains guidelines for Nedap and its managers. My research is done within the business unit Light Controls and the implementation of OE is done for the product group Luxon. The purpose of this research is to explore and develop an initial understanding of the implementation and sustainability of OE. The research question and sub questions are:

***"How to implement Operational Excellence in different product groups within the business unit Light Controls in the organizational structure of Nedap?"***

1. How to efficiently organize operational processes with Operational Excellence?
2. What is the state of the art with respect to Operational Excellence at Nedap?
3. What steps still need to be done with respect to Operational Excellence at Light Controls?
4. What is essential when planning to implement Operational Excellence?
5. How to enroll Operational Excellence in a new upcoming business within the organizational structure of Nedap?

The sub questions mentioned above were researched with the method Focus Groups (FG) in order the get a better understanding of the context and generate actions to further research with the method Action Research (AR). Actions that are researched were the service level, lead time, stage in the Product Life Cycle (PLC), the market positions, demands from the supply chain, and the stock model. The application of Action Learning and Action Research has been fundamental in this research to develop knowledge on OE. The action learning approach was used to learn from what was done at the implementation of OE in the product group Quality lightning (QL) of the business unit Light Controls. AR contributed to the development of an increased awareness of the concept and benefits of implementing OE at the Luxon product group. Employees recognized the importance of a structured process towards improvement and learning by monitoring the performance of the supply chain.

As a result of my research, the following recommendations for the implementation are made to Nedap. The OE implementation starts by appointing a project leader who is responsible for the implementation of OE. Preferable is to appoint a person that has ambition to improve, a helicopter view, analytical skills, knowledge about OE, and supportive leadership style. Essential is that there is steering by management with the support of the right resources and infrastructure in place. During my research, I developed the following project approach that a project leader can follow for developing and implementing OE:

1. **Intake** – In the first step, interviews with management are conducted and the deliverables are set. Important is to create a timeline that outlines when the deliverables become effective.
2. **Analysis** – In the second step, analysis is done of the available historical sales order lines, actual stock, the market position, the stage in the Product Life Cycle, and the demands that stakeholders in the supply chain have. The demands have to be researched to find out what sales, production, and customer demand are from the supply chain. The actual stock must be optimized before a quality stock can be created.

3. **Modeling** – In the third step, different settings of the variables delivery time, standard deviation of the forecast, service level, and lead times should be simulated. The right mix of the variables should be chosen by simulating the safety stock and the maximum stock in the inventory model for the creation of a quality stock.
4. **Implementation** – In the last step, the inventory model, forecasting process, a reporting structure with KPIs, a service level, and agreed delivery conditions are implemented. Important is to schedule a monthly meeting to facilitate communication, monitor the performance, and plan actions for improvement on a continuous basis.

The result of executing the steps of the project approach is to structure and align the supply chain to enable reliability. Reliability, with regard to OE, is defined as: safe (for the right use), stable (available during the full life cycle), sustainable (manageable over time), scalable (volume independent), predictable (performs as expected), provable (supported by data). The characteristics of implementing OE are: assortment management, a service level to reach, forecasts for the demands in the future, a stock model, a reporting structure, and communication for monitoring of KPIs. These characteristics combined determine how successful the implementation of OE is and what the improved organizational performance is. The organization's performance can be expressed in a quality stock with quick stock turns and flexibility in the supply chain, which results in high internal and external service. The implementation of OE for the product group Luxon resulted in the following:

**Assortment management –** Luxon products that serve commercial purposes are divided in the categories: *Mainstream* (Product "runners") are produced on the basis of a forecast and have a lead time of 4 weeks, *Specials* (special products with low sales volume) have only a small safety stock (SS) and are produced to customer order with a lead time of 6 weeks, and *Custom* (Customer specific product) products that are produced on project basis.

**Service level -** The customer demands were analyzed and it turned out that a service level of 95% is acceptable and a lead time of 4 weeks is favorable for the mainstream products in the EU and US market for orders up to 250 pieces. For small projects a 4 weeks lead time is more desirable than for large projects. Small projects can be planned on a short term and for large projects installation is time consuming, and has to be planned a long time beforehand.

**Forecasting -** The forecasting is difficult, because some Luxon types have been on the market for just a few months and others for a few years. The forecast needs to be updated every quarter by the sales responsible.

**Stock model -** A stock model was created and implemented; the model calculates a safety stock and a maximum stock level with the determined lead time and service level on the basis of the forecast. The model can be used for simulation, adjustments and steering when unexpected things happen in the market or in the supply chain. During this research the actual stock for Luxon was optimized. Half of what is in stock are products that serve commercial purposes. The components that were in stock were transferred to Inventi, which is a wholly owned Nedap subsidiary that produces for instance Luxon. The obsolete part (10%) that was in stock was discarded.

**Reporting -** The following KPIs were implemented in Qlikview that is a flexible business intelligence platform for easily consolidate, and visually analyze all data for business insights. The Qlikview dashboard was used for monitoring and reporting the supply chain performance: *out of stock, delivery reliability, stock value, days sales outstanding, throughput time, stock turns, forecast reliability, lead time, and stock value.* A report has to be created and sent on a weekly basis to all supply chain management members.

**Communication** Essential in the implementation and success of OE is communication. Important is to communicate the sales forecast to the supply chain. A monthly supply committee meeting was scheduled to facilitate communication about the forecasts, service levels, and the monitoring of the performance with the use KPIs. The goal of these meetings is to communicate efficiently and continuously improve the supply chain.

# Preface

This report marks the end of my studies in Business Administration with the specialization Innovation & Entrepreneurship at the Faculty of Management & Governance of the University of Twente. My project took place at Nedap N.V. in Groenlo for the business unit Light Controls. I am very grateful for the opportunity that Nedap gave me to do my graduation project within their company.

I am glad to start writing this preface. Why? It reminds me that these are actually the last few steps towards the completion of my Master studies and dissertation. It has been a stressful and frustrating process with confronting moments. That sounds as a horrible time. But no, it was a constructive time that helped me to develop knowledge and skills in practice. It has been a very interesting process with inspiring, challenging, and a very valuable personal learning experience.

This work could not be performed without the help of a number of people, which I would like to thank. First of all I would like to thank my university supervisors, Peter Schuur and Olaf Fisscher. Thank you for your interest in my research, enthusiasm, guidance and the constructive criticism during the feedback sessions.

At Nedap I would like to thank Paul Bolwerk for his support during the project. He was the company supervisor that gave me the opportunity to get to know Light Controls. I found it interesting to observe the various operational processes at Light Controls at such a close distance. Further I would like to thank Jacob Schermers, OE Consultant, for his support, expert view on the project, guidance, and inspiring energy to keep improving the project and most importantly myself. I would like to thank Jeroen Somsen, Business unit Manager for his support and his professional attitude in managing the project. Of course I would also like to thank the direct colleagues at Light Controls for their help and for creating the pleasant working environment.

I would like to thank my parents for their unconditional support throughout my entire studies. It has not always been easy, therefore their continuous support and especially their trust have been very important to me. Finally, I would like to thank the person that I am most grateful to my sister Karlijn. We started our MBA studies together in 2010. Thank you for your understanding, your encouragement and for providing me with a setting that enabled me to keep going on good and in difficult times.

John Bruns

November 2012

# Table of Contents

# List of figures and tables

## List of figures



## List of Tables

# 1 Introduction

In the framework of completing my master degree in Business Administration the opportunity was given to perform a research at Nedap. In this report the final result of this research is presented. The reason for this research is that Nedap started last year with the Road to Excellence program. Central target of this program is the improvement of the scalability of the organization. The scalability of the organization determines how supply volume of trade growth becomes processed. The Road to Excellence program is a five year program with six different parts: Development Excellence, Marketing Excellence, Sales Excellence, Operational Excellence (OE), Support Excellence en People Excellence (Ruben Wegman, CEO, 2012).

The implementation of OE is the main subject in this report. How a business unit should implement OE and keep the focus on operating excellent raised the opportunity to start a research on how OE should be implemented. The topic OE covers diverse subjects as prognoses, product portfolio management, order processing, purchase, production, and logistics. In this research the subject will be analyzed and improved where needed. Aims are realization of the optimum stock level, improvement of delivery reliability, and lowering costs per order line. The measurement of supply chain performances are done with Key Performance Indicators (KPIs) that will researched as well.

Doing the daily activities and at the same time work on structural organizational improvement is very difficult. Therefore Nedap contracted a consultant to coordinate OE through the whole organization as project leader. He started with the product group QL within the business unit LC. The main foundations for OE are implemented and the first improvements are visible. From here my graduation assignment starts.

The need for OE within the product group Luxon is high, because of the growth in Sales and higher demands from customers. To respond on the growing market with higher and growing demand a more flexible, improved Supply chain is needed to keep operation and stock cost low. Finding a way through with the use of Focus Groups (FG) and Action Research (AR) made it an exciting way of learning. AR is an approach to research that aims both at taking action and creating knowledge or theory about that action (Coughlan and Coghlan 2002). Knowledge is created by interviews, and usage of the available theory on the topics. This report ends with answering the main question. This answer contains an advice for implementing OE in a proper way at Nedap LC.

This report starts with a description that introduces Nedap and can be found in chapter 2. The business units with their products and activities are described. Further, the reason of this research is introduced. In chapter 3, the research goal and design are described. In that chapter the research questions and the chosen methods are explained. In chapter 4, a literature research about OE is done to create a theoretical basis for this research. Further, the used models that support the implementation are explained. Chapter 5 starts with learning and analyzing from what is done till now at Nedap by the mentioned consultant. Chapter 6, describe the lessons learned from the literature and what is learned from the analysis of QL. During the research several improvements are described that are made in cooperation with the Project Leader to complete the implementation of OE at the product group QL. Further, the essential factors that should be taken into account are worked out. In chapter 7, a project approach is explained and OE is developed and implemented by following the steps of the approach. The report ends with chapter 8, where the conclusion and recommendations can be found.

# 2 Nedap N.V.

The name Nedap stands for "Nederlandse apparatenfabriek" located in Groenlo with production at Neede. Nedap was established in 1929, has been listed on the stock exchange since 1947, has more than 680 employees, and is active around the world. Nedap is a manufacturer of intelligent technological solutions for themes like; sufficient food for a growing population, clean drinking water throughout the world, and smart networks for sustainable energy (http://www.nedap.com). These are just a couple of examples of themes Nedap is working on. In this chapter the information about the company, the business units, and major changes that are related to the research assignment are described.

Nedap offers its employees the opportunity to be entrepreneurs in technology that matters. The organization structure is horizontal, because it is not the place in the hierarchy that matters, but the quality of the arguments. Nedap will not be showed in an organization chart, because the CEO of Nedap does not want to have layers in the organization. Initiative, perseverance and personal entrepreneurship are crucial. At Nedap, personal entrepreneurship means taking responsibility and converting ideas into action. The strength of Nedap is the creation of added value with products that solve relevant problems. That is why they talk about technology that matters. The key focus is this is not the technology, but the way in which it is used on a day-to-day basis. The distinctive aspect of the solutions of Nedap is that new technologies are processed in a creative and innovative way into elegant, user-friendly products.

In the first section *2.1,* the different business units and the products that are sold in the different markets are described. In the beginning of 2009 a new board of management made a new strategy plan for Nedap. In the second section *2.2,* this plan is described and the reason of this research assignment is explained. The main principal of this strategy plan is to turn the potential of Nedap into more concrete results.

## 2.1 Business units

In addition to detailed knowledge of technological developments in the section above, Nedap also has deep insights into various market segments. Nedap has different business units, each of which focuses on its own market segment. Each unit is responsible not just for the development of its products, but also for their own marketing and sales. A business unit functions as an independent enterprise, this results in balanced combinations of technology, products and businesses targeted at a specific market segment. The major reason for Nedaps competitive strength is the smart use of the knowledge and experience of other market groups; products are developed and launched on the market more quickly.

The business unit Light Controls that is subject of this research assignment is described more extensively in the first section. The other business units are described very concrete in the second section. These units are not directly involved in the research but interesting to mention and to read, because it gives an overall understanding about the markets in which Nedap is active. The used source for describing the business unit is the website of Nedap and can be used to gain more information about specific units.

### 2.1.1 Light Controls

The business unit develops produces and distributes intelligent dimmable electronic lamp drivers (ballasts) for gas discharge, Ultra Violet (disinfection and Curing) and a variety of other lighting applications. Nedap LC is a leading company of electronic ballast equipment. Key advantages of the products are: energy savings, ease of use, improved lamp life and reliability (http://www.nedap-lightcontrols.com). Within the business unit there are different product groups, for this assignment the product group General Lighting is important. The group exists of QL Induction Lighting and Luxon.

**UV** - The drivers for UV (ultraviolet) light are used in water purification systems throughout the whole world. Large UV drinking water purification plants in New York, Paris, Beijing, Shanghai, Melbourne and Vancouver use the Nedap Light Controls technology. In the segment of UV-lamp drivers for water purification is Nedap Light Controls the market leader. Another application of UV is, UV Curing that is a technology for curing printing ink and varnish.

***Luxon*** - The Nedap Luxon electronic HID lamp drivers –ballasts- in the range of 250W -1500W can offer energy savings up to 65% when compared with traditional magnetic technologies. Superior design and integrated two way controls can reduce the energy consumption and maintenance costs. The products are used to control lighting systems in warehouses, airline hangars, shipyards, factory buildings, big box retail and supermarkets. Most buildings still use outdated lighting technology. New, energy efficient solutions will lead to significant cost savings. Nedap Luxon e-HID ballasts enable dimming and offer optional wireless control.

Luxon has a range of 250W – 1500W which can be delivered in 59 product types. There are several reasons for so many product types. Luxon types are made for Europe, United States, and Canada. The products differ in Europe from US and Canada, because of the different quality standards over there. The product types in US and Canada have the same quality standards but differ in main grid voltages.

Luxon has an E, L, and S series ballasts. The E-series have a range of 250W-600W and can be controlled by cables 1-10v or wireless. Further, some types have a standby option, water resistant option, and with a bracket for installation of a reflector. In Figure 1, a ballast is illustrated, with bracket and the reflector attached. The E-series has 45 different types of ballasts.

Figure 1 E-series with bracket and attached reflector (www.nedap-luxon.com)

The L-series has a range of 250W-600W and can only be controlled by cables 1-10v. The L-series is smaller and looks different, like in Figure 2 This solution is used for the OEM business and can be placed in the housing of the customer's luminaire. The L-series has six different types of ballasts.

Figure 2 L-series (www.nedap-luxon.com)

The S-series are the latest ballasts developed and have a range of 1000W-1500W. The S-series can be controlled wirelessly and by cables 1-10v. In Figure 3, the Luxon ballast is illustrated. This series has three different types, a 1000W High Voltage and Low Voltage, and a 1500W.

Figure 3 S-series (www.nedap-luxon.com)

***QL*** - For hard-to-reach locations, for Example Street lighting, where the maintenance of the lighting system is expensive, Nedap Light Controls has developed reliable drivers for QL induction lighting shown in Figure 4. The QL light bulbs have up to 100.000 hours lamp life.

Figure 4 driver and lamp QL (www.nedap.com)

***Explosion safe*** - In environments such as drilling platforms and the petrochemical industry, the smallest spark can cause a chain reaction, with catastrophic consequences. For these high risk work environments, Nedap Light Controls has developed an explosion proof solution with electronic fluorescent lamp drivers for light fixtures.

***Naiade*** - The Naiade is a standalone and easy-to-use water purification unit for drinking water, which operates on solar energy. Nedap Light Controls developed the Naïade because there are still places in the world where people do not have access to safe and clean drinking water. The Naïade is mostly used in developing countries in Africa and Asia.

### 2.1.2 Other business units

**Security Management -** *Security Management* believes that the best security management system has to bring complexity back to transparency, clarity and (apparent) simplicity. For this reason, they developed AEOS, a system that offers certainty, and is trusted by banks, governments, airports and oil refineries around the world. AEOS is highly innovative, is clear to use and offers effective solutions for now and in the future. AEOS is a powerful and user-friendly web-based security management system, based on intelligent network technology. It combines and integrates, in real-time, systems for access controls, visitor management, burglary detection, locker management, car park management and I video management.

**Agri -** In traditional sow farming, sows used to spend almost all their lives lying and enclosed in gestation stalls. Nedap Agri changed all this with Velos ESF (Electronic Sow Feeding). The introductions of special feeding stations means that the sows can walk around freely and can live in groups, as they do in the wild. And this also benefits people. Firstly, the farmer. He has a system that saves him a lot of work, and is much more efficient in its feed distribution and energy consumption. As a result, the costs are lower, while he gets more out of it.

**Retail -** A key consideration in security for shops is finding the balance between customer friendliness and effectiveness. On the one hand, offer shoppers a welcoming, pleasant environment, and not give them the sense that they are under suspicion from the moment they walk in. on the other hand, security must be visible, because of its preventive effect. Nedap Retail specializes in security for shops, including chemists, perfumeries, clothes shops and supermarkets. Retail developed an elegant Plexiglas design gate for H&M, featuring the very latest patented detection technology. The familiar round antitheft buttons on clothes were also giving a makeover. There are now happy-looking flowers for children's clothes, for example, and hearts for lingerie. Retail increasingly became a pioneer of antitheft systems. In order to maintain this advantage, customer counters and metal detectors were incorporated into the gates over the years.

**Energy Systems -** The Power Router of Nedap Energy Systems is a fully integrated energy management system. This makes it possible for everybody to build their own network for sustainable energy at home. Solar panels, wind turbines, energy efficient boilers, generators, batteries, everything can be connected to it very simply. The energy generated can be used immediately, stored in batteries for later use or fed into the grid. An intelligent web portal enables customers to have full control over the total energy consumption.

**AVI -** Searching for available parking is a common source of frustration for motorists. Aimlessly driving around, competing for parking is a waste of both time and fuel. In an era of seemingly endless technological developments, it's logical to assume that there must be a better way. Capable of delivering real time parking guidance for visitors, the new SENSIT wireless sensor from Nedap AVI solves this problem. Once installed, SENSIT creates a network of wireless vehicle detection sensors that detect occupancy at each individual parking spot so that information can be relayed to drivers. This clever parking technology delivers benefits such as better traffic flow, reduced pollution, and last but not least, reduced frustration for drivers.

**Healthcare -** A nurse or carer always puts the client first. Good care, that's what's important. With an aging population and staff shortages, Nedap Healthcare is making this easier. Healthcare fully automates the administration, so that the staffs no longer have to worry about it, and have more time available for care.

**PEP -** In the temporary agency sector, the use of time sheets causes a lot of problems. They are often filled in inaccurately and carelessly. When they are being processed, 1s are often mistaken for 7s, or 6s for 8s. As a result, the administration is incorrect, and the wrong salaries are paid out. This makes the traditional time administration of flex workers a time-consuming chore. PEP makes it simple and accurate. The hours are registered using simple hardware, making time sheets at thing of the past.

**Library Solutions –** The system recognizes the books, know who has returned them and confirms the returns on a screen. So customers never have to stand in line again, and the staffs no longer have to carry out a lot of tedious work. This intelligent bookcase is an excellent example of the approach of Nedap Library Solutions. The idea to use RFID technology in the library sector originated in 2001. After all, it should be possible using a smart combination of hardware and software – to make a lot of routine manual work superfluous.

**Cimpl -** Construction in Metal & Plastics. Most of the metal and plastic parts of Nedap's products are produced in house at Cimpl. This department specializes in, amongst others, metal manufacturing, plastics manufacturing and tooling.

**Inventi -** *Inventi* is a wholly owned Nedap subsidiary, they produce advanced and high-quality electronics. Inventi is set up entirely to produce larger series of fully developed products. The production company works with a small core of Nedap employees, in combination with a large team of flex workers. This working method makes it possible to produce electronics competitively, even in the Netherlands. The research assignment is also important for Inventi and information from Inventi is needed for the assignment.

## 2.2 New strategy plan

In the beginning of 2009 a new board of management made a new strategy plan for Nedap. The main principal of this strategy plan is to turn the potential of Nedap into more concrete results. This plan consists of two important steps. The first step within this plan is "doing the right things". This means clear goals for future activities on what Nedap will do and will not do any longer. Nedap chose to direct for a complete development, manufacturing and sales of own products. And thus the classic role of Original Equipment Manufacturer (OEM) has to cutback. Nedap has already made an enormous shift within its business. They changed from an internally oriented business with a strong emphasis on production to much more externally direction with a focus on Product Development, Sales, and Marketing now. The first effects of these decisions are visible. The last two years, Nedap finally made a solid volume of trade growth again. The next step in this strategy is "doing the things right". Within the organization there are different activities that can be improved. The way of which new products are developed, how these products can be sold, and how orders are processed and delivered are all examples of activities that can be improved. This is the reason why Nedap started the Road to Excellence program.

Central target of this program is the improvement of scalability of the organization. The scalability of the organization determines how supple volume of trade growth can be processed. The Road to Excellence program is a five year program with six different parts: Development Excellence, Marketing Excellence, Sales Excellence, Operational Excellence, Support Excellence en People Excellence (CEO Nedap R.Wegman, 2012). This research is about the implementation of OE within LC and is part of this program.

A definition of OE is: *"Operational excellence strategies can support business strategies of overall cost leadership through total cost reduction, efficient and reliable supply, and high levels of basic service"* (Morash 2001). OE addresses the whole order trajectory. That means that subjects as prognoses, management of the product portfolio, order processing, purchase, production, and logistics will be analyzed and improved where needed. Aims are realization of the optimal stock level, lowering cost prices, improvement of delivery reliability, and lowering costs per order line. These are only a few of the Key Performance Indicators (KPI) that will be used. Later on in the chapter four the method will be explained further. Important strategy challenge is to first develop and later implement OE in practice.

# 3 Research goal and design

The goal of this research is to develop a standard way of implementing OE within different product groups. The content of the implementation is not the same for different product groups but the way how to efficiently implement OE is important. In this research I have learned from the QL product group, improved where possible, and make the link to the Luxon product group. Learning from the QL product helps with developing knowledge about OE at Nedap and the implementation pitfalls of OE. The implementation of OE within the product group Luxon is the practical part where the theory can be tested. The purpose of the research is in terms of Babbie (2010) to explore and develop an initial understanding of the phenomenon.

## 3.1 Research Question

The research question for this explorative research is:

***"How to implement Operational Excellence in different product groups within the business unit Light Controls in the organizational structure of Nedap?"***

The question reflects the sketched problem that is described above in the introduction part. Nedap can use the answer in a way that they can implement OE in different business units for a wide range of product groups. In order to answer this question the research question will be divided into sub questions. The answers to the sub questions can be used to answer the main question in the end. The following sub questions have to be answered:

1. How to efficiently organize operational processes with Operational Excellence?
2. What is the state of the art with respect to Operational Excellence at Nedap?
3. What steps still need to be done with respect to Operational Excellence at Light Controls?
4. How to create commitment for Operational Excellence?
5. How to enroll Operational Excellence in a new upcoming business within the organizational structure of Nedap?

The sub questions, mentioned above were researched with the method Focus Groups (FG) in order the get a better understanding of the context and generate actions to further research with the method Action Research (AR). In section 3.2, the method approach is worked out for both methods on basis of theory. Firstly, per sub question is explained what will be researched and which method are applicable to use.

### 3.1.1 Sub questions

1. **How to efficiently organize operational processes with Operational Excellence?**

For companies it is important to deal with the business environment. Some researchers even say that it is so important that in an uncertain environment, only organizations that can adapt quickly will survive. A way to improve the Supply chain is to use the method OE. How to efficiently organize operation processes with OE is researched in literature. The next sub question is about the way Nedap has implemented OE so far.

2. **What is the state of the art with respect to OE at Nedap?**

Within product group General Lighting of the Business unit LC the OE program is already launched. An external consultant made the basic plans and implemented OE. Still, the final improvements have to be made in order to reach the goals that were set at the start. The processes are generally described but, employees are not working or work partly with the KPIs that are provided. So, a lot of improvements have to be done. What the steps are that still have to be done are analyzed at the next sub question. The project objectives at the start of the implementation of OE were to realize a continued improved process for QL products from purchasing, production to sales.

The answer to this sub question is researched with analyses of the implemented parts of OE already in place, for instance the KPIs. The information about OE at Nedap so far can be collected through meetings, interviews, and simply by asking colleagues at Nedap. This is how data is collected normally and has not further been explained as a method. In the FG meetings the work on OE that has already been done is discussed and will be described under this sub question.

3. **What steps still need to be done with respect to OE at Light Controls?**

On the basis of the outcome of the sub question "How to efficiently organize operational processes with OE" and "What is the state of the art with respect to OE at Nedap" this sub question can be answered. The difference between the theory and the practice has to be analyzed. The steps that still need to be done are discussed during the FG meetings. The steps that can be implemented during the internship period will be taken. The methods that will be used are FG and AR. Later on, under methods, they will be described.

4. **What is essential when planning to implement Operational Excellence?**

With essential is meant for instance that the people in the organization are motivated to work with OE. Commitment within the organization is essential for the implementation to succeed. The performance of an organization depends on different the factors: management & organization, technology, processes & content, and people and competences. This question is important for Nedap because working with OE should be a normal way of every day working.

The idea for the creation of commitment is to continuously improve the processes for products from purchasing, production to sales. Because the markets are continuously changing and the organization processes have to continuously improve as well in order to respond to the changes. How this is done is based on literature about Continuously Improvement (CI). The literature will be selected on relevance, amount of citations, and year it is published. The method AR is used for collecting data in different sub questions. With the use of AR commitment and CI will be created. Process improvement is the result of people taking the steps within AR in order to improve together with the researcher.

The KPIs can help with continuous improvement of the processes. In this sub question the further development of the KPIs will take place. With developing is meant that the KPIs provide the right data, but also how to interpret the KPIs, what they mean, who is responsible, and what action should roll out. Further within this part attention to continuous improvement will be given to the way people report and what policy they have in order to improve the KPIs for which they are responsible.

5. **How to enroll Operational Excellence in a new upcoming business within Light Controls in the organizational structure of Nedap?**

Within Nedap a basis of OE is already enrolled within the product group General Lighting for QL. The new upcoming business is Luxon, also for this product OE has to be implemented. The answer of this question is a combination of results of the different sub question above. The key product in this research is the 250 up to 400 watt type of the Luxon series. This delineates the research in the amount of different product types of Luxon. The series 250 to 400 watt are the product types that are already sold in the market. Other product types are not sold yet or still under development. The 250 to 400 watt types are most suitable to start with, because the product types are sold already in the past 2 years. So, there is data available from the past 2 years. Interesting data from these products are the turnover per product type, order amount, and for instance the lead time.

Different products need different approaches. How to enroll OE will be answered with the experiences that are provided in the sub questions above. From the question above we know now how to efficiently organizing a supply chain, the situation at Nedap, and what the preferable setting of OE at Nedap is. So, the basis of this sub question is on the work that is done for the implementation of OE in the product group QL.

For Luxon, the same analyses will be executed as for QL. Luxon is in some principles different than QL. The difference between the products is the market they are in. The stage in the Product Life Cycle (PLC) is for Luxon in the introduction phase and QL is in the decline phase. Because of the different stages in the PLC another supply chain strategy is needed in order to be efficient in a way that a quality stock is created. Beside the phase in the PLC the Decoupling point (DP) is expected to be different. In Figure 5, an illustration of the possible decoupling points is shown. The DP is the point where the stock is placed, and where the customer In this part the link between the PLC and market position are investigated to find out what the right DP would be.

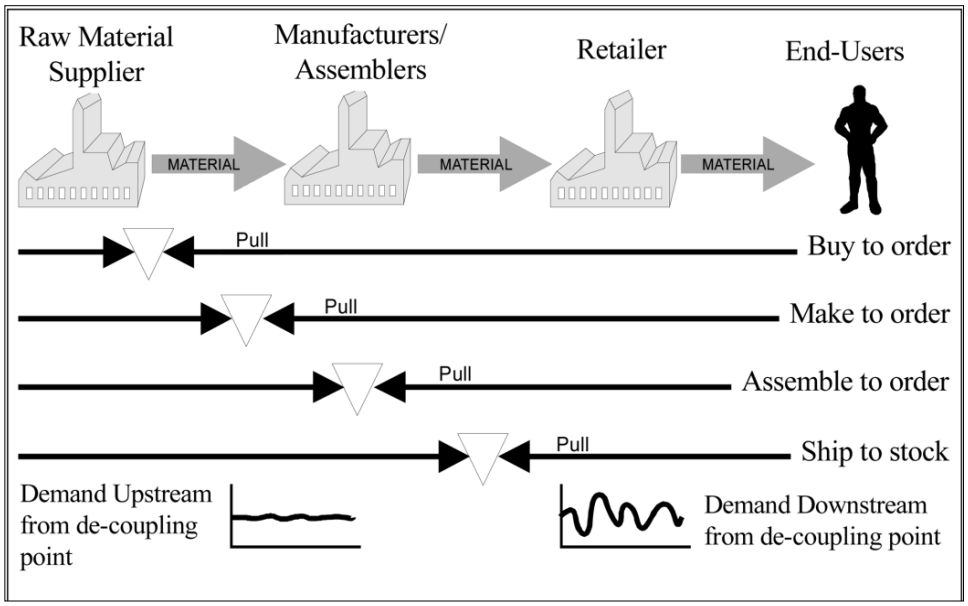



Figure 5 Decoupling point, Adapted from Hoekstra and Romme, 1992)

## 3.2 Method approach

In this section will be described with which research methods the research question will be answered. The reason why this approach is suitable for answering the research question will be explained in the second part of this section. The first method is FG and the second method is AR.

### 3.2.1 Method: Focus groups

The focus group method, which is also called group interviewing, is a qualitative method. It is based on structured, semi-structured, or unstructured interviews. The purpose of the study is to explore rather than to describe or explain in any definitive sense (Babbie 2010). FG is used for generating knowledge, exploring opinions, attitudes, attributes, and evaluating etc. Advantages of FG are that people in groups are more willing to entertain novel ideas, and explore their implications. Group interaction may generate emotion, humor, spontaneity and creative insights. Groups have been found to take greater risks and to show attitude polarization – the movement to more extreme positions. Based on these insights the focus group is more naturalistic and holistic setting in which the participants take account of the views of others in formulating their responses and commenting on their own and others' experiences (Bauer 2000).

Krueger (1988) points to five advantages of FG:

- The technique is a socially oriented research method capturing real-life data in a social environment.
- It has flexibility.
- It has high face validity.
- It has speedy results.
- It is low in cost (Babbie 2010).

FG may also play a vital role in combination with other methods. Morgan (1996) wrote that "Focus groups are currently used as both a self-contained method and in combination with surveys and other research methods, most notably individual, in-depth interviews". In this research the method will be used in combination with AR. FG will be used to explore the sub-question in order to make a start for AR. The participants in this research are the employees of the business unit LC.

**Preparation of focus group -** First think about what to ask, and what a good topic for the focus group interview is. It is essential to put time and effort into the construction of the topic guide. Ideally the topic guide should cover one page. It is not an extensive series of specific questions, but rather a set of section headings. A topic guide is also an agenda that can be followed during the focus group interview (Bauer 2000).

During the preparation phase the participants should be chosen for the focus group interview. It is advisable to take a small group with 5-15 participants. According to Bauer (2000) "there is not one method for selecting respondents for qualitative inquiries. Here, because the numbers of respondents are necessarily small, the researcher must use his or her social scientific imagination to inform the selection of respondents. Whatever the critical of respondent selection, the procedures and choices should be detailed and justified in any report".

**Role of the moderator -** In the focus group the interviewer, often called the moderator, is a catalyst for social interaction (communication) between the participants (Bauer 2000). Moderators may use free association tasks, pictures, drawings, photo-graphs and even drama as stimulus materials to promote ideas and discussion as a means of getting people to use their imagination and to develop ideas and themes (Bauer 2000).

**The focus group interview -** For the focus group interview a private and comfortable environment to engage in a guided discussion of some topic (Babbie 2010) is needed. A congress room is a perfect location for a focus group

interview. During FG interviewing the participants and the moderator sit in a circle so that there can be eye-to-eye contact between everyone. When people have sat down the moderator's first task is to introduce himself or herself, the topic and the idea of a group discussion (Bauer 2000). After the focus group interview the data has to be analyzed and the findings reported. It might be useful for the analysis to record this focus group session. But, be aware of the disadvantages like privacy and participants that will be afraid to say what they want.

**Limitations of the method -** The group interview presents several advantages, but it also has its challenges. (Babbie 2010) wrote that "participants in FG are not likely to be chosen through rigorous probability-sampling methods. This means that the participants do not statically represent any meaningful population. However, the purpose of the study is to explore rather than to describe or explain in any definitive sense.

Krueger (1988) also notes some disadvantages of the focus group method, however:

- FG afford the researcher less control than individual interviews
- Data are difficult to analyze
- Moderators require special skills
- Difference between groups can be troublesome
- Groups are difficult to assemble
- The discussion must be conducted in a conductive environment (Babbie 2010)

**Focus Groups at Nedap**

In this research the method is useful because the ideas, problems, and opinions about OE can be explored en discussed. The data is collected from employees through group interaction. Within the business unit Light controls there are some employees that are invited in the FG. As described before this is a non-probability sampling because the members of the FG are selected because they are involved in the OE project. The involved members are the Business unit manager, Operations manager, Account manager, OE Consultant, Financial controller, and Quality manager, and the researcher that facilitates the meeting. The findings from the focus groups are the actions that still need to be researched or worked out. With the method AR that is described after this section the actions can be researched and worked out.

The role of the facilitator will be the preparation of the meeting, initiator, and communality of the problem. In this research the advantage of the role as facilitator is that I am a young student that is a stranger for the organization with no position in the organization. That brings me as researcher in the positions to ask critical questions and surface problems that other FG members won't do, because they don't have this position with the ability to make faults without consequences.

### 3.2.2 Method: Action Research

According to Avison, Lau et al. (1999) AR combines theory and practice (and researchers and practitioners) through change and reelection in an immediate problematic situation within a mutually acceptable ethical framework. AR is an approach to research that aims both at taking action and creating knowledge or theory about that action (Coughlan and Coghlan 2002).

AR research originated in the social sciences out of the passive social changes of World War two (Baskerville and Myers 2004). The origins of AR are primarily in the work of Kurt Lewin and his colleagues and associates. Lewin and his associates started in the mid-1940s with AR project in different social settings. Through the following decades, AR in organizations developed in organization development, particularly in the USA (French 1999), the

industrial democracy tradition in Scandinavia (Greenwood and Levin 1998) and the socio-technical work of the Tavistock Institute in the UK.

Major characteristics of AR conducted from Gummesson (2000) lays out ten major characteristics of AR.

- Action researchers take action
- AR always involves two goals
- AR is interactive
- AR aims at developing holistic understanding
- AR is fundamentally about change
- AR requires an understanding of the ethical framework
- AR can include all types of data gathering methods
- AR requires a breadth of pre-understanding
- AR should be conducted in real time
- The AR paradigm requires its own quality criteria

Several broad characteristics define AR (Baskerville and WoodHarper 1996; Greenwood and Levin 1998; Gummesson 2000; Coughlan and Coghlan 2002) as:

- Research in action, rather than research about action;
- Participative;
- Concurrent with action
- A sequence of events and an approach to problem solving.

**When is AR appropriate -***"in general, AR is appropriate when the research question relates to describing an unfolding series of actions over time in a given group, community or organization; understanding as a member of a group how and why their action can change or improve the working of some aspects of a system; and understanding the process of change or improvement in order to learn from it" (Coghlan 2001)*.

**What role does the action researcher play -** Action researchers are outside agents who act as facilitators of the action and reflection within an organization. Schein (1999) distinguishes between two main models of helping. One is the expert model as in the doctor-action model as in the situation where patient go to doctors for expert diagnosis and prescriptive direction. The other is the process consultation model in which helpers work in a facilitative manner to help the clients inquire into their own issues and create and implement solutions. In the latter model, helpers work as action researchers (Schein 1987; Coghlan 2001).

**Implementing action research -** The AR cycle comprises three types of step, as illustrated in Figure 6:

1. A pre-step, to understand context and purpose;
2. Six main steps, to gather, feedback and analyze data, and to plan implement and evaluate action;
3. A meta-step to monitor

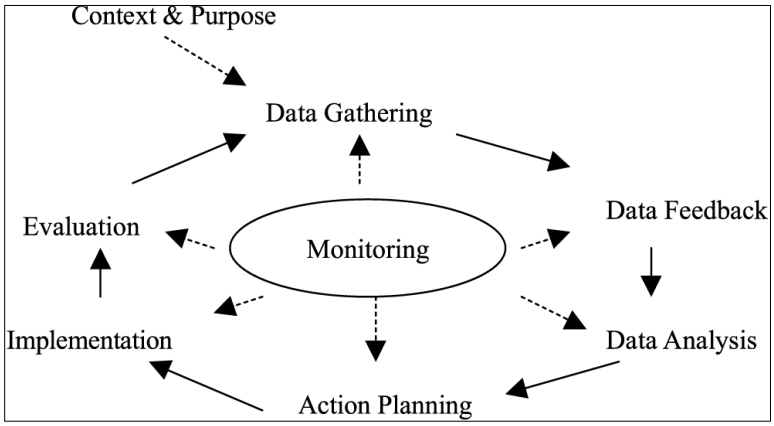



Figure 6 Action Research cycle (http://www.emeraldinsight.com)

AR is an iterative process involving researchers and practitioners acting together on a particular cycle of activities, including problem diagnosis, action intervention, and reflective learning. Data is gathered within this cycle of continuously improvement. AR aims to solve current practical problems while expanding scientific knowledge. Unlike other research methods, where the researcher seeks to study organizational phenomena but not to change them, the action researcher is concerned to create organizational change and simultaneously to study the process (Baburoglu and Ravn 1992).

**Action Research at Nedap**

As we saw above the first (pre)step is to understand the context and purpose of what to research. FG meetings are use to find that out and generate actions to research further with AR. For instance the Service level, lead time, calculations, and Product Life Cycle (PLC) need to be researched with AR. Imagine that not all the steps as described above are the same for the different actions. The six main steps are to gather feedback and analyze data, and to plan implement and evaluate action.

The practical usages of AR is in a way that for instance the action create a service level is executed with AR in a way that the researcher collects literature and test this in practice. The AR setting for solving or taking an action has different forms depending on the formulated action. Creating the service level also depends on different aspects like the lead time, customer preferences, and stock level. Besides the literature an interview with customers is needed and internal interviews for lead time and stock levels.

# 4 Theoretical framework Operational Excellence

In this chapter the Theory about OE and why it is used is explained. This theoretical chapter delineates the need of OE and the importance of implementing OE. The origin of OE is described and how OE changed over time is showed in a timeframe. The theoretical backgrounds are researched for a better understand of OE.

The first section 4*.1,* OE is described generally, the origin of OE is described on basis of what is known in literature, and the different meanings of OE over the years is described. In section *4.2*, the themes processes, forecasting, service level, and the key performance indicators (KPI) are described. These themes are selected by the researcher in order to realize structure and alignment to enable reliability and are collected during the research with FG and AR. The selected themes are needed for organizing OE, so that the operation processes can be organized efficiently. The last section 4.*3*, explains the models that are used to support the implementation of OE.

## 4.1 Operational Excellence

The goal of OE is a way of attaining exceptionally high standards of reliability in performance for the customer. For the customer this means that they know that if they order at an organization that they know that they actually get it, right as ordered the first time, always on time and at a price that suits. According to the Opexgroep OE means: "*for the organization it means that it is structured in such a way that it delivers a reliable product on all occasions and is able to maintain the entire portfolio at today's quality standards and for a realistic return"*.

According Treacy and Wiersema (1993) the term OE describes a specific strategic approach to the production and delivery of products and services. The objective for the organization is that following this strategy is to lead its industry in price and convenience. An organization that is pursuing OE is according (Treacy and Wiersema 1993) "*indefatigable in seeking ways to minimize overhead costs, to eliminate intermediate production steps, to reduce transaction and other friction costs, and to optimize business processes across functional and organizational boundaries*". They focus on delivering their products or services to customers at competitive prices and with minimal inconvenience. Because they build their entire businesses around these goals, these organizations do not look or operate like other companies pursuing other value disciplines.

### 4.1.1 Origin of Operational Excellence

The growing number of recent papers and special issues in the Operation Management (OM) literature on Supply Chain Management (SCM), and OE demonstrates the rapidly increasing importance of these issues (Corbett and Klassen 2006). SCM has been increasingly adopted by companies worldwide so as to better utilize their supply chain activities for competitive advantages (Kanji and Wong 1999). OE in terms of quick and reliable deliveries, short lead times, high resource utilization, and low inventories is desirable for all manufacturing firms (Olhager and Persson 2006). Manufacturing-based competitive advantages are becoming successively more important to address and to achieve. Managerial literature and practice reveals that supply chain strategies, capabilities, and performance are increasingly important topics for practitioners and researchers alike (Morash 2001). To the researcher and to the manager, a running operation is an enigma. On the one hand, it can be a highly visible entity where people or machines seem to be working away. On the other hand, a running operation will neither come right nor stay right of its own accord (Coughlan and Coghlan 2002).

Every organization has to deal with its environment. The environment is the external setting in which an organization works. In the broader scope it is called business environment, which includes complex interactions of the economic system, political system, legal restraints, society, industry, labour relations, customer expectations, markets, stakeholder's demands, natural environment, and labour conditions. The important point is that these

external factors are almost completely outside the organization's control. An organization's environment is constantly changing (Waters 2006).

Companies world-wide recognize the importance of meeting customers' needs to succeed in the competitive market-place (Kanji and Wong 1999). The view that adopting an environmental perspective on operation can lead to improved operation in itself is not novel; phrases such as "lean is green" are increasingly commonplace. According Middel (2008) Companies have to increasingly respond quickly and accurately to changes within the market and constantly have to improve their performance. Kozlowski (2009) say that in an uncertain environment, only organizations that can adapt quickly will survive. So, meeting needs of customers in an uncertain environment is very important. Companies do this with OM. The implication is that any operational system that has minimized inefficiencies is also more environmentally sustainable (Corbett and Klassen 2006). The supply chain improvement changed over the years and can be better measured with new technologies. Like Cachon and Fisher (2000) say: in traditional supply chains inventory management, and orders are the only information firm's exchange, but information technology now allows firms to share demand and inventory data quickly and inexpensively. Firms have Operation managers that have to deal with an uncertain environment and have to deal with Forecasting (FC), Lead Times (LT), supply planning, purchases, and dynamic Inventories (Jay Heizer 2011). The improvement of the supply chain performance is the key issue in this research. Firms can use different strategies to react in different circumstances and several methods are applied.

A lot of different definitions and methods in order to improve the performance can be found. Morash (2001) says supply chain strategy is an increasingly important topic in an environment of deregulation, inter-firm cooperation and partnerships, strategic alliances, and technological advancement. Internationalization of markets, increasing complexity of new technologies and speed of innovation are mentioned as several key drivers that changed competition (Prahalad and Hamel 1990). According Morash (2001) supply chain capabilities are the building blocks for supply chain strategy and a source of competitive advantage for firm success**.**

Companies have to continuously improve their supply chain in order to deal with a changing environment. The subject continuous improvement (CI) is used a lot. In essence, it involves a company-wide process of enabling a continuing stream of focused incremental innovation (Bessant, Caffyn et al. 1994). A definition of continuous improvement is according Boer (2001) *"the planned, organized and systematic process of ongoing, incremental and company-wide change of existing practices aimed at improving company performance"*. This definition is used because it is used in literature and fits within the context of this research.

The way the supply chain should be improved raises a lot of questions. Coughlan and Coghlan (2002) raise some questions that are not obvious to answer: What makes it work as it does? Could it work better in its current form? What different forms could it takes and still achieves the same result? What market, internal or environmental change would cause most trouble to the working of the operation, and with what effect? There is not one general good answer, but dependable per organization. According to Morash (2001) excellent firms, a demand focus on customer service and proactive quality is more apparent at both the capability and performance levels than a supply focus on cost, productivity, distribution, and speed. Morash (2001) gives four major types of supply chain performance: logistical cost and productivity versus customer service and quality. The first two can be classified as primarily supply-focused performance, while the latter two can be characterized as primarily demand-focused performance. In this research the focus is on primarily demand performance, because the company in this research has a demand focus on customer service and proactive quality.

### 4.1.2 Stages in the concept of Operational excellence

OE had different meanings throughout the years. To illustrate these different meanings throughout the years the Opexgroep made Figure 7 below. Depending on the economic phases OE changed over the years. The figure can be described in three stages:

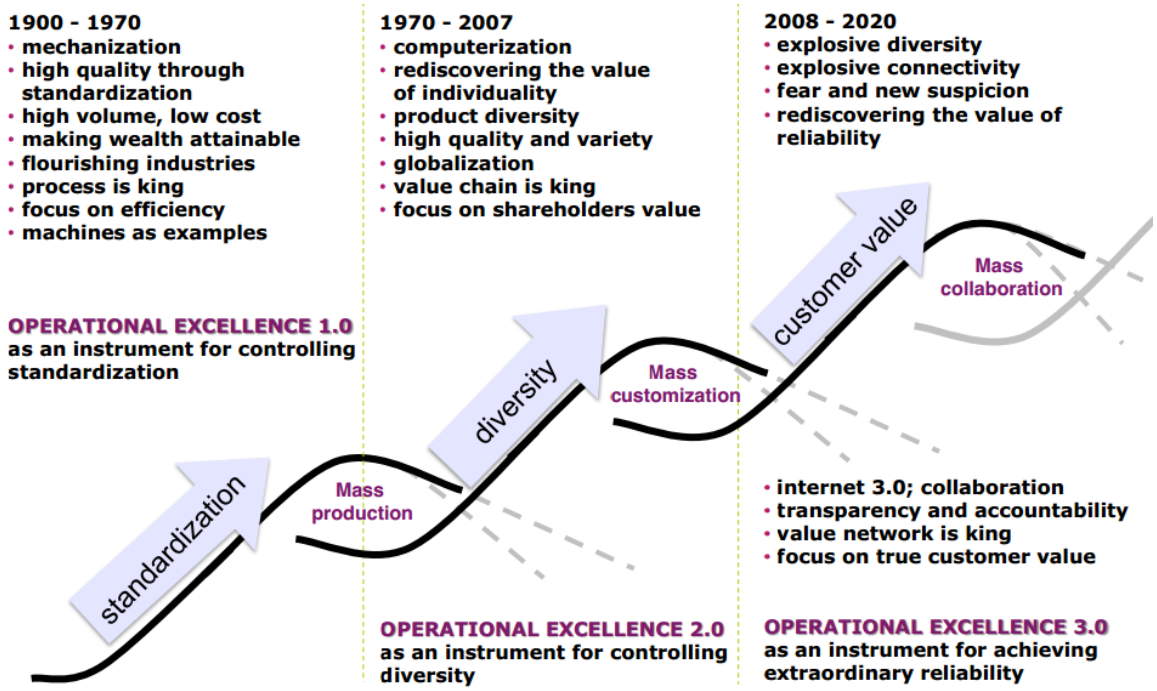



Figure 7 Timeframe Operational Excellence (www.opexgroep.nl)

**Standardization**

OE started as a means of controlling standards early in the 20th century. Mechanization and standardization were seen as pillars of economic wealth. In 1911, Taylor introduced the separation of management (thinking and workers (doing) resulting in production processes using high level of specialization in jobs and operations.

**Diversity**

OE changed around the 1960s, from controlling standards to controlling diversity. Social movements opposing standardization and its resulting uniform monotony where beginning to develop. "Back to the individual", became the new motto. Subsequently, the seventies saw the start of product diversity and its integration in the production processes. Product differentiation, Total Quality Management, Robotisation, Automation, Six Sigma and Business Process Reengineering all focused on mass-customization and maximizing shareholders value. In 1993, Treacy and Wiersema introduced the word Operational Excellence as a value strategy. Cited from (Treacy and Wiersema 1993) *"by operational excellence, we mean providing customer with reliable products or services at competitive prices and delivered with minimal difficulty or inconvenience"*.

**Customer value**

The last change of OE is from controlling diversity to achieving extraordinary reliability. The Opexgroep states on its site that in the early in the 21st century, due to a continued focus on product differentiation as well as enormous growth in prosperity, the concept of customer value became of secondary importance. Managerial focus on shareholders' interests created an increasing distance between the management of large corporations and its customers. Organizations explained OE as 'pumping up' processes to maximize profits with minimal costs

and services at the lowest level of acceptance. Through internet it is now possible for everybody to communicate and exchange experiences about products and services of companies worldwide, faster than ever in history (www.opexgroep.nl).

The internet exposes more and more shame files containing examples of the existence of corporate cultures of greed, underperformance and abuse of power. This in turn leads to an international re-emergence of corporate reliability as a competitive edge for organization and pushes the concept of customer value to number one on the social agenda.

## 4.2 Operational Excellence characteristics

This section describes the main characteristics of OE that are applicable for Nedap. In the previous section we saw that in theory the goal of OE is that a competitive edge is created with offering extraordinary product and service reliability with clear customer value. In order to achieve that, the organization must be structured and aligned to enable, achieve, and maintain extraordinary reliable standards and at a realistic turn.

If we look at reliability with respect to OE than we can define it as: safe (for the right use), stable (available during the full life cycle), sustainable (manageable over time), scalable (volume independent), predictable (performs as expected), provable (supported by data). As an organization an excellent inventory is needed. The main characteristics for the implementation of OE are optimized processes, forecasts for the demands in the future, a service level to reach, and KPIs to measure performance. Besides these characteristics, specific organizational settings are essential for a successful implementation of OE. The model that is used for analyzing these organizational setting is described in section 4.3.l

### 4.2.1 Processes

Within an organization there are a lot of processes. Different processes can be indentified in a process overview from planning to production to stock to delivery. For instance the order trajectory process of Sales and Operations that is from planning to production to stock to delivery. Further the forecasting process and stock processes are worked out in an overview. For OE it is important to develop new capabilities and to improve the embedded work habits, processes, and attitudes that prevent them from achieving excellence in their discipline (Treacy and Wiersema 1993).

### 4.2.2 Forecasting

The starting point of virtually all production planning systems is forecasting. According to Hopp and Spearman (2001) this is because the consequences of manufacturing planning decisions almost always depend on the future. Because of uncertainties in the future the best approach is to use all market information available in the present in order to choose the policies that we predict to be successful in the future.

The forecasting function aims to predict demands in the future. Long-range forecasting is important to determining capacity, tooling and personnel requirements. Short-term forecasting converts a long-range forecast of a product range to short-term forecasts of individual end items. Both kinds of forecasts are input to the intermediate-level function of demand management (Hopp and Spearman 2001). Because there are many approaches one can use to predict the future, forecasting is a large and varied subject. Hopp and Spearman (2001) come with one basic distinction between methods and that is Qualitative forecasting and Quantitative forecasting.

The qualitative forecasting method is defined as attempt to develop likely future scenarios by using the expertise of people, rather than precise mathematical models. Logically quantitative methods are based on the assumption that the future can be predicted by using numerical measures of the past in some kind of mathematical model.

Hopp and Spearman (2001) give two basic classes of quantitative forecasting models, a causal model and a time series model. The causal models predict on future parameters as a function of other parameters. The time series models predict a future parameter as a function of past values of that parameter.

Every organization that wants to forecast has to find the right forecasting method for their setting. Reading literature about forecasting methods and experiencing the method in practice differs. Hopp and Spearman give three general laws of forecasting. First law of forecasting is that forecasts are always wrong. Second law of forecasting is that detailed forecasts are worse than aggregate forecasts. Third law is that the further into the future, the less reliable the forecast will be.

### 4.2.3 Service level

The lead time of a given routing or line is the time allotted for production of a part on that routing or line. As such, it is a management constant. In contrast, cycle times are generally random. Therefore, in a line function in a make-to-order environment, an important measure of line performance is service level shown in Figure 8. This is defined as: Service level = P (cycle time ≤ lead time)

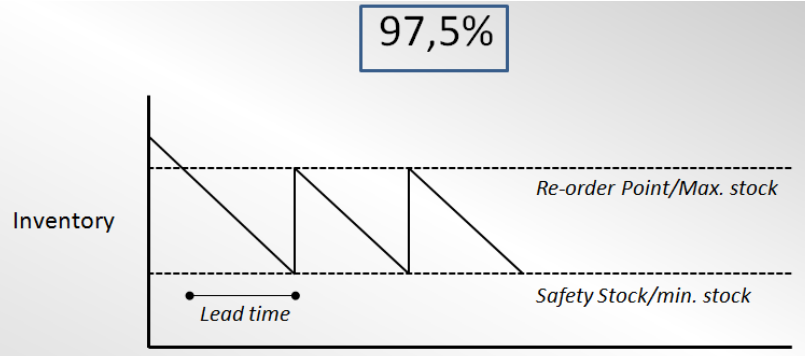



Figure 8 Service level, Schermers (2011)

Service level, typically used in make-to-order systems, is the fraction of orders filled on or before their due dates. Equivalently, it is the fraction of jobs whose cycle time is less than or equal to the planned lead time. Consider a specific replenishment order. Because lead times are constant, we know that all the other R-1 items either in inventory or on order will be available to fill new demand before the order under consideration arrives. Therefore the only way the order can arrive after the demand for it has occurred is if demand during the replenishment lead time is greater than or equal to R (Hopp and Spearman 2001).

### 4.2.4 Key Performance Indicator

One of the goals of OE is to improve the supply chain. According to Chae (2009) the success of SCM depends on, among other things, the closed-loop of planning and execution in regard to the process of minimizing possible gaps between planning and execution. In practice, it is impossible to remove such gaps entirely from one's supply chain. This is because the future cannot be fully known and decision-makers develop various operational plans under high uncertainty (Chae 2009).

If an organization wants to perform successfully in operations they have to monitor how planning and execution are synchronized. In this regard according Chae (2009), "*SCM performance measurement or monitoring is the term for a set of metrics and processes related to assessing and evaluating how accurate the planning is and how well the execution is carried out*". In practice putting performance measurement in place is often a daunting task. Important to succeed are incentives to work on performance measurement and top management support as well as an organizational culture unfavorable to performance measurement.

The performance measurement is done with Key Performance Measurement (KPIs). KPIs are used in different forms, for example: Cox, Issa et al. (2003), KPIs are compilations of data measures used to assess the performance of an operation. The KPIs are used to evaluate business performance. A particular task these evaluations typically have to compare the actual and estimated performance in terms of efficiency, and quality; and Chae (2009), measuring or monitoring supply chain performance reveals the gap between planning and execution and help companies to identify potential problems and areas for improvement.

How many KPIs are needed is important. Cited from Chae (2009) "*The experience from, and the review of, industry standards and best practices in supply chain performance measurement suggest that "less is better" as to developing performance metrics. Companies should focus on only a small list of KPIs which are critical for their operations management, customer service, and financial viability".*

## 4.3 Models to support implementation

The characteristics from the section above are essential for the implementation of OE at Nedap. Besides, executives do not only need to understand the importance of focusing the business on its value discipline. But, also push relentlessly to advance the organization's operating model. They will personally lead the company's drive to develop new capabilities and to change the embedded working habits, processes, and attitudes that prevent them from achieving OE (Treacy and Wiersema 1993). The layer planning model is used to analyze and formulate action for improvement separately. In the next sub section the layer planning model is explained. The model is used in chapter 6 to analyze the actual situation and to define what the essential factors are for a successful implementation of OE at Luxon. In sub section 4.3.2, the model for defining the decoupling point is explained.

### 4.3.1 Model: Layer planning

By means of "Layer planning", a controlled implementation can take place despite the complex situation. The sub-dividing of the different layers will help to analyze and formulate action for improvement separately. In the model will be concretely defined per factor what the present situation is and what the preconditions are to succeed in implementing OE. The factors are Management & Organization, Processes & Services, People and Culture, and Infrastructure. In Figure 9, an illustration of the "Layer planning" is shown.

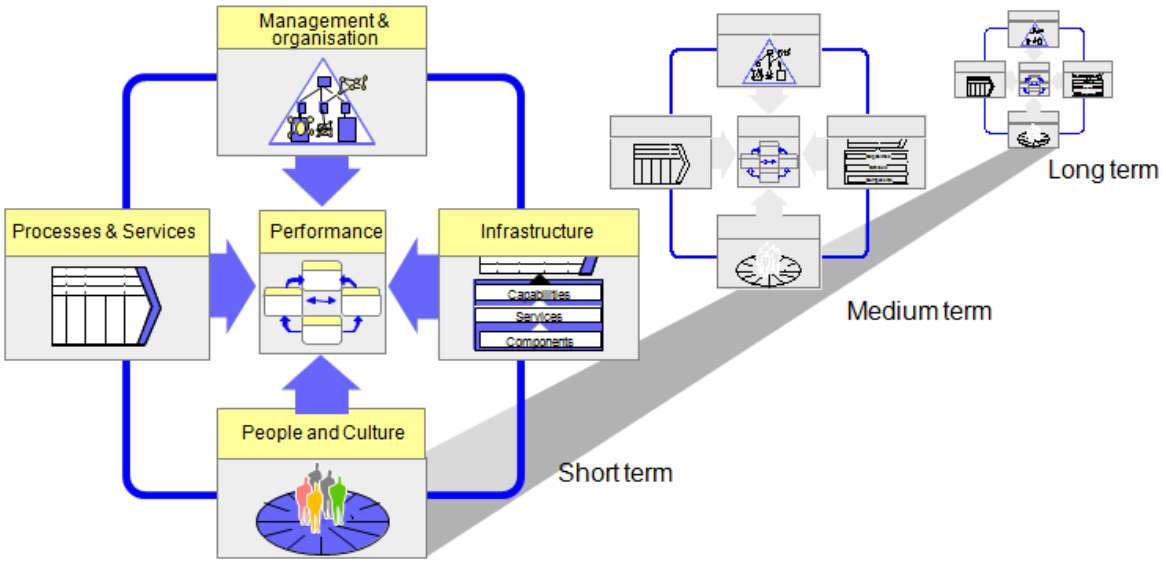



Figure 9 Planning in Layers (Hsiao and Ormerod 1998)

Per factor solutions are indicated on how the layers can be improved on the short, medium, and long term. The difference between the created layer of the present situation and the created layer of the needed preconditions provide actions for improvement. The total implementation of OE is a long term strategic plan. In the short term several actions need to be executed to make OE in the long term successful. Through planning actions, improvement between the different layers in time the "Layer planning" is created. These factors can be improved by taking some actions for improvement. The goal is to align these factors and create a balance between them to facilitate performance.

### 4.3.2 Model: Decoupling point

In Figure 10 the basic structure and also the material flow chain from supplier to customer is shown. Hoekstra and Romme (1992) describe a very fundamental and straightforward concept for ensuring control over the flow of goods. The "decoupling point" separates the part of the organization oriented towards customer orders from the part of the organization based on planning. In general, the DP will coincide with a main stock point (Hoekstra and Romme 1992). The principle of the DP is that downstream from (to the right of) the DP there are no stocks, while upstream (to the left) there are stocks only if this is economically justified. For Luxon the selection of the position of the DP is a balancing process between market requirements (including delivery times required by the customer) and lead times in the production and distribution process.
The model has five different points for order release. Five different position of the DP are sufficient to describe all possible product-market situations in the concept (Hoekstra and Romme 1992). These positions are indicated in Figure 10.

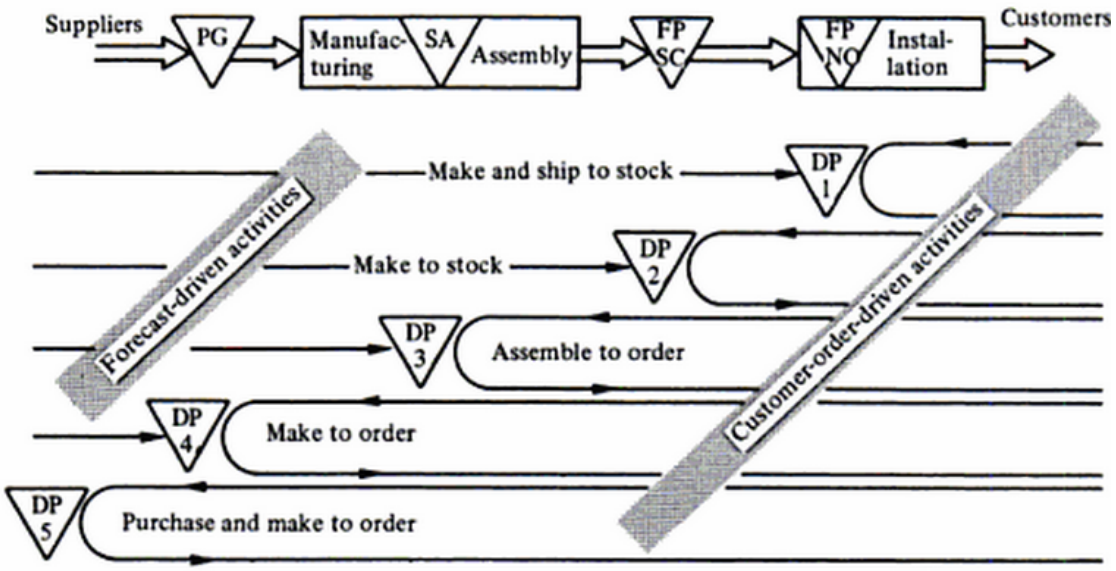



Figure 10 Decoupling point, Hoekstra and Romme (1992)

The DPs conducted from Hoekstra and Romme (1992) are:

**Decoupling point 1 (DP 1)** *"Make and ship to stock".* Products are manufactured and distributed to stock points which are spread out and located close to customer.

**Decoupling point 2 (DP 2)** *"Make to stock"* (central stock). End products are hald in stock at the end of the production process and from there are sent directly to many customers who are scattered geographically.

**Decoupling point 3 (DP 3)** *"Assemble to order"* (assembly for one specific customer). Only system elements or subsystems are held in stock in the manufacturing centre, and the final assembly takes place on the basis of a specific customer order.

**Decoupling point 4 (DP 4)** *"Make to order".* Only raw materials and components are kept in stock: each order for a customer is a specific project.

**Decoupling point 5 (DP 5)** *"Purchase and make to order"* (for a apecific customer). No stocks are kept at all: purchasing takes place on the basis of the specific customer order; furthermore, the whole project is carried out for the one specific customer.

According to (Fisher 1997), the nature of the demand for the products need to be considered, before devising a supply chain. So, before we can choose the right DP the nature of demand is described. He makes a distinction between functional products and Innovative products. The Functional products include according Fisher the staples that people buy in a wide range of retail outlets, such as grocery stores and gas stations. Because such products satisfy basic needs, which don't change much over time, they have stable, predictable demand and long life cycles. But their stability invites competition, which often leads to low profit margins. For Luxon this is not the case, but instead the Innovative product applies to Luxon. With Innovative products low margins are avoided, by introducing innovations in technology. Customers have an additional reason to buy products from Nedap. Innovations can enable the organization to achieve higher profit margins, although, according to Fisher (1997), the very newness of innovative products makes demand for them unpredictable. In order to deal with innovative products Fisher (1997) advices that innovative products require a responsive process. Responsive supply chains are necessary in order to respond to the demand fluctuations (Towill 2000).

## 4.4 Conclusions Theoretical framework Operational Excellence

With OE the goal of exceptionally high standards of reliability in performance for the customer can be attained. Important is to optimize the organizational processes to maximize profits with minimal costs and high services. The main characteristics applicable for Nedap are: optimized processes, forecasts for the demands in the future, a service level, and KPIs to measure performance. These main characteristics are explained above in order to know what they mean and why they are used. Further, the layer planning model is described that will be used for the analysis of the actual organization of Luxon. The essential organizational settings can be researched and shown in the model. The decoupling point model is used later in the modeling phase of OE.

With the theoretical framework of OE: the origin, the stages in the concept, the main characteristics, and the used models are described. That provide me the knowledge about OE that I needed to understand the concept of OE and explain the steps that are taken in this research. Besides, it is useful for the further research of what is done for the implementation of OE at QL. With the characteristics in mind, not only the actual situation of how OE is implemented for QL can be research, but also the possible improvements can be made during the research. In the next chapter the actual situation is described for QL. In chapter 6 the lessons learned from QL, the possible improvements, and the filled in layer planning are described. Further, in chapter 7 the decoupling point is used to delineate the places of the different stocks.

# 5 The state of the art with respect to Operational Excellence at Nedap

This chapter describes what has been done with respect to OE until this research started in March 2012. Recall from section 2.2, that within the product group General Lighting of the Business unit LC the OE program has already been launched. The answer to this sub question is researched with analyses of the implemented parts of OE already in place. Examples are the process overviews, data analyses, forecasting model, stock calculation model, and the KPIs. The information about OE at Nedap so far will be collected through meetings, interviews, presentations, documents, and simply asking colleagues at Nedap. Besides describing the actual situation, I use the opportunity of action learning to learn from the implementation at QL so far. Possibilities for improvements are done at the same time and will be described in the next chapter. So, this chapter only describes the state of the art and the next chapter described what the opportunities for improvements were and what the learned lessons are for Luxon.

The management of Nedap hired an external consultant for the project. His task is to lead the project and implement OE in different business units. The reason for this decision is that it is hard to implement OE during the daily activities. In this chapter the basic plans for OE are described. The start was to make overviews of the processes, simplifying the processes where possible, clear appointments about responsibilities, and concrete deliverables. The project objective for the QL phase is to realize a continued improved process for QL products from purchasing, production to sales. The deliverables are (Schermers 2011): Describe and improve the QL process, Design a report set-up, Implement Key Performance Indicators (KPIs), Provide solutions to realize a more flexible supply chain, and provide an Inventory Policy. In section 5.1 the implementation approach is described and explained in the next paragraphs per step. In section 5.1.1 the process optimization is described. In section 5.1.2 the modeling of the forecast, inventory policy, pricing, service level, account management, and production are described. Section 5.1.3 is about the reporting structure and section 5.1.4 is about the communication structure. This chapter ends with a conclusion in section 5.2 that is about what was learned from QL and what will be used for the implementation at Luxon.

## 5.1 Implementation approach

The approach of this project is shown in Figure 11 below. In this model some steps are indicated and describe a way to deal with this project. Per step of the model the actions that are taken are described in the figure below. This approach has the following steps: Process optimization, Modeling, Communication, and Reporting. In the optimizing step the overall process are shown in an overview. The modeling step is about the forecast, inventory policy, pricing, service level, account management, and production that have to be organized and set. The reporting and communication steps are about the monitoring of the organizations performance with KPIs. In the next sections the steps of the approach are explained in more detail per step.

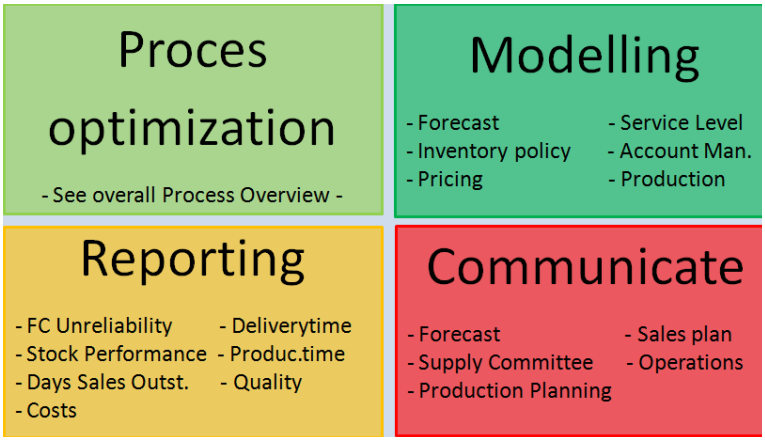



Figure 11 Cycle of Deming modified by Schermers (2011)

### 5.1.1 Process optimization

The approach starts with an overview of actual processes that are important for OE. The following process overviews are optimized: Overall process overview, Sales Order Management, Sales Planning, Sales Order Management, and Supply Planning. The process overviews can be found in Appendix I. The optimization of the processes is done were it was possible, only process steps that are essential are shown in the overviews.

### 5.1.2 Modeling

The next step in the cycle is the modeling of: Forecast, inventory policy, pricing, service level, account management, and production. The first step was to analyze the quantitative data about the quantities that are sold in the past. Analyzed parts are total sales, number of orderliness, gross margin, and number of orders divided in order categories till 100, 100-1000, and more than 1000. The division of the order categories is done on basis of the analyses. The observations of Schermers (2011) quantitative analysis are:

- Majority of orders are with the orders & order lines with a quantity less than 100 pieces
- Gross margin of these orders are better than the bigger orders (logical)
- The smaller orders provide 53% of total gross margin and 44% of total sales
- Big orders however provide 9% of total gross margin and 19% of total sales, but have high impact on market awareness

The conclusion is that every order category demands a different approach for both logistical and commercial reasons. The solution is that they have indentified three approaches to deal with the order category differences. The order quantities are: small orders (<100 pieces), midsized orders (<1.000 pieces), and projects (>1.000 pieces). The agreements in Table 1 are made about order handling per category:

| 1. Small order quantities (<100 pieces per order) | 2. Mid Sized orders quantities (< 1.000 pieces per order) | 3. Projects (> 1.000 pieces per order) |
|---|---|---|
| · These orders probably need quick stock delivery | · These orders need planning by customer, | · These orders need to be discussed with Nedap NL |
| · Order process completion within 48hours (from order receipt to sending invoice) | · Order process completion within 3 weeks (from order receipt to sending invoice) | · 30% of order quantities delivered after 3 weeks (goal) |
| · Shipment ex-works (to be discussed) | · Shipping conditions are DDP (for new customers to be discussed) | · Shipping conditions and handling costs are subject to quotation |
| · Order handling costs (small order surcharge) | · No order handling costs | |
| · 97,5% service level guaranteed | · 97,5% service level guaranteed | |

Table 1 Order handling agreements per category, Schermers (2011)

It all starts with a reliable forecast. A forecast is needed to calculate what to have in stock. To create a reliable forecast the top 30 customers (90% of sales) are asked to give prognoses of what they expect to sell. In Appendix 1, the process for forecasting is shown. The following agreements are made: Every quarter customers send a forecast, Customer forecasts are not binding, but subjects for discussion. Forecasts are based on top 30 customers (90% of sales), are executed by office USA, processed in NL for Operational purposes, and align sales forecast with sales budget.

The objective is to decrease the unreliability of the forecast. In Appendix II, a spreadsheet of the forecast is shown. This forecast is used to calculate stock levels. The stock levels are calculated in an Excel file and are done on basis of how the quantities were divided in the past, the forecast, service level, and the lead time. The formula to

calculate the Safety Stock (SS) is: SS=Service level x standard deviation x √ Lead time. The formula for the Re-order point is: demand during Lead Time + SS. In Table 2, a fictitious overview of the calculation of the stock level is shown.

| Group | Value of SS | Value of ROP | Quantity FC USA | Avarage Stock Level | Average Stock Value | Lead Time | SS% | ROP% |
|---|---|---|---|---|---|---|---|---|
| Gen | € 112,145 | € 549,321 | 49,501 | 8,954 | € 330,733 | 10 | 8% | 23% |
| Lamp | € 69,872 | € 357,980 | 48,524 | 6,548 | € 213,926 | 9 | 7% | 18% |
| PC | € 21,243 | € 96,788 | 47,132 | 5,431 | € 59,016 | 9 | 7% | 18% |
| Total | € 203,260 | € 1.004,089 | 145,157 | 20,933 | € 603,675 | | 7% | 20% |

Table 2 Calculated Stock levels Schermers (2011)

To give a better understanding of this model, the calculation of SS and ROP is created for eleven different lamp types, twelve generators, and 3 different power couplers. The Lamps and the power couplers are ordered externally. The generators are produced at Inventi and orders have a fixed loading period of 8 weeks. Forecasting is very important, but as we know, forecasts are always wrong. This is no surprise, because the forecast is made on the basis of 30 customers who are also trying to predict the future. In order to deal with the forecast unreliability the formula contains a 40% standard deviation.

### 5.1.3 Reporting

The reporting phase is to check if the set of goals are achieved and how the stock is performing. The software program Qlikview is used. Qlikview is a flexible Business Intelligence platform for easily consolidate, and visually analyze all data for business insight. The performances of the set KPIs are visible in Qlikview that is developed at the same time as the implementation of OE. With Qlikview a dashboard is created to monitor the performance. Efficient organization of the operational processes will be described as customer satisfaction, cost control, and process quality. Under each description the measurement is done with the KPIs showed in Figure 12 “the implemented KPIs” in the process are shown.


Figure 12 Implemented KPIs overview, Schermers (2011)

In order to measure the customer satisfaction KPIs are used to get more insights in the experience of customers. The KPIs that can be used are: *Stock availability, Out of stock, Quality and Delivery Reliability.* With these KPIs it becomes clear how well and fast Nedap delivers. Main attention will be stock value. With cost control I will look further to the KPIs: *Stock Value, Days Sales Outstanding, Trough put time, and stock turns.* The KPIs provide an overview and on the basis of these KPIs the amount of products in stock can be controlled. The quality of the supply chain processes will be measured with the KPIs: *delivery reliability, forecast reliability, lead time, and stock value.*

### 5.1.4 Communication

The next step is communication. The different parties involved in this new model need to know what the new agreements are. Firstly the internal organization of Light Controls, secondly Inventi, the production company of Nedap, and thirdly the customers need to be informed. Internal communication about the model will be in a supply committee at every start of a new financial period. In the supply committee Sales and Supply are aligned and agreed. In the supply committee the operation manager, account manager, quality dept, accounting, business unit leader are attendees. In this meeting the KPIs are reviewed and prognoses are adjusted. Explanation of the new concept to the customers is needed in order to realize a stable forecast process for customers. Every quarter the customers are asked to communicate their prognoses for the coming year and feedback of actual Sales are given to the customers as well. It is important to explain customers the need of prognoses and what the benefits are for them.

## 5.2 Conclusion

The implementation of OE at QL is mainly done and executed by the project leader. The steps from the project approach are taken and the OE structure is in place. Processes are optimized in a proper way. Within the modeling step the forecasting process is made and started. Order handling agreements are made for different categories divided on basis of order quantities. Further, the stock levels are calculated in a stock model on basis of handling agreements.

I learned a lot from the implementation of OE at QL. Important is to start with finding out what the deliverables are for the implementation of OE. Stakeholders have to be interviewed to find out their demands from the supply chain. With the management of LC the demands from the supply chain should be discussed and translated in deliverables. After that, a timeline that outlines when the deliverables become effective can be created. The used project approach in figure 11 can be used, but probably a more dedicate project approach should be developed.

The stock model is a very important tool to create. In the model the different setting of the variables delivery time, standard deviation of the forecast, service level, and lead times can be simulated. The input for the model is an accurate forecast. With the model the developed categories can be calculated with specific setting. The model is used to calculate the safety stock and the maximum stock that can be set as a goal to reach for the stock level.

With implementing OE, a clear policy is implemented for different product categories if that is needed. For QL we saw that every order category demands a different approach for both logistical and commercial reasons. The categories for QL are based on the size of the orders. Important is to find out if the same categorizing of products is applicable for other product groups or to find out other methods to categorize products if that is necessary.

The importance of reporting and communication should not be underestimated. OE does not end with implementing a policy, a stock model, Supply meeting, reporting structure, and improved processes. It is a nice start but with a continuous improvement structure the supply chain should keep improving end never ends.

# 6 Lessons learned: opportunities for improvement

In chapter four I made a theoretical framework and in chapter five is described what is done before this research started by the hired consultant. During my search of what OE is and developing an initial understanding of OE several opportunities surfaced that I could improve during this research. As described in section 5.4, a supply meeting is organized every start of a new financial period were the data about the past and the future are discussed and analyzed. In the form of a FG setting this supply meeting takes place. New actions are planned to keep improving OE for the QL product group. Most important in the meetings were the new calculations in the model that was developed. Discussions were about the stock level, production prognosis, and forecast.

Opportunities for improvement that surfaced during my research were discussed during several supply meetings. In section 6.1 the improvements done for QL with AR are explained. The next section 6.2 is the transition described from what we learned from the implementation at QL to what we can use for the implementing OE at Luxon. In the section 6.3 the opportunities for improvement at the supply chain Luxon are described. The Layer planning model is used to analyze the factors: Management & organization, infrastructure, people & culture, and processes & services. The performance of the company balances and depends on these factors. The model is used to support me in finding out were opportunities for improvements are and defining how the improved factors should look like. This chapter ends with section 6.4, the desired performance for the Luxon supply chain is described with the result of improving the mentioned factors.

## 6.1 Improvement opportunities done in the QL phase

The first Supply meeting had a lot of possible actions for improvements. The actions where researched with the use of AR. The use of the AR cycle helped in gathering data; analyzing the data, planning, and improvement of the subject. In this section several actions that I did during the analysis of the QL phase and the search for the right model for Luxon are described.

The used print of the model on A3 paper needed some attention to make the information easier to find and understand for the attendees in the supply meeting. With layout changes in the Excel sheet the data was easier to find and understand. Also column titles and formulas were added for a more understandable overview. In the second meeting this resulted in a better understanding of the print out and the discussion was more to the point.

Besides improved layout, the model had to be developed further into a more flexible model that also can be used to simulate stock. Making the model more flexible and simulating stock levels the variables had to be taken out the formula and into an input field. The input field is shown in Table 3. These input fields help to adjust the model to the situation. If the forecasts are more reliable and the standard deviation is steady on 30%, than this can be changed and the model calculates the new stock levels. This also applies to the Service level that is easy to adjust. In this way the model can be changed easily and quickly, and can be simulated what happens if the forecast is more precise if the service level is downscaled. This results in new goals for the stock level.

| | | |
|---|---|---|
| Service level | 97.50% | 1.96 |
| Standard Deviation over Forecast | | 40% |
| Lead Time calculation maximum stock | 4.33 weeks | 1 |
| Amount on projects maximum | Multiply with | 0.5 |
| Safety Stock | € …. | |
| Average stock | € …. | |
| Maximum stock level (ROP) | € …. | |

Table 3 Input table calculation SS and ROP

More in detail, the used lead time for the maximum stock is 4.33 weeks; however the fixed period for orders at the production unit Inventi is 8 weeks. First the model was calculating with a lead time of 8 weeks, an improvement was to set this to 1 month. The reason for this change is that every month a container with produced products is send to the stock in the USA. For the maximum stock the amount of products in stock can be lower than the demand in 8 weeks, because a new load of products is already on its way that refills on monthly basis.

Some other improvements were made in order to fine-tune the model. The historical data about the sales and the categorizing in groups for the ordered amount contained some values that made the model less reliable. With a more precise analysis this resulted in a better analysis for categorizing in groups. The projects in the past are also in the model for calculating some extra stock for new project business achieved. This extra generated stock was also too high, so by multiplying with 0.5 he generated stock for projects was cut in half as correction.

The diversity of different generators that are on stock is quite high. The main distinction of the twelve generator types is that one halve is dimmable and the other halve isn't. What would really help in decreasing the stock level is that all versions have the option to dim the light. The price of a dimmable type is a couple of euro's higher than the non dimmable, but a lower stock of a couple of thousands of euro's would weigh higher than the price difference positive side effect is that a dimmable product that saves energy is delivered at the same price. Therefore the decision is made that only dimmable version will be produced. The action is planned for the end of the year, so new price lists can be made, the whole supply chain can be informed, marketing action can be made, and the stock of non dimmable products decreased till zero.

During some of the Supply meetings it has been agreed for a couple of times that the stock level is still too high, because the stock turns are too low. This means that with less stock the same delivery standards can be achieved, so production orders have to be canceled to lower the stock level. The above described model helped in this process of lowering the stock levels. Besides correcting and improving the model also the Sales forecast was too high and in the meeting agreed to downscale the Sales forecast. All in all, the goal for QL stock in the end was about a million Euros lower than when we started. The real stock level is slowly decreasing over time, but at the end of the year we expect that the stock level is in line with the goal for maximum stock.

## 6.2 Learned lessons from the QL phase

The analysis of the QL phase helped me with finding out what OE is, and finding out what is done till now. Several subjects for improvement surfaced during this research and were improved by applying AR. Some of the improved subjects can also be used for the Luxon phase. The improvement of the Stock model gave a lot of insights in how to create a model for Luxon. The stock model is important to use for the creation of a quality stock. The model captures all variables and can be used for adjustments and steering when unexpected things happen in the Market or in the supply chain.

What is learned from the QL phase and will be use for the Luxon phase is the following:

- Conduct interviews with management and discuss the deliverables
- Set the deliverables and outline the supply chain
- Important is to create a timeline that outlines when the deliverables become effective
- The demands should be researched in order to find out what Sales, Production, and customer demands are from the supply chain
- The actual stock should be optimized before a quality stock can be created

- Different settings of the variables delivery time, standard deviation of the forecast, service level, and lead times should be simulated in a stock model
- The right mix of the variables should be chosen by simulating the Safety Stock and the maximum stock
- After implementation, a meeting to facilitate communication about the forecasts, Service Levels, and to monitor the performance should be scheduled
- People and culture have to be committed to the plan and carry the plan
- That means that a CI culture has to be created by communicating and taking actions to keep improve the performance of the supply chain.

The learned lessons above will be used for the development and implementation of OE at the Luxon supply chain. In the next section the mentioned learning's from QL and the possible organizational shortcomings are described for Luxon in the layer planning model.

## 6.3 Opportunities for improvement supply chain Luxon

In the section above the lessons learned from the QL phase are described. In this section the layer planning is made with the obtained experience and knowledge in my research. Recall from section 4.3, the layer planning model is explained, and here it is used to define what the present situation is and what the opportunities are for the improvement of the supply chain of Luxon. The layer with the opportunities for improvement describes more or less the precondition that determine together how successful the implementation of OE will be. The model supports me to define what the opportunities for improvement are when implementing OE for the Luxon supply chain. Through planning actions per factor for improvement between the different layers in time the "Layer planning" is created. The goal is to align these factors and create a balance between them to facilitate performance. In the coming sub sections these analyzed factors are described and solutions are indicated on how the layers can be improved. This chapter ends with a layer that shows opportunities for improvements and will be used as input in the next chapter where OE is develop and implemented for Luxon.

### 6.3.1 Actual performance Luxon supply chain

The different factors of the model have influence on the performance of the organization. Firstly, the performance of the actual organization for the Luxon supply chain is described. The stock levels are too high when the comparison is made with the total Sales. Looking further and ask why stock is high and what is actually in stock, it surfaces that an overview of what is in stock is unclear. A part of the stock serves for commercial purposes, part is obsolete, and a part consists of components for production. Nedap had to buy components for big projects that are hard to get and long lead time items. What is known is that the stock turns are too low.

The supply chain in general has further a low flexibility. For instance the products that serve commercial purposes are made to stock. Product types differ mostly not much, but after assembly is changing one type in another is too much work. That raises questions about the decoupling point. Should the stock consist of assembly parts or finished products for instance? The model to calculate stock levels, the decoupling point, and the development of the model are taken into account in the next chapter. Further the learning curve is slow, because the lack of KPIs for instance to monitor the process and learn from the faults of the past. In Figure 13, the analysis of the actual organization is analyzed per factor. In the middle the performance are shown and around the factors are shown that influence the performance.

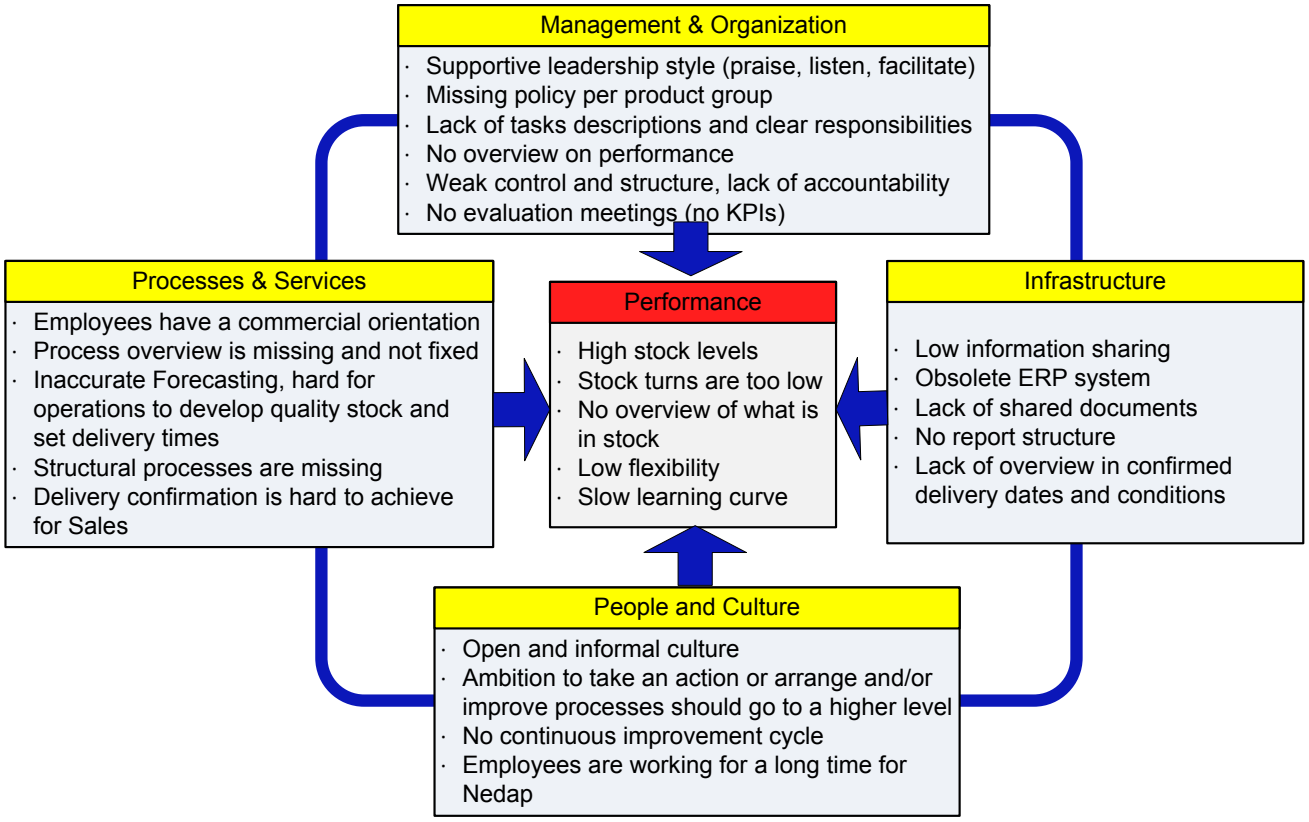



Figure 13 Actual situation Luxon

### 6.3.2 Management & organization

In this factor the organization structure, performance indicators, and management steering principles are described. With steering of the organization is meant the way that processes are steered and controlled. Think about the level of support, level of delegation, result responsibility, performance indication, and steering tools. Nedap offers their employees the opportunity to be entrepreneurs and has a horizontal structure. That means that it is not the place in the hierarchy that matters, but the quality of the arguments. Initiative, perseverance and personal entrepreneurship are crucial. At Nedap, personal entrepreneurship means taking responsibility and converting ideas into action. The ideal world of an organization that has personal entrepreneurs that taking responsibility and converting ideas into action is also in the case of the Luxon supply chain not totally true.

Applying this layer on the present situation of the business unit LC than the unit can be described in a quick scan as follows. The policy per product group is missing, so also for Luxon. Some examples are that there is no clear service level, no goal for the maximum stock level, and no fixed delivery times. That makes the central goal vague and not clear for the employees. Besides, there is a lack of tasks descriptions and clear responsibilities. Further, the structure and controls are weak, what results in a lack of accountability and no evaluation meetings. These mentioned points are the result of a supportive leadership style (praise, listen, facilitate) that is in line with the organization of Nedap.

The possible subject for improvements mentioned above for the Management and Organization factor are initiated in the next layer. Different solutions and improvements are possible and are described here to give a direction to go. The management should start with defining the policy per product group, especially for Luxon of course but the other product groups as well. The policy for Luxon should says something about the turnover goal,

service level, fixed delivery time, goal for the stock level, and maximum stock turn in days. When that is clear the accountabilities per responsible should be defined and communicated. The development of a Dashboard on basis of KPIs would be an outcome. That will also make it easier to control the processes and tasks and responsibilities can be described per KPI. The importance of these actions is that commitment is created for the processes within the supply chain. Management should steer on continuous improvement what means that they should facilitate employees to learn and share information to keep improving processes and performance.

### 6.3.3 Infrastructure

Infrastructure is about the long term plans for IT infrastructure within the organization. The systems should facilitate the information that the processes need to operate. The internal information sharing could be improved, because the abilities to share information are installed but finding the right documents in the shared map is a time consuming job. What is missing are documents that are leading or a reporting structure to improve the sharing of information. The ERP system in place is obsolete in comparison with new available systems where more information can be added and the ERP gives more possibilities. An example is the automatic generation of reports about performance measurement.

The best improvement that can be made is the replacement of the obsolete ERP system. Actually, this action is already planned at the end of the year so no investments will be done in trying to improve the ERP system self. What can be used is Qlikview that uses KPIs for measuring the performance of the supply chain and shows this in graphics as we already saw in the QL phase. With the implementation of KPIs in Qlikview the Stock levels (SS and Maximum Stock) can be monitored. With a report from this system the sharing of sharing of information will be improved and a monthly meeting to facilitate information sharing should be planned. The system can facilitate the reporting by automatically generating reports and sending them to the mail boxes of the responsible employees to confront them with the actual performance.

### 6.3.4 People & culture

The factor people and culture looks at the perspective of the employees on the organization and their own possibilities within the organization. Think about the determination of tasks, competences, and responsibilities. Recall from the Management and organization section the organization of Nedap offers its employees the opportunity to be entrepreneurs and has a horizontal structure. At Nedap, personal entrepreneurship means taking responsibility and converting ideas into action. For the Luxon group the culture can be described as open and ambitious. With that in consideration it is imperative that the internal positions within the group take on a more pro active approach. First step's in getting this process started are initiated and showing results, nevertheless there is still work to be done to achieve a work environment where both internal and external staff challenge each other to a higher level. The switch between acting as a main supplier and selling own a product is one that will need time and coaching to overcome.

As action researcher the improvement of this factor started right away at the beginning of this research. In this role the preparing, leading, and initiate improvements are facilitated. In this research the advantage of the role as facilitator is that I am a young student that is a stranger for the organization with no position in the organization. That brings me as researcher in the positions to ask critical questions and surface problems that other FG members won't do. Here starts the realization of a CI culture by facilitating communication and information sharing between Supply members. Another important part is improving the communication between Inventi and LC. Important is that both parties realize that they should know what the interests of the other party is when they what to improve their relationship. Than they can take into account the needs of the other party. The importance in this relationship is that a good relationship lowers the administrative pressure and cost involved.

### 6.3.5 Processes & services

The factor processes and services is about the added value that the processes deliver for the organization. Processes are a collection of activities and their underlying connections that are needed to reach sustainable goals. Characteristically for processes is that they deliver products to other processes within the organization (internal customer) or to processes outside the organization (external customer). The importance of processes is that they are aligned to each other to reach added value in an efficient way. For Luxon in the organization of LC the process overview is not worked out. The alignment of processes is lacking within the Luxon organization. That is for instance the lack of a reliable forecast for Luxon that operations need to develop a stock and guarantee on delivery time. The reason is that the Luxon market is new for Nedap and that makes it hard to make a reliable forecast. The structural setting of processes is missing to operate efficiently and get the right information output. For Sales and Operations it is hard to achieve the delivery status of ordered products. That has to do with a lack of feedback on the delivered products that processes deliver to each other.

The first thing to do is make a process overview so the alignment between the processes can be improved. In and outputs between the processes become clear and tasks and responsibilities can be divided. Important general output of the whole process is that customers are satisfied. Customer demands have to be indentified to know how processes should be aligned to meet these demands. To measure the performance of the processes KPIs have to be set, so decide what information is needed to monitor processes and Services. The translation of the demands from the customers with the possibilities in product types, and production flexibility can be simulated in a model. A Stock Model should be developed for the determination of the stock levels to serve the demands of the customers and the alignment of Sales, Operations, and the manufacturing party Inventi. In the Figure 14, the preconditions are showed per factor.

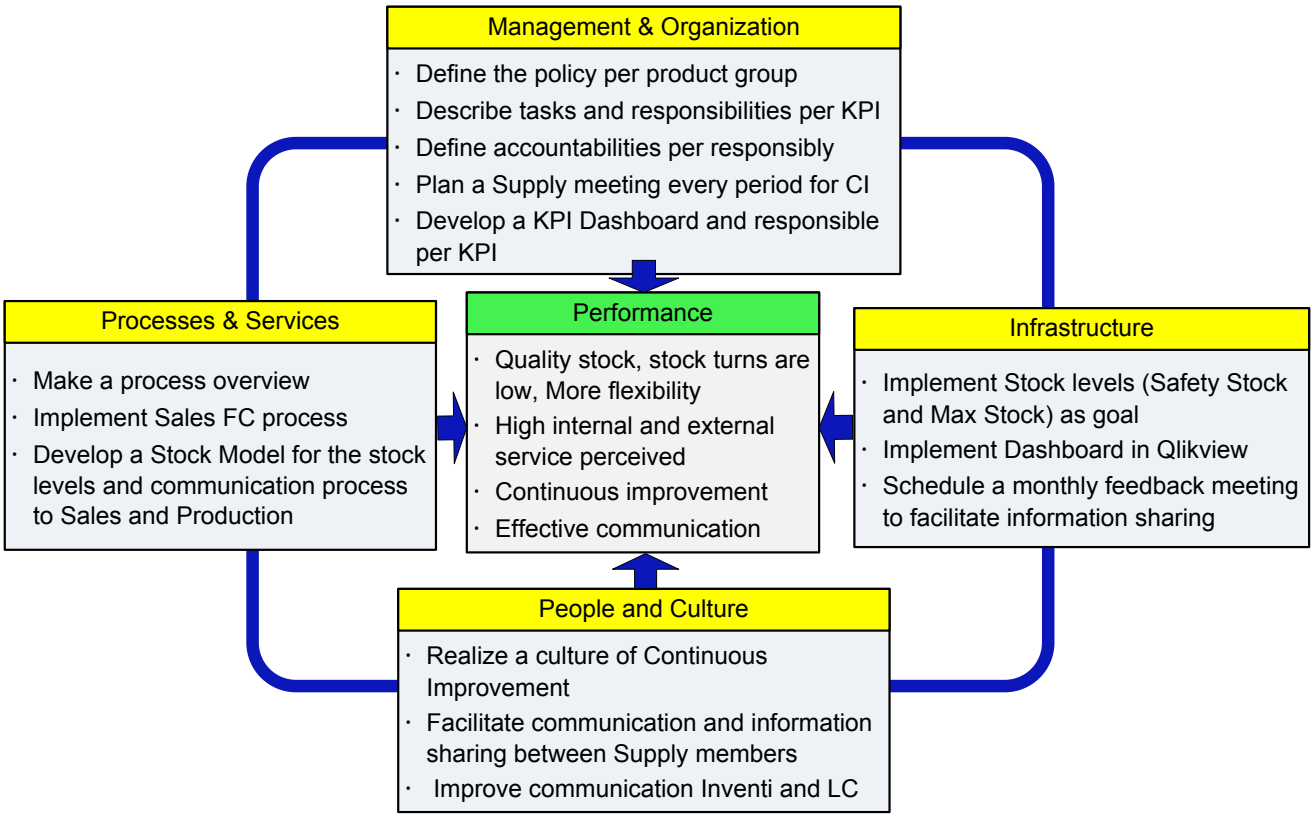



Figure 14 Preconditions for implementing OE Layer

## 6.4 Desired performance Luxon supply chain

The layer of the actual situation and how the factors can be improved are described. The factors are essential for a successful implementation of OE. Essential is that there is a particular steering by management with the support of the right resources and infrastructure in place. People and culture have to be committed to the plan and carry the plan. That means that a CI culture has to be create and the involved processes should be organized efficiently and mapped in an overview. These factors combined determine how successful the implementation of OE will be and that should result in improved organizational performance. The organizations performance can be expressed in a Quality stock with quick stock turns and flexibility in the supply chain, which results in high internal and external service. Important is to communicate efficiently and continuously improve the supply chain. The layer with the preconditions for implementing OE is showed in Figure 14, with the performance in the middle.

In the layer planning model per factor are defined what the present situation is and what the preconditions are to succeed in implementing OE. The difference between the created layer of the present situation and the created layer of the needed preconditions provide actions for improvement. Through AR the action for improvement are worked out and can be found in the next chapter.

# 7 Implementation of Operational Excellence at the product group Luxon

In this chapter the opportunities for improvement of the Luxon supply chain from the chapter before are translated into an implementation of several aspect of OE. That means that the whole process of developing and implementing OE for Luxon is described. The product group Luxon, differs from QL in the number of product types, their place in the PLC, and the market position. Another question that arises is; what to do about the high stock that has already been built up over the years. For measurement of the performance quality is needed without obsolete products, parts and components, and other stock items that disturb measurement of the products in stock that serve commercial purposes. During my research, I developed a project approach in order to make it easier to understand and to explain the taken steps in developing and implementing OE.

The essential preconditions in the previous chapter are used as input for this project approach. The project approach is shown in Table 4. Firstly, the approach starts with an intake is described at 7.*1 Operational Excellence Intake*, where the deliverables are set and the supply chain is mapped. Secondly, in 7.*2 Operational Excellence analyses, the* available data, actual situation, and demands from supply chain is analyzed. Thirdly, variables for the inventory model are modeled in 7.*3 Operational Excellence modeling* and efficiency improvement steps are worked out. Finally, the implementation is described in 7.*4 Operational Excellence Implementation.* All the modeled parts are implemented and actions are taken to work on continuous improvement.

| 7.1 Intake → | 7.2 Analyze → | 7.3 Modeling → | 7.4 Implement |
|---|---|---|---|
| Deliverables<br>Supply chain overview | Sales order lines<br>Demands Supply Chain<br>Product Life Cycle<br>Market position<br>Current Stock quality | Stock policy & KPIs<br>Key Performance Indicators<br>Stock model<br>Stock simulation<br>- Lead time<br>- Service Level<br>- Delivery time | Forecasting<br>Stock Model<br>Supply Committee<br>Reporting structure (KPIs)<br>Continuous improvement |

Table 4 Project approach

## 7.1 Operational Excellence intake at Luxon

The goal of the project is to create growth in Turnover with the same number of employees. To reach this goal for Luxon, a continued improvement process from purchasing, production to sales should be realized. The processes need to be organized efficiently from sales planning to delivery, so that they fulfill the demands of the customers; with low process costs, low stock levels but the right products types (that serve commercial purposes) in stock and optimized lead times. In Figure 15 the factors that influence the stock are shown. I made the overview to show what the connection between the disciplines that are involved in the creation of a quality stock. The disciplines Sales, Purchase, Production, Finance and Product Management have factors that have influence on the choices that they make. The factors customer service, customer demand, delivery time, order quantity, capacity, components in stock, budget, liquidity, assortment, and development are attached to the disciplines. The variables service level, lead time, and forecasting are shown in the model to illustrate their influence on the factors and disciplines.

**Stock influences**

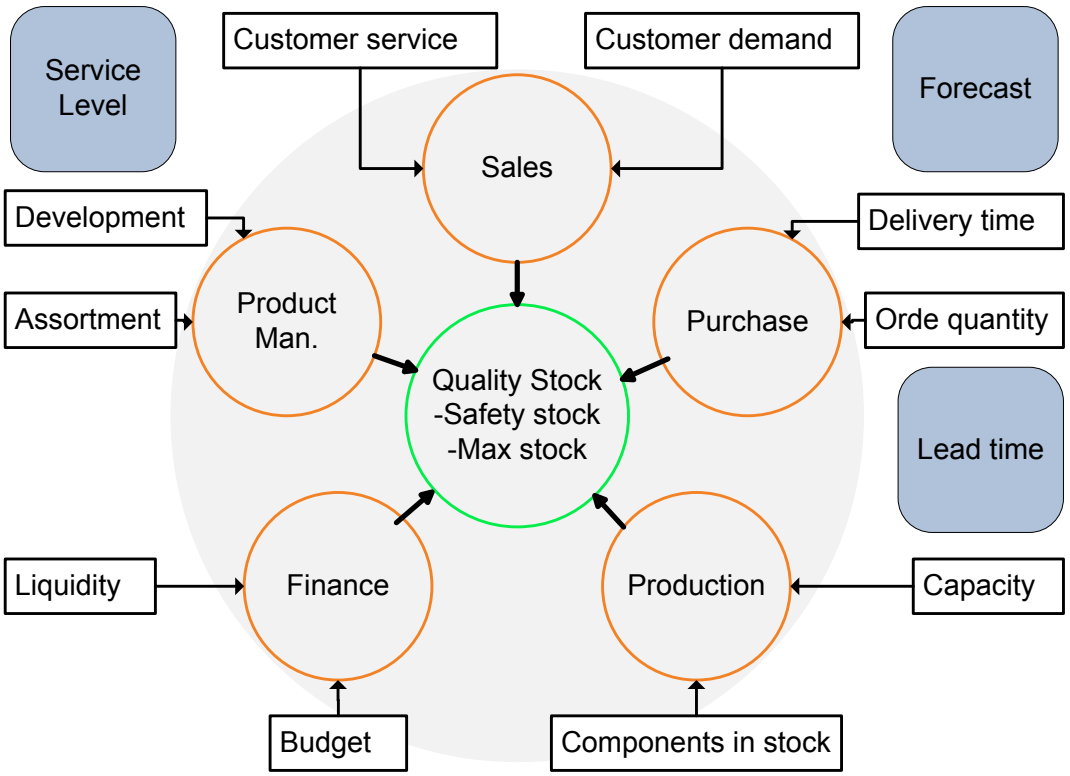



Figure 15 Stock influences

### 7.1.1 Deliverables

To realize a continued improvement process from purchasing to production to sales, the deliverables are set. The process needs to be organized efficient from sales planning till delivery, so it fulfills the demands of the customers with low process costs, low stock levels but the right products that serve commercial purposes. In this intake, interviews with management are conducted and the deliverables discussed. The deliverables for this project are:

- Supply chain process shown in an overview
- Define Key Performance Indicators
- Formulation of policy
- Realize flexible supply chain
- Structural report with KPIs
- Continuous improvement with KPIs

### 7.1.2 Supply chain in card

To start the analysis we need an overview of the supply chain in place. This process overview can be found in Appendix III. In the overview the different disciplines that are responsible for the process are shown on the left side. The processes are described in the rectangle illustrations, the outputs and inputs in are shown in the illustration of a document, and the stock is shown as a triangle.

## 7.2 Operational Excellence Analysis

In this second section the Sales order lines from the past are analyzed. This analysis is done to get more insights in ordering behavior of customers, margins, sold products, differences between markets, and total sales. The next section is about the demands that for instance Sales, Production, and customers have from the supply chain. In the last part the actual stock is analyzed and the lead times are worked out. In the next section the collected information will be used in converting the variables into a model.

### 7.2.1 Analysis Sales order lines

The E-series 250 to 400 watts are the product types that are already sold in the market. Other product types are sold in a small amount or still in development. Data is available from the past 2 years. Interesting data from these products are the turnover per product type, order amount, order behavior of customers, margins, differences between markets EU and US, and total sales. The content of this analysis is confidential, so the data is mainly expressed in percentages.

We saw in the analysis of the QL products in chapter 5 that they divided the order amounts in the categories till 100, 100-1000, and more than 1000. In the analysis of Luxon the categories are made till 100, 100-250, and more than 250. The categories are smaller, because the order amounts for Luxon are lower. In Figure 16, the graphics of how the value is divided by order size is shown. The total overview I made of the quantitative analysis of the order lines of Luxon can be found in Appendix IV. Main findings in the comparison of the Sales order lines Luxon EU and US:

- Most of the orders are smaller than 100 pieces (EU+US)
- Low difference in Gross margin between the categories till 100 and 100-250
- Orders EU till 100 are 52% of the total Sales EU
- Orders EU 100-250 are 48% of the total Sales EU
- Orders US till 100 are 56% of the total Sales US
- Orders US 100-250 are 31% of the total Sales US
- Orders US 250+ is 13% of the Total Sales US

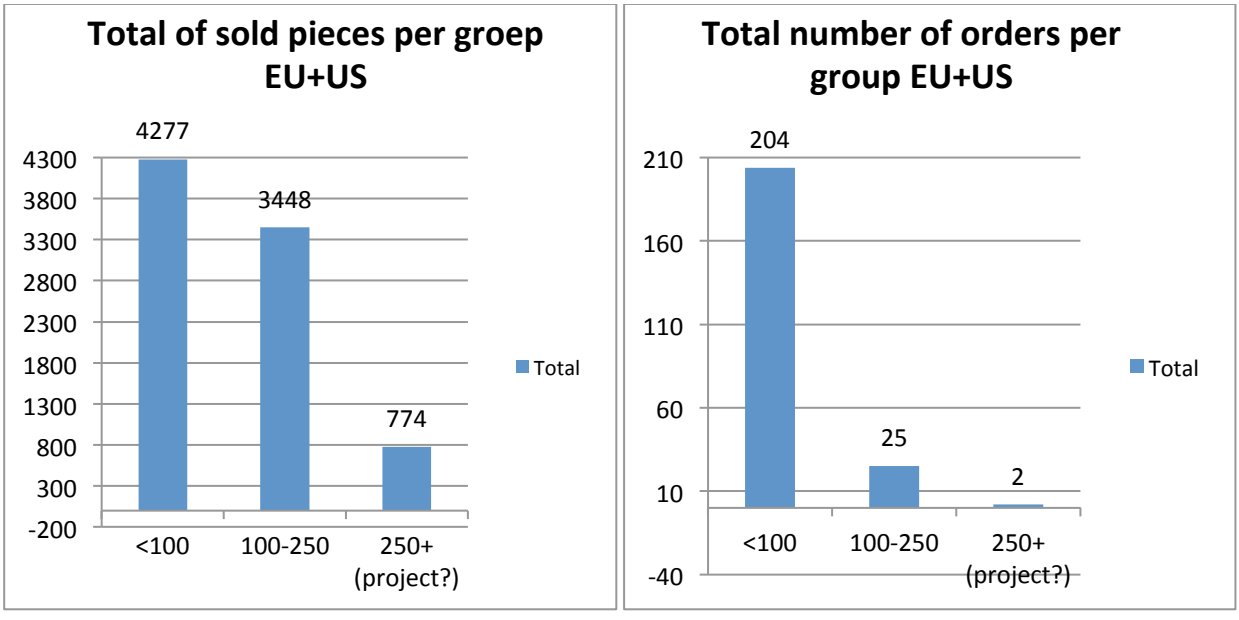



Figure 16 Order line analysis

After this analysis it turned out that the categorizing for Luxon would not work out. Most orders are under a 100 pieces and almost all orders below 250 pieces. This has to do with the size of the project. If Luxon has a project with 100 pieces then the size of the project is quite large. Also the bigger projects are known earlier on, because of customer contacts with a Sales manager in an early stadium. The Sales manager has to plan the project and installation a long time before the products should be delivered. A different planning method has to be chosen to deal with high stock levels that are needed to deal with large order amounts. The method to keep the stock as low as possible and still serve the customers will be discussed in the paragraphs below.

The analyses of the sold amounts per customer are shown per market in Figure 17. In the figure the top 5 customers are shown and the percentage stands for the amount of products that are sold to a customer. Under customers we also include the partners in the Sales network. The EU market consists mainly of one big partner (53%) and some smaller partners and customers. The same thing can be seen for the US market where one large partner is located and some small partners and customers.

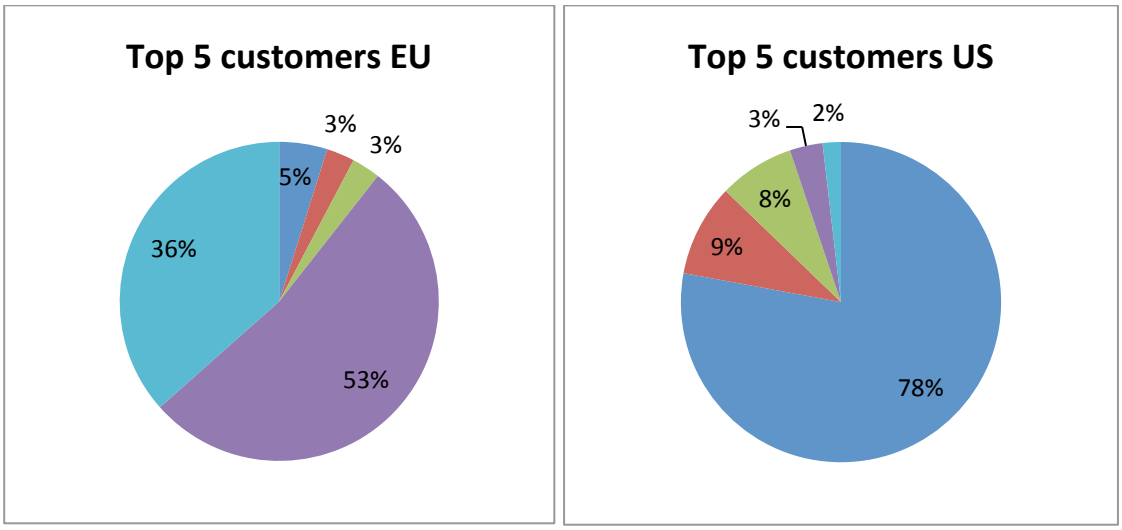



Figure 17 Top 5 customers EU and US (percentage of turnover)

### 7.2.2 Demands from Supply Chain

The question here is to find out what the demands are from the manufacturing party and what the demands for services are. According to (Towill 2000), the objective of supply chain management must be to satisfy end customer requirements. Firstly, the demands from the manufacturing party Inventi will be analyzed and described. Secondly, the Sales responsible employees for EU and US are interviewed. Finally, the large partners are interviewed to discover their demands from the supply chain. Topics of discussion are about the market they are in, preferred delivery times, forecasting, and what service level they would like to have.

Recall from section 2.1, Inventi is a wholly owned Nedap subsidiary that produces advanced and high-quality electronics. Inventi is set up entirely to produce larger series of fully developed products. The production company works with a small core of Nedap employees, in combination with a large team of flex workers. This working method makes it possible to produce electronics competitively, even in the Netherlands. This working method demands at the moment a detailed production prognosis from the business units.

The production process of Luxon ballast only works on the basis of good production prognoses. The inputs for the production prognosis are the forecasts made by Sales. The delivery time of some components and parts for the

Luxon ballast is about 20 weeks. The purchasing of parts and components is done on basis of the production prognosis. At the start of this research no clear agreements were made. Operations thought that the average delivery time was about six weeks depending on the availability of parts and components. After visiting Inventi, Figure 18, was made to show the lead time for Luxon products. In the discussion the production time turning out to be three weeks, but is dependent on the availability of space to produce, employees to produce and the components in stock. Inventi can be flexible when these three variables are arranged. In the modeling section is explained how this is done.

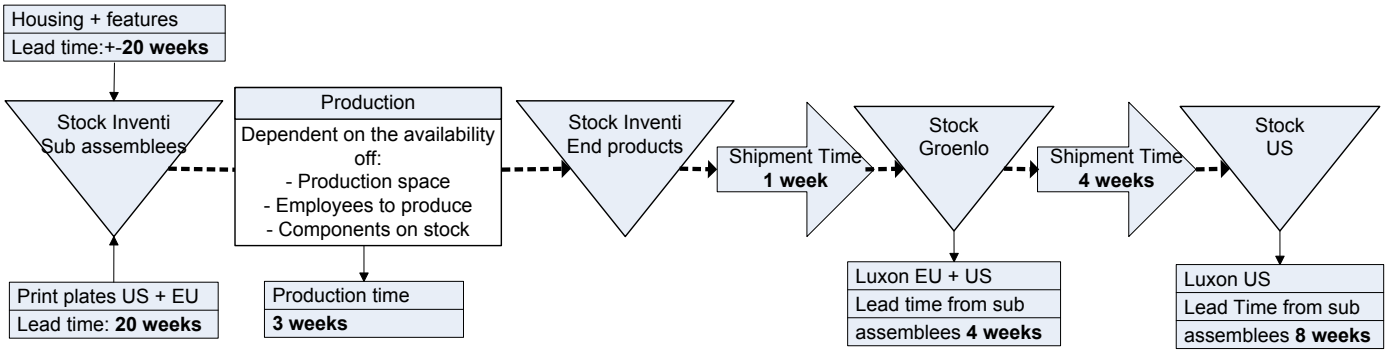



Figure 18 Supply Chain Lead times Luxon

Market demands are analyzed by conducting interviews with Sales team members and also by interviewing large partners. In, Appendix VI, the leading questionnaire can be found. The overall findings are that a lead time of six weeks is acceptable in Europe. A lead time of four weeks would be better and even be favorable. If we look at the order size, than the lead time depends on the number of products that are ordered. An example is that if a customer orders 10 pieces, installation can be done in a day, and can be planned on a short term. If we compare that with an order of 200 pieces then the value is high, installation is time consuming, and has to be planned a long time beforehand.

On questioning the service level it turned out that a service level of 95% is sufficient. In relation with the delivery time, the importance of the service level is clear. Conformation of the delivery time of four weeks than it should be delivered on time. If a project is scheduled on this delivery time and a team of installers are ready to start, then it cannot be afforded that the product delivery being too late. Besides, if a relatively big project for the installation of 100 pieces is done, then the possibility of products that are not working, miscalculation, and fall out due to wrong installation can happen. If they need for instance five extra ballast than they cannot wait four to six weeks. They need the ballast as soon as possible. This point gives some discussion, because this can be seen as a problem for the partner of Nedap and not for Nedap. Of course, if the ballast doesn't work than it would be a problem for Nedap. So, a small Safety stock would be nice that can serve for these issues but also for giving out samples to customers to test the ballast.

### 7.2.3 Place in Product Life Cycle and Market position

We have to take into account that Luxon is in some principles different than QL, so a different supply chain strategy is needed. But, what is the difference and does it matter? Let us start with the place in the PLC. At the moment QL is between the maturity and decline phase and the market position is stable. There are no new product developments, the market is stable, and customers are known. As described in chapter 5, a supply chain strategy has been made and executed for the QL products. However this supply chain strategy does not apply to Luxon, because Luxon is in the growth phase and the market position is not stable and settled. In Figure 19, the

PLC stage of QL and Luxon are shown. This means that for Luxon new developments are possible, but the market is uncertain and hard to predict, and the distribution network is still under development.

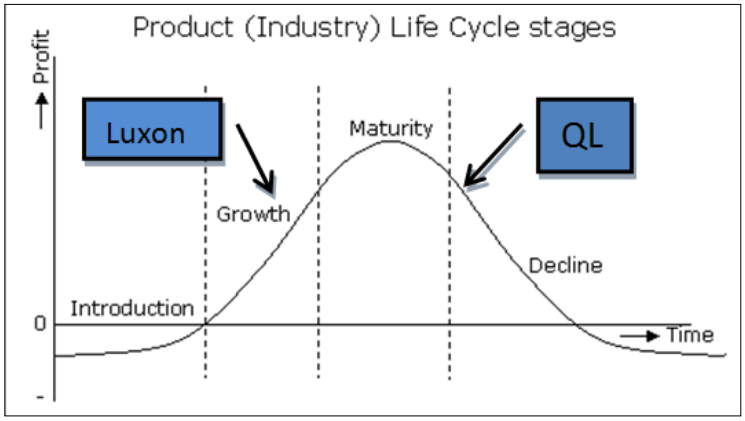



Figure 19 Product Life Cycle

The risk of product series in the growth phase is that new product types are developed and products in stock can turn obsolete. The uncertain market can change every day and this result in a high obsolete stock level. High stock levels mean high costs for organizations. The cost of stock is often underestimated, for instance insurance cost, investment cost, and risk of products turn into an obsolete stock.

Ideally stock would not be necessary, orders can be produced and components bought on the basis of customer orders. But, from last section we know, that the lead time is too long for this. Stock has to be created, to serve the customers on time. How to deal with the stock for Luxon is worked out in section 7.3 where a model will be created to deal with this problem of uncertain predictions.

### 7.2.4 Current stock quality

Let's start with the stock that already is build-up over the years. The real stock levels should remain confidential, so the amounts are fictitious. Imagine that the stock level is € 1,000,000 at the start of this project. The goal is that only products that serve commercial purposes are in stock. Part of the stock could still turn into obsolete stock. Obsolete stock can contain obsolete components and/or finished products that don't serve commercial purposes anymore. An efficient stock policy is needed to keep these numbers as low as possible. The components are used only in the production of ballasts. Time to market of new products make it a necessity to buy components beforehand. All ballasts are firstly developed at Nedap Groenlo till all faults are eliminated, before they are taken into production at Inventi Neede.

In general Nedap has the policy that products are not longer in stock than 70 days. At the moment 30% of the items in stock at LC fall within this policy (Wegman, 2012). After analyzing the stock it became clear that the part of products that serve commercial purposes was € 500.000 in value. The obsolete part, that have to be discarded have a value of € 100.000. The components combined have a value of € 400.000 that can be transferred to Inventi. Finding out what products could go to Inventi, what is obsolete, and what is not. After analyzing the stock a list was made, the products were divided into products that serve commercial purposes, obsolete products or components that should go to Inventi.

A project team was created in order to reduce the stock. A list of 497 different article numbers of products and components in stock had to be evaluated. At every article number an action should be defined and decisions had to be made. The components that should go to Inventi had to be counted per article number, the number of

pallets, and indicated which location it needs to go at Inventi. The complete list of all components that are not obsolete has to be discussed with Inventi. First a plan was made to transport all components to the stock at Inventi.

## 7.3 Operational Excellence Modeling

In this chapter the variables for the inventory model will be modeled and efficiency steps are worked out. The first step was to create a stock policy and define KPIs to measure the performance. Secondly, the stock model is developed, products are categorized, and formulas are explained. Finally, a simulation of the inventory model is executed by filling in the forecast. Different settings of the variables delivery time, standard deviation of the forecast, service level, and lead times are simulated.

### 7.3.1 Stock policy and Key Performance Indicators

In general Nedap has the policy that products should not be in stock over 70 days. To achieve this policy some agreements have to be made to fulfill this policy in the future. From the analysis part of the stock quality we know that 40% of the stock level was parts and components. Another 10% was obsolete stock that consists mainly out of obsolete parts. The policy since all Luxon products are released for production at Inventi is finished products. That can be Luxon Ballasts, accessories, and controls. Parts and components used for production will be booked to the production department and no longer are LC stock. Another part will be booked to the service department that needs parts and components for replacements.

The start of OE is done with a stock that only has finished product and the policy of maximum 70 days in stock can be taken into account. Also, the KPIs are based on the right products in stock without the parts and components that give a wrong or different view on the graphics produced by the KPIs. The stock created by the Service department and the production department is now known and directly visible for management.

With the KPIs the quality of stock can be measured and monitored. Measuring and monitoring supply chain performance reveals the gap between planning and execution and helps companies to identify potential problems and areas for improvement (Chae 2009). The KPIs are developed during the implementation and improvement phase at the QL product group. The KPIs can also be used at the Luxon product group in the same way. Redesigning here is not needed anymore, because the QL phase was leading in the development of the KPI dashbord in Qlikview.

### 7.3.2 Stock model

In this section a stock model is created for the simulation and calculation of the Stock level. According (Olhager and Persson 2006) *"The search for operational excellence includes both a thorough understanding of the nature of the manufacturing operations and a choice of the right production and inventory control system for the environment in which it will operate"*. They continue that with understanding the nature of manufacturing operations can be facilitated by simulating the manufacturing system, so that the interrelationships among parameters can be studied. The development of the stock model is done during this research. The stock model used for QL can't be used, because of the differences mentioned in the beginning of this chapter. The model will consist of all the 59 product types of Luxon including the accessories and controls. Per product type a Safety Stock (SS) must be calculated and a Maximum Stock. The formula to calculate the Safety Stock (SS) is: SS=Service level x standard deviation x √ Lead time. The formula for the Re-order point is: demand during Lead Time + SS.

The input for these formulas is the Forecast that are made by the account manager for the US an EU. From the analysis part we use the Lead time of 4 weeks and Service Level of 97.5% to calculate the Safety stock and

Maximum stock. With the delivery time extra time to refill the stock is created. If delivery should be immediately, then a higher stock level is needed than for instance with a lead time of four weeks. When a delivery time is accepted that is longer than the lead time the production and shipment combined, products can be produced on order. In such case no stock of end products is needed. The importance of reducing the Lead Time is high, because a reduced LT means a lower stock. Recall from section The DP as showed in

In order to provide appropriate customer service for different types of product and their relative customer requirements, product categorization is required to indentify different generic groupings of products (Towill 2000). For The different Luxon types it turns out that a part is sold on a regular basis and a forecast can be made. The other products are sold on a more irregular basis and forecasting is very hard to do. To deal with this difference in product types the terms “Mainstream”, “Special”, and “Custom” are introduced. The idea to divide product types into these groups is derived from interviews with the Operations Manager from the business unit Retail. They also had to deal with a large amount of products types. With this product categorization the product types of Luxon can be divided into three groups. The different groups have the following meaning:

Mainstream → Product “runners” and new products with forecast
Special → Special products with low Sales volume, old products (phase out)
Custom → Customer specific products

All product types are categorized in Mainstream products or Special prodcuts on the basis of Sales volume. No custom products are defined, because this is only done when a customer orders a specific Ballast that will be a project in itself. Now diferent product types are defined. In these groups the DP can be on three different positions to provide appropriate customer services per group. This is a balancing process between the delivery time requested by the customer and the throughput time in the purchaising, production and distrubution process (Hoekstra and Romme 1992). The shorter the lead time and the more flexible the organization, the furhter upstream a DP can be located.

In Excel a Stock model is created on basis of the information collected during this research. In Figure 20 the stock model is shown with fictitious prices. The developed stock model for Nedap contains 122 rows of article numbers. 70 are product types of Luxon, 35 for EU and 35 for the US (59 different types, but some types can be used in EU and US). Then there are 42 accessories for Luxon in the product list and again part is for US en a part for EU. The last 10 are controls for Luxon systems. The whole stock model for Luxon can be found in Appendix V.

| Stock EU for orders smaller than 250 | | | | | Forecast per month | Lead Time months | Safety Stock= Service level x amount x root of LT | Maximum Stock= Pieces x Lead Time + Safety Stock | Safety Stock Value | Maximum Stock Value |
|---|---|---|---|---|---|---|---|---|---|---|
| LUXON E FIXTURE / WIRELESS | 9949291 | LUXON E250-3EU-ZXBH-WS | Mainstream | € 50,00 | 150 | 0,9 | 112 | 247 | € 5.600 | € 12.350 |
| | 9958983 | LUXON E320-3EU-ZXBH-WS | Special | € 50,00 | 10 | 0,9 | 7 | 16 | € 350 | € 800 |
| | 9955364 | LUXON E350-3EU-ZXBH-WS | Special | € 50,00 | 10 | 0,9 | 7 | 16 | € 350 | € 800 |
| | 9949917 | LUXON E400-3EU-ZXBH-WS | Mainstream | € 50,00 | 150 | 0,9 | 112 | 247 | € 5.600 | € 12.350 |
| | | | | | | Total | 238 | 526 | € 11.900 | € 26.300 |

Figure 20 Stock model Luxon

With the created stock model operations has an overview of the products that are sold in the US and EU. In the next section the stock will be simulated in the created model. This stock model provides the following information:

- Products that are sold in EU and US
- List of accessories EU and US
- Categorizing in Mainstream or Special
- Cost price per article
- Forecast EU and US
- Lead time per article
- Service Level
- Needed Safety Stock and Maximum Stock

### 7.3.3 Stock simulation

The created model is used to simulate stock levels of the safety stock and maximum stock. With the simulation of the stock different variables can be set in order to create a quality stock. This means that the right products are in stock when the customer orders, products are not longer in stock than 70 days, and delivery can be within the promised delivery time. The simulation is done to find out what the stock value would be for different settings of the service level, standard deviation over the forecast, the lead time, and the delivery time. The stock model as shown in Figure 20 calculates the value of the safety stock and maximum stock with the variables that are in table 7. That means that changing the variables in the input field of table 7 the values in the formulas of Figure 20 change as well and new stock levels are calculated. Important output of the model is the value of the safety stock and the value of the maximum stock level. The value of the stock should be set on basis of the total Sales budget. Nedap has in general the policy that products are no longer in stock than 70 days. The total stock value should be around the value of the sales that can be done in 70 days. An example:

| | |
|---|---|
| Total Sales budget: | € 1,000,000 |
| Sales in 70 days: | € 191,781 |
| Margin 30% | € 57,534 |
| 70 days policy: | **€ 134,247** |

The variables that can be used to steer on this policy are the Service level, standard deviation over the Forecast, and Lead time. The Service level can be set as well as the Lead time. The standard deviation over the Forecast is more an output of the model, but in the beginning this will be set at 40% on basis of the data of forecasting reliability. The Lead time is at the moment 4 weeks for Luxon Ballasts. For the US the Lead Time is 4 weeks longer due to shipment transit time. To set the variables and simulate different outcomes the stock input table is made. In Table 5, the Safety Stock, average Stock, and Maximum stock are calculated in the simulation model with fictitious values. The Maximum Stock is in this calculation in line with the total Sales budget.

| **US or EU** | | **EU** | **US** | |
|---|---|---|---|---|
| Service level | 97.5% | 1.96 | 1.96 | |
| Standard Deviation over Forecast | % | 40% | 40% | |
| Lead time | Weeks | **4** | 8 | |
| Mainstream Delivery time | Weeks | 4 | 4 | |
| Special Delivery time | Weeks | 6 | 8 | |
| Safety Stock | | € 40,000 | € 60,000 | € 100,000 |
| Average Stock | | € 60,000 | € 90,000 | € 150,000 |
| Maximum Stock (ROP) | | € 80,000 | € 120,000 | € 200,000 |

Table 5 Stock simulation input field

If stock values are not in line with the stock policy then for instance the Service level should be adjusted to 95% in order to lower the stock level. Another variable is the delivery time to lower the stock level, although customer demands should be taken into account. An improvement in the production process that reduces the lead time will also lower stock levels or the stock level can remain the same with a higher Service Level or shorter lead time. The last variable is the standard deviation over the forecast; this percentage should be as low as possible. Accurate forecasting is hard but very important for calculating the stock levels. With the stock simulation model different scenarios can be calculated.

After the simulation of Luxon Stock levels the right mix of variables and DP are set. The Service level will be 95% for Luxon, the standard diviation of the forecast is 40%, and the lead time is 4 weeks for EU and 8 Weeks for the US. The DP are set per product group and also the difference between US and Europe is taken into account and are shown in Table 6.

| | Europe | US | Delivery time |
|---|---|---|---|
| Mainstream | DP 2 | DP 1 | 4 weeks |
| Special | DP 3/4 | DP 3/4 | 6 weeks EU/8 weeks US |
| Custom | DP 5 | DP 5 | To Be Defined |

**(DP 1) "Make and ship to stock"(Warehouse US)**
**(DP 2) "Make to stock" (stock Groenlo)**
**(DP 3) "Assemble to order" (stock Inventi)**
**(DP 4) "Make to order".**
**(DP 5) "Purchase and make to order"**

Table 6 DP positions per category

That means that the Mainstream product types for the US will be in the US Warehouse. The Mainstream product types for the EU will be in stock in Groenlo. The mainstream product types are the "runners" and a forecast can be made. The Special product types for both the US and EU will be assembled on order. In the US Warehouse and in the stock in Groenlo there will be a sample/reserve stock of the special product types. This is done in order to provide new customers with samples for testing purposes or deliver some products when they fail on installation or needed for service. The consequence is that sub assemblies and components are held in stock at Inventi, and the final assembly takes place on the basis of a specific customer order. DP 4 is not applicable, because the sub assemblies are bought from suppliers.

The number of sub assemblies and components that have to be on stock at Inventi is also researched. A sheet is made for the calculation of the stock that should be present at Inventi. Important was to find out: firstly what the differences between Mainstream and special products are. Secondly, what the overlapping components and sub assemblies are in special and mainstream products. Thirdly, what are the differences between the types in components/sub assemblies. In Table 7, a part of this sheet is shown as an example.

| | Amount Forecast --> | | | 100 | 4 | 7 | 120 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Main | Special | Special | Main | | Actual stock | | | |
| Artikel Nr | Description | Amount basis | | 9949291 | 9958983 | 9955364 | 9949917 | **Total** | Pieces | Value | periods stock | In main and/or in sp. |
| 1234544 | CABLE ASSY LAMP 250-40 | 1 | ST | 100 | 4 | 7 | 120 | **231** | 2534 | € 3.454 | 11 | In all Fixtures A+B |
| 4469054 | SPRING WASHER DIN7980 | 1 | ST | 200 | 4 | 7 | 240 | **451** | 2030 | € 700 | 5 | In all C+E |
| 1431129 | PACKGN BLOCK 50x50x12 | 1 | ST | 0 | 0 | 0 | 0 | **0** | 350 | € 354 | | no |
| 7708076 | CABLE ASSY MAINS L PCB | 1 | ST | 100 | 4 | 7 | 120 | **231** | 3240 | € 908 | 14 | In all E - EU Main+Sp. |
| 1409131 | PACKGN INTERIOR CORRU | 0,2 | ST | 160 | 0,8 | 1,4 | 240 | **402,2** | 2999 | € 2.427 | 7 | In all Fixtures A+B |
| 7707673 | CABLE ASSY GROUND LD 7 | 1 | ST | 100 | 4 | 7 | 120 | **231** | 2880 | € 721 | 12 | In all E - EU Main+Sp. |

Table 7 Components and sub assemblies per product type

In the first columns a list of all components that are used in Luxon ballasts with a description is shown. In the yellow marked cells are the numbers of products that are forecasted per period. The second column shows if the product type is a Mainstream or Special and in the third row is the article number of the product type shown. In the Bill-Of-Material (BOM) it has been looked up what components and sub assemblies are in the product type. When filling in the forecast the column "Total" calculates how many components and sub assemblies are needed per period. In the column "pieces" and "value" the actual stock can be filled in to calculate actual stock value. In the column "periods stock" is calculated for how many periods (10 periods per year) the parts and components are in stock.

The calculation sheet is also used for the analysis of the actual stock. If in the table the column "total" gives a value of zero, than the particular component can be obsolete for instance. With the forecast filled in the need for a particular component is calculated. The sheet was useful in analyzing the actual stock in chapter 8.2.4.

## 7.4 Operational Excellence Implementation

In this section the implementation steps for OE are described. The first step is the forecasting by the Sales team. The second step is the simulation of the SS and the Maximum Stock by operations. The next step is the creation and scheduling of a Supply Committee that will meet on a monthly basis. In the final paragraphs the KPIs are implemented to measure the performance and a report structure is implemented to keep improving the stock quality.

### 7.4.1 Forecasting

It all starts with a forecast made by the Sales Manager. We know from the QL phase that a forecast is needed to calculate what the stock levels should be to have the right products in stock. The difference with QL is that the market and phase in the PLC are in a later stage and they are further developed. That is why they could actually create a reliable forecast by using the prognoses of the top 30 customers (90% of Sales). For Luxon forecasting is more difficult and less reliable. Luxon has many more product types than QL. Besides that, some product types have been on the market for just a few months and others a few years. The categorizing of product types in Mainstream and Special makes the model more flexible. The forecast for Luxon is made for the Mainstream products, because those are the runners and can be forecasted.

Sales representatives have to deliver a budget plan with the expected sales for the upcoming year. The budget plan is made on basis of the knowledge of the Sales team members, because they know what the possible projects are. They also ask Sales partners to give Sales forecasts so that they know what the partners are planning. By combining all these forecasts the Sales manager can create the forecast. He knows from historical data that there are some season influences. A correction can be executed by dividing the forecast in seasons.

The forecast is a prognosis of what the expected Sales will be in the coming year. The prognosis for the upcoming months will probably more precise than the prognosis for end of the year. To make the forecast more reliable the forecast needs to be updated every quarter of the coming year. These data are used for long term planning, but by adjusting every quarter this will be in time for rescheduling the production planning and for most of the components.

### 7.4.2 Supply Committee and Continuous improvement

In the previous chapters the Stock model is created and the Stock simulations are done. After receiving the official forecast from Sales, Operations can simulate the SS and the Maximum Stock within the Stock model. A Supply Committee is organized with the following attendees: the Operation Manager, Account Manager, Quality dept,

Financial Controller, and the business unit leader. The meeting is scheduled as every start of a new period after the Supply meeting for QL. The advantage for Luxon is that the Supply Committee is not new, but the same as it is for QL. In the meeting the simulated stock levels are discussed and actions are taken for further alignment.

From the findings in this research a proposal is done for the settings in the model. The Supply Committee should argue on the settings of the variables in the model to decide on the final setting. The outcome of the Supply Committee is the filled in model with a SS level and a Maximum Stock level that can be communicated throughout the organization. The Operations Manager should prepare these meetings by calculating of the new data, and is Chairman in this meeting. The Sales Manager is responsible for new Sales data. All members have to look critically at the new data and together analyze what actions for improvement are possible.

In the supply committee Sales and Supply are aligned and agreed. In this meeting the KPIs are reviewed and prognoses are adjusted. Explanation of the new concept to the partner network and Sales representatives is needed in order to realize a stable forecasting process with partners. Every quarter the partners are asked to adjust their prognoses for the coming year. It is important to explain customers the need of prognoses and what the benefit is for them.

During the research the actual stock is already analyzed and optimized for as far as possible. Everything that is in stock is defined in the model. With the set stock levels the actual stock can be brought further in line with the set goals. In the next section implementation of KPIs is described. Important is the Continuous Improvement (CI) of the process through monitoring and steering. That can be done on basis of the KPI reports on performance. Remarkable performances should be analyzed and new actions can be taken to improve the quality of stock. The Supply Meeting is scheduled to facilitate the members to discuss the last period and what actions should be taken to improve in the next period.

### 7.4.3 Reporting structure (KPIs)

The Supply Committee is organized to discuss the performance of the supply chain. To measure the performance KPIs are developed for monitoring the supply chain and Sales forecast. The KPIs are an important input for the Supply meeting where they are discussed. Actions from the Supply Committee can be monitored in Qlikview. In Qlikview they can find a Dashboard with the implemented KPIs in the categories: Forecast unreliability, Stock Performance, and Stock Evolution. The KPIs have already been developed in the QL phase and can also be used for Luxon. The KPIs are shown in Table 8 per categories.

| Forecast unreliability | Stock Performance | Stock Evolution |
|---|---|---|
| – FC and Sales abs | – Out of stock | – Stock mutation |
| – FC trellis per period | – Stock turn | – Stock levels |
| – FC unreliability | – Stock level | – Theoretical stock detail |
| – FC unreliability # | | |

Table 8 Implemented KPIs

Important is the communication between Operations Manager and Sales Manager. The Sales Manager is responsible for the forecast reliability and is measured with the KPI forecast unreliability. The Operations Manager can use the KPIs Stock performance and Stock evolution. The cause of a growing Stock can be a high forecast or Sales that are lower than expected. The Operations Manager has to discuss the cause with the Sales Manager and an action can be the adjustment of the prognosis. Operations should then communicate the new prognosis with Inventi to adjust the planning.

The Dashboard is accessible for the members of the Supply Committee. From this Dashboard a report with the new figures and KPIs can be created by the Operations Manager and sent weekly. The reporting step is to control if the set of goals are achieved and how stock performance is. By facilitating the members with a report they are confronted with the performance of the stock and the part they are responsible for. By reporting the KPI figures, they can monitor the performance and take action, if needed right away. In Appendix VII, the implemented process with the KPIs is shown.

# 8 Conclusions and recommendations

This last chapter presents both the conclusions resulting from the project described in this report and also the recommendations for Nedap are discussed. The research question for this research was: *"How to implement Operational Excellence in different product groups within the business unit Light Controls in the organizational structure of Nedap?"* The conclusion describes the realized results of implementing OE at the Luxon product group. In the recommendations is presented how to implement OE in different product groups.

## 8.1 Conclusions

AR contributed in this research project for the development of an increased awareness of the concept and benefits of implementing OE at the Luxon product group. The aim of this research was to develop a standard way of implementing OE within different product groups. This thesis contains a possible guideline for Nedap and/or its managers. The main findings contribute to the development, implementation and sustainability of OE that can be used in different product groups.

In this research the main characteristics are selected for implementing OE in order to realize structure and alignment and to enable reliability. Reliability with regard to OE we can define as: safe (for the right use), stable (available during the full life cycle), sustainable (manageable over time), scalable (volume independent), predictable (performs as expected), provable (supported by data). For organizations an excellent inventory is necessary to operate excellently. Essential characteristics for the organization when planning to implement OE are: optimized processes, forecasts for the demands in the future, a service level to reach, and monitoring KPIs.

During this research OE is implemented at the supply chain for the Luxon product group and the realized results are given below:

- **Assortments Management -** Product types that serve commercial purposes are divided in the categories "Mainstream", "Special", and "Custom". This is done to indentify different generic groups of products, because some Luxon types turn out to be sold on a regular basis (Mainstream), some types are sold on a more irregular basis (Special), and some product types are specific to customer needs (Custom). Mainstream products are produced on the basis of a forecast and have a lead time of 4 weeks. Specials have only a small safety stock and are produced to customer order with a lead time of 6 weeks and custom products are produced on a project basis.

- **Service level -** Customer demands were analyzed and it turned out that a service level of 95% is acceptable; a lead time of 4 weeks is favorable for the mainstream products in the EU and US market for orders up to 250 pieces. For the small projects 4 weeks lead time is desirable more than for large projects. Small projects can be planned on a short term and for large projects installation is time consuming, and has to be planned a long time beforehand.

- **Forecasting –** The forecasting process is started for the mainstream product types by the sales manager. Luxon forecasting is difficult and less reliable than QL forecasts, because some Luxon types have been on the market for just a few months and others for a few years. The forecast for Luxon is made for mainstream products. The forecast needs to be updated every quarter in the next years.

- **Model -** The actual stock for Luxon is optimized. Imagine that the stock level was € 1,000,000 at the start of this project. Half of the stock levels were products that serve commercial purposes and are divided in

the categories mainstream and special. The obsolete parts, that are discarded, had a value of € 100,000. The components combined had a value of € 400,000 that can be transferred to Inventi (the real stock levels should remain confidential, the amounts are fictitious). A stock model is created and implemented; the model calculates the safety stock and the maximum stock level with the determined lead time and service level on the basis of the forecast. The model can be used for simulation, adjustments and steering when unexpected things happen in the market or in the supply chain.

- ***Reporting*** **-** The following KPIs are implemented in a Qlikview dashboard for monitoring the supply chain performance: *out of stock, quality and delivery reliability, stock value, days sales outstanding, throughput time, and stock turn, delivery reliability, forecast reliability, lead time, and stock value.* A report is created end sent on a weekly basis to all supply chain members.

- **Communication -** Essential in the implementation and success of OE is communication. Important is to communicate the sales forecast throughout the supply chain. A monthly supply committee meeting to facilitate communication about the forecasts, service levels, and monitoring of the performance corresponding with the used KPIs was scheduled. The goal of these meetings is to formulate actions to keep improving the performance on a continuous basis.

## 8.2 Recommendations

As a result of this project, the following recommendations are made to Nedap. It is recommended to start by appointing a project leader that is responsible for the implementation of OE. Preferred is to appoint a person that has ambition to improve, a helicopter view, analytical skills, knowledge about OE, and a supportive leadership style. Make use of the created project approach. Essential is that there is steering by the management with the support of the right resources and infrastructure in place. Several insights emerged as the understanding and improvement of OE developed:

1. The first step of the approach is the intake. The process needs to be organized efficiently from sales planning till delivery, so it fulfills the demands of the customers with low process costs, low stock levels but the right products that serve commercial purposes. In this intake, it is recommended to conduct interviews with management and discuss the deliverables. Set the deliverables and outline the supply chain. Important is to create a timeline that outlines when the deliverables become effective.

2. The second step is the analysis of: the available historical sales order lines, actual stock, the market position, the stage in the product life cycle, and the demands that stakeholders have on the supply chain. The analysis should be done to gain more insights in the ordering behavior of customers, margins, sold products, differences between markets, and total sales. The demands should be researched in order to find out what sales, production, and customer demands are from the supply chain. The actual stock should be optimized before a quality stock can be created. That means that all obsolete products should be discarded, components go to Inventi, and only products for commercial purposes are in stock.

3. The third step of the approach is modeling. Different settings of the variables delivery time, standard deviation of the forecast, service level, and lead times should be simulated. The right mix of the variables should be chosen by simulating the safety stock and the maximum stock in the inventory model for the creation of a

quality stock. The model captures all variables and can be used for simulation, adjustments and steering when unexpected things happen in the market or in the supply chain.

4. The last step of the approach is the implementation. Implement the inventory model, start forecasting, implement a reporting structure with the KPIs, determine the service level, and agree on delivery times/conditions. Important is to schedule a monthly meeting to facilitate communication about the forecasts and service levels, and to monitor the performance. People and culture have to be committed to the plan and carry the plan. That means that a continuous improvement culture has to be created by communicating and taking actions to keep improve the performance of the supply chain.

These insights/factors combined determine how successful the implementation of OE will be and to what extent it will result in improved organizational performance. The organization's performance can be expressed in a quality stock with quick stock turns and flexibility in the supply chain, which results in high internal and external service. Important is to communicate efficiently and continuously improve the supply chain.

# REFERENCES

Avison, D., F. Lau, et al. (1999). "Action research." Communications of the Acm **42**(1): 94-97.

Babbie, E. (2010). "The Practice of Social Research."

Baburoglu, O. N. and I. Ravn (1992). "NORMATIVE ACTION RESEARCH." Organization Studies **13**(1): 19-34.

Baskerville, R. and M. D. Myers (2004). "Special Issue on Action Research in Information Systems: Making is Research Relevant to Practice - Foreword." Mis Quarterly **28**(3): 329-335.

Baskerville, R. L. and A. T. WoodHarper (1996). "A critical perspective on action research as a method for information systems research." Journal of Information Technology **11**(3): 235-246.

Bauer, M. W., Gaskell, G. (2000). "Qualitative Researching with text, image and sound. A practical handbook."

Bessant, J., S. Caffyn, et al. (1994). "Rediscovering continuous improvement." Technovation **14**(1): 17-29.

Boer, H. A. D. (2001). "Innovation. What innovation? A comparison between product, process and organisational innovation, ." International Journal of Production Planning & Control(22 (1-3)): 339-344.

Cachon, G. P. and M. Fisher (2000). "Supply chain inventory management and the value of shared information." Management Science **46**(8): 1032-1048.

Chae, B. (2009). "Developing key performance indicators for supply chain: an industry perspective." Supply Chain Management-an International Journal **14**(6): 422-428.

Coghlan, D. a. B., T. (2001). "Doing Action Research in Your Own Organization." Sage, London.

Corbett, C. J. and R. D. Klassen (2006). "Extending the horizons: Environmental excellence as key to improving operations." M&Som-Manufacturing & Service Operations Management **8**(1): 5-22.

Coughlan, P. and D. Coghlan (2002). "Action research for operations management." International Journal of Operations & Production Management **22**(2): 220-240.

Cox, R. F., R. R. A. Issa, et al. (2003). "Management's perception of key performance indicators for construction." Journal of Construction Engineering and Management-Asce **129**(2): 142-151.

Fisher, M. L. (1997). "What is the Right Supply Chain for Your Product." Harvard Business Review: 1-16.

French, W. a. B., C. (1999). "Organization Development." Prentice-Hall **9**(2): 250-284.

Greenwood, D. J. and M. Levin (1998). "Introduction to action research social research for social change."

Gummesson, E. (2000). "Qualitative Methods in Management Research." Sage, Thousand Oaks, CA.

Hoekstra and Romme (1992). "Developing Customer-oriented Goods Flow." Integrated logistic structures **MCGraw-Hill, London**.

Hopp, W. J. and M. L. Spearman (2001). Factory physics: foundations of manufacturing management, Irwin/McGraw-Hill.

Hsiao, R. L. and R. J. Ormerod (1998). "A new perspective on the dynamics of information technology-enabled strategic change." Information Systems Journal **8**(1): 21-52.

Jay Heizer, B. R. (2011). "Operations Managerment." 837.

Kanji, G. K. and A. Wong (1999). "Business Excellence model for supply chain management." Total Quality Management **10**(8): 1147-1168.

Kozlowski, W., Jensen, Kim, and Botero (2009). "Developing adaptive teams: a theory of dynamic team leadership."

Krueger, R. A. (1988). "Focus Groups."

Middel, H. G. A. (2008). "Collaborative Improvement: Action Learning in the Extended Manafacturing Enterprise."

Morash, E. A. (2001). "Supply chain strategies, capabilities, and performance." Transportation Journal **41**(1): 37-54.

Morgan, D. L. (1996). "Focus groups." Annual Review of Sociology **22**: 129-152.

Olhager, J. and F. Persson (2006). "Simulating production and inventory control systems: a learning approach to operational excellence." Production Planning & Control **17**(2): 113-127.

Prahalad, C. K. and G. Hamel (1990). "THE CORE COMPETENCE OF THE CORPORATION." Harvard Business Review **68**(3): 79-91.

Schein, E. H. (1987). "The Clinical Perspective in Fieldwork." Sage, Thousand Oaks, CA.

Schein, E. H. (1999). "Process Consultation Revisited, Building the Helping Relationship." Addison-Wesley.

Towill, P. C. a. D. (2000). "Engineering supply chains to match customer requirements." Logistics Information Management **13**(6): 337-445.

Treacy, M. and F. Wiersema (1993). "CUSTOMER INTIMACY AND OTHER VALUE DISCIPLINES." Harvard Business Review **71**(1): 84-93.

Waters, D. (2006). Operations Strategy.

Middel, H. G. A. (2008). "Collaborative Improvement: Action Learning in the Extended Manafacturing Enterprise."

Morash, E. A. (2001). "Supply chain strategies, capabilities, and performance." Transportation Journal 41(1): 37-54.

Waters, D. (2006). Operations Strategy.

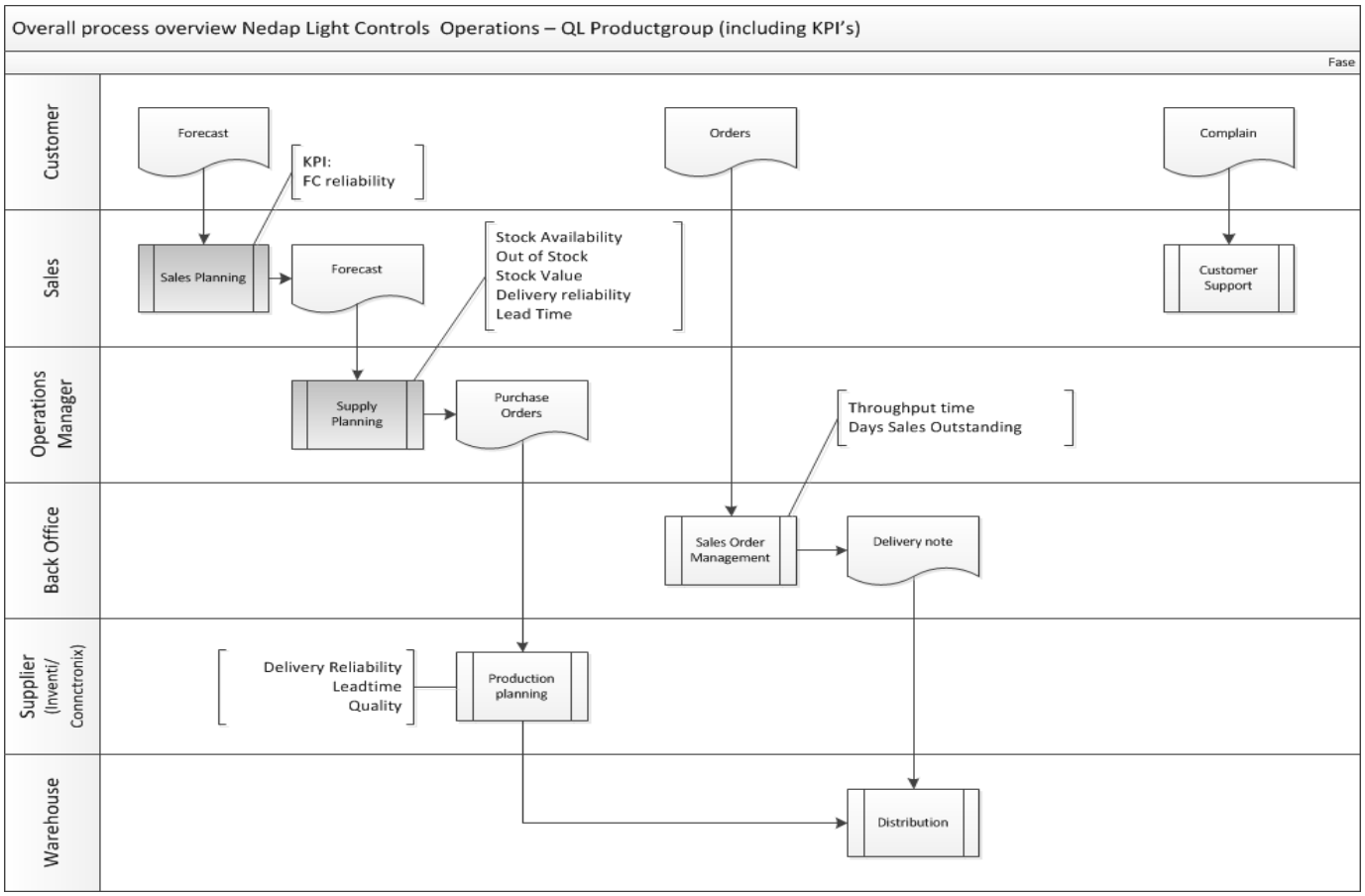
Wegman, Ruben (2012) CEO of Nedap

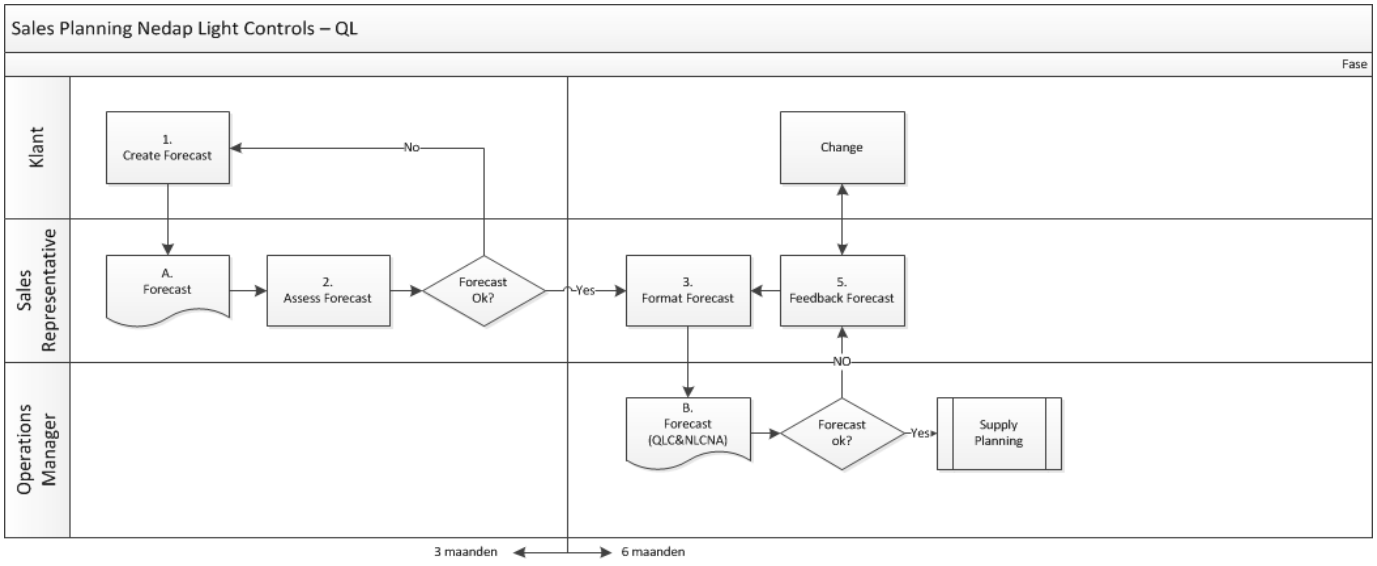
Schermers, Jacob (2011), consultant NRG Advice studio 18

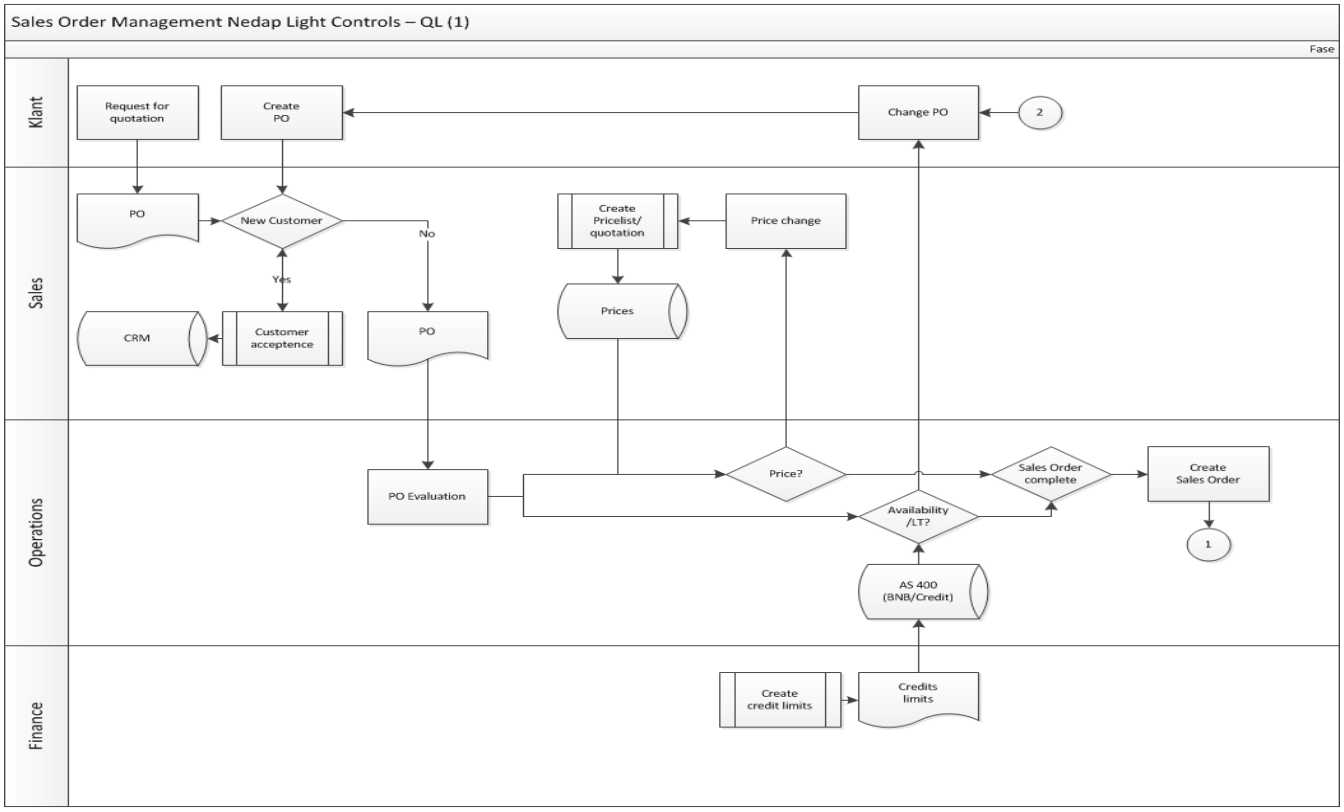
**Internet sites:**

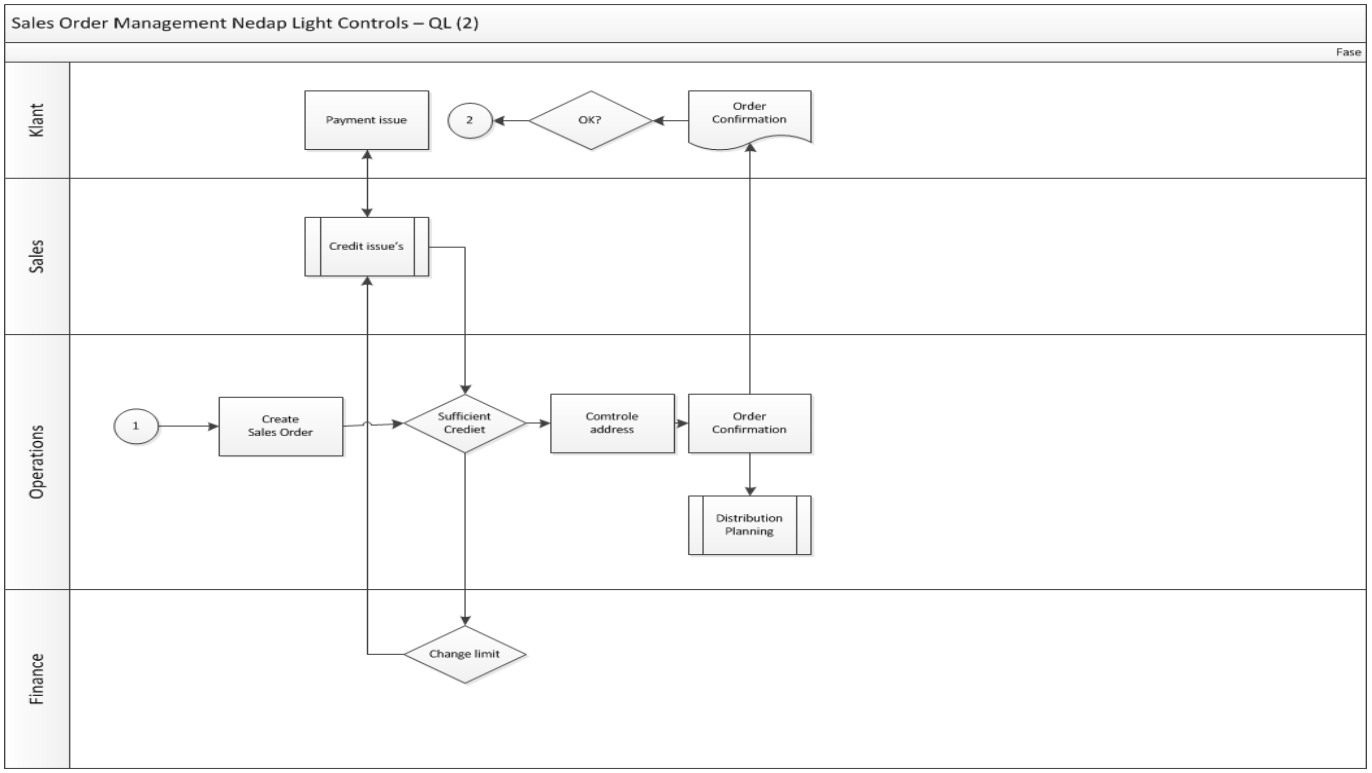
www.nedap.com
http://www.nedap.com/about-nedap/company-profile/
http://www.nedap-lightcontrols.com/
www.opexgroep.nl

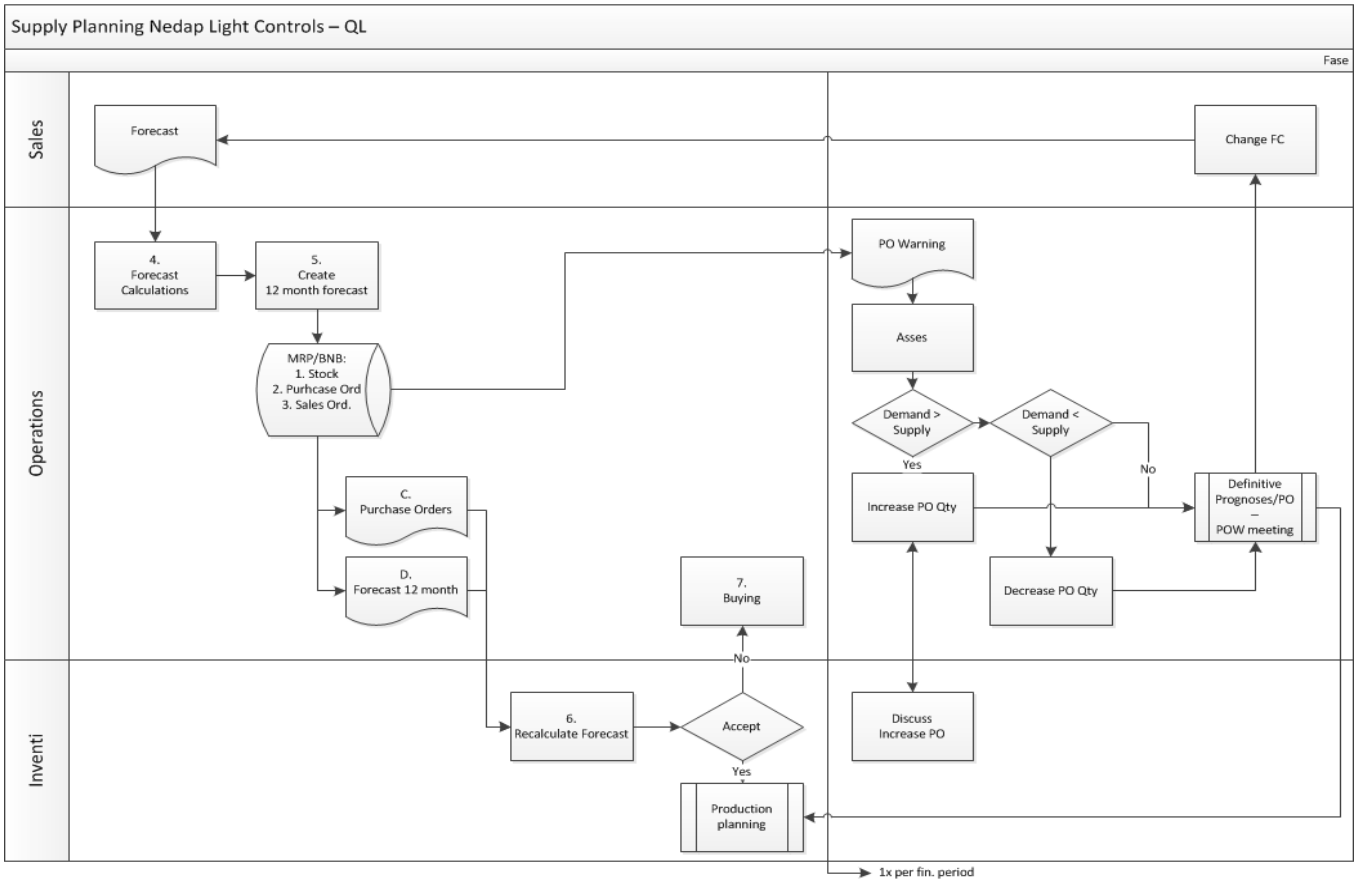
# Appendix I Process overviews QL




Sales Order Management Nedap Light Controls – QL (1)
Fase
Klant
Sales
Operations
Finance
Request for quotation
Create PO
Change PO
2
PO
New Customer
No
Yes
CRM
Customer acceptence
PO
Create Pricelist/ quotation
Price change
Prices
PO Evaluation
Price?
Availability /LT?
Sales Order complete
Create Sales Order
1
AS 400 (BNB/Credit)
Create credit limits
Credits limits

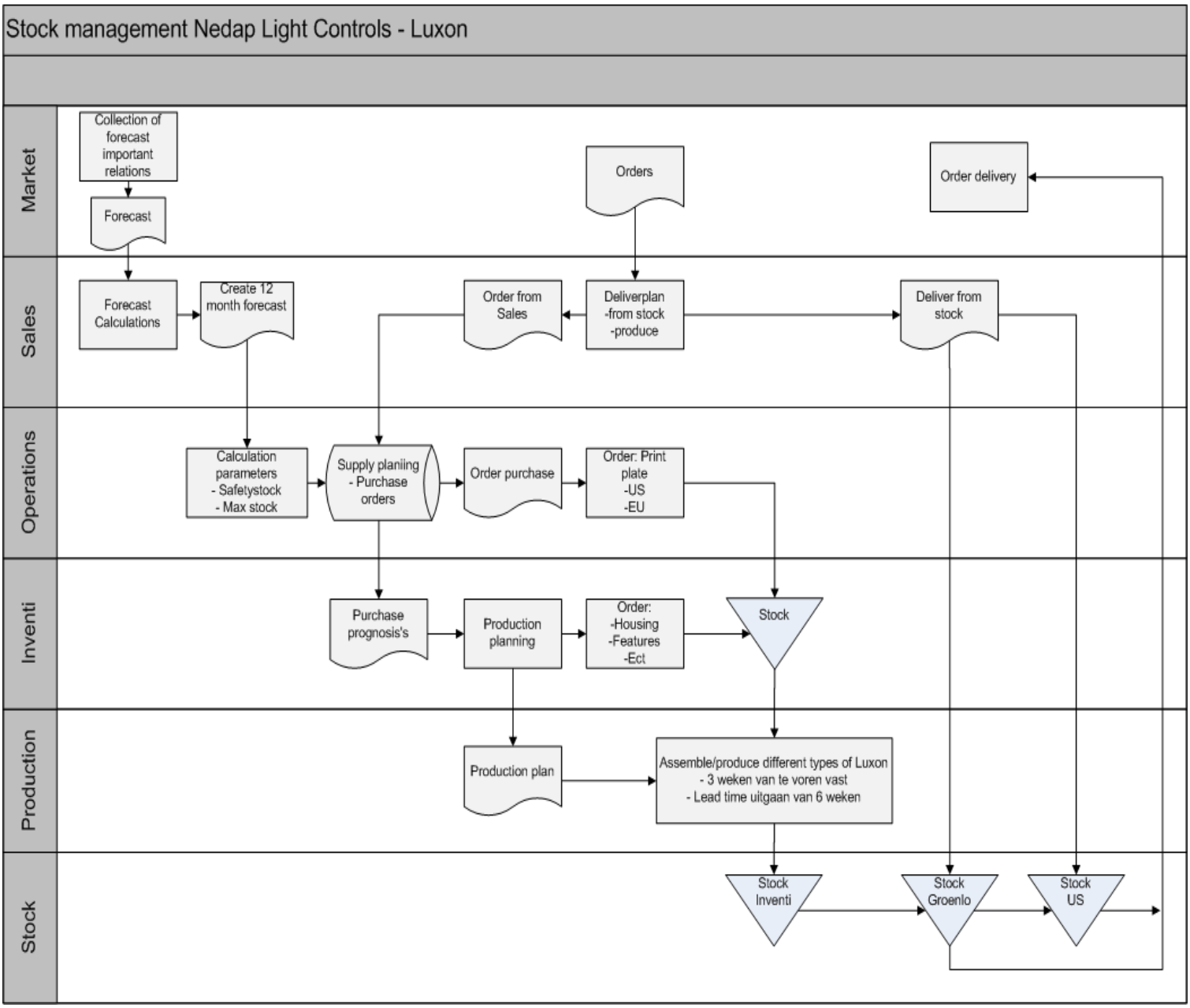

Sales Order Management Nedap Light Controls – QL (2)
Fase
Klant
Sales
Operations
Finance
Payment issue
2
OK?
Order Confirmation
Credit issue's
1
Create Sales Order
Sufficient Crediet
Comtrole address
Order Confirmation
Distribution Planning
Change limit


Supply Planning Nedap Light Controls – QL
Fase
Sales
Operations
Inventi
Forecast
Change FC
4.
Forecast
Calculations
5.
Create
12 month forecast
MRP/BNB:
1. Stock
2. Purhcase Ord
3. Sales Ord.
C.
Purchase Orders
D.
Forecast 12 month
7.
Buying
6.
Recalculate Forecast
Accept
No
Yes
Production
planning
PO Warning
Asses
Demand >
Supply
Yes
Demand <
Supply
No
Increase PO Qty
Decrease PO Qty
Definitive
Prognoses/PO
–
POW meeting
Discuss
Increase PO
1x per fin. period

# Appendix II Sales Forecast

Content is confidential

# Appendix III Supply Chain process overview



# Appendix IV Quantitative analysis of the order lines of Luxon

Content is confidential

# Appendix V stock models Luxon EU and US

Content is confidential

# Appendix VI Qualitative research about delivery time for Luxon products

**Questions**

*What is an acceptable delivery time for Luxon in general?*

*Why do you thing that will be an acceptable delivery time in the market?*

*Do you know what the delivery time is of our competitors?*

*Is it possible that the delivery time is longer when the amount of products per order is higher?*

*Do you think that the delivery time is crucial in gaining new customers?*

*Which delivery time is not accepted in the market and will cost us at least some potential buyers?*

The service level is important in the calculation of the safety stock. The service level 97,5% means for instance that deliveries are in 97,5% on time if they are in the forecast.

*Which service level do you prefer and why?*

*Do you want to communicate a service level to the market? Why?*

The forecasting function seeks to predict demands in the future. Long-range forecasting is important to determining the capacity, tooling and personnel requirements.

*How many updates of the forecast do you propose?*

*How long ahead do you thing that you can make a forecast that is still reliable?*

*Do you think that you can make accurate forecast figures? Why or why not?*

# Appendix VII Implementation of KPIs