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MASTER

The design and implementation of the planning approach that increases the stability and reliability of the production planning
a case study

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EINDHOVEN UNIVERSITY OF TECHNOLOGY

The Design and Implementation of a Planning Approach that Increases the Stability and Reliability of the Production Planning: a Case Study

Master Thesis

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Cloetta

Abstract

Supply Chain Planners and Production Schedulers at Cloetta Roosendaal Spoorstraat are continuously working on rescheduling the production planning to avoid out-of-stocks towards Cloetta's customers. The main research question of this research was, therefore, to understand how a new planning approach could be designed and implemented that increases the stability and reliability of the volume and production plan at Cloetta Roosendaal Spoorstraat. Based on a comparison between the current and desired future state within Cloetta, a literature review was performed on scheduling theories within food-processing environments. Moreover, a literature review was conducted to understand how a new planning approach could be implemented throughout a company like Cloetta. Analyses show that not executing the production plan as scheduled, a fluctuating demand plan, and planning the volume plan to the minimum safety-stock cause the rescheduling of the production plan. The results of this research indicate that Cloetta should differentiate product categories to understand which items can be produced when the line-performance differentiates from average production. Moreover, production schedules should not be based on unreliable demand forecast but on actual data, and production plants and sales markets within Cloetta should communicate more transparently with each other. The solution should be implemented via an iterative process to make use of quick wins and, thereby, increase stakeholder's readiness for change. Moreover, a test phase should be used in this iterative process to test solutions on a small scale before actually implementing them throughout the Cloetta organization.

Executive Summary

This research addresses the design of a planning approach and implementation plan at Cloetta Roosendaal Spoorstraat (RSD-S) with the main objective to increase the stability and reliability of the volume plan (eight weeks rolling) and the production plan. The volume plan includes the expected production plan for the upcoming two years rolling per stock-keeping unit (SKU). From these two years, the upcoming eight weeks rolling are firmed by the Scheduler while the other weeks are automatically planned in Cloetta's material resource planning system. Hence, only the upcoming eight weeks have to be rescheduled by the Scheduler. The production plan, on the other hand, includes the finished production schedule that is released to this system. The main research question of this project is, therefore, defined as: '*How to design and implement a new planning approach that increases the stability and reliability of the volume plan (eight weeks rolling) and production plan at Cloetta Roosendaal Spoorstraat?*'.

Problem Analysis

With the production of candy, chocolate, pastilles, chewing gum, and nuts, Cloetta is one of the leading confectionery companies in Northwestern Europe. Cloetta's headquarters is located in Stockholm and owns eight factories that are located in Belgium, Ireland, the Netherlands, Slovakia, and Sweden. These factories produced approximately 102 kilotons of confectionery in 2018, which resulted in annual sales of 6.2 billion SEK, of which 483 million SEK profit. This Master Thesis project is executed at RSD-S, which is one of the two factories located in Roosendaal. About 180 employees are working at RSD-S, who produced approximately 17.8 kilotons of confectioneries in 2018, which is about 17.5% of the total production within the Cloetta group. (Cloetta, 2019)

At RSD-S, the volume plan (eight weeks rolling) and production plan are currently scheduled by the Scheduler such that the expected stock level is at least equal to the minimum safety-stock. However, this expected stock level fluctuates significantly prior to a production week, which cannot be covered by the safety-stock. The volume plan (eight weeks rolling) and production plan are, therefore, rescheduled by the Scheduler to guarantee enough stock available at the distribution centers such that out-of-stocks are prevented. Analyses have been performed to understand why this stock level fluctuates and, therefore, why both plans have to be rescheduled. It can be concluded that this fluctuating expected stock level is caused by two larger underlying problems, being: the production plan is not executed as released, and the demand plan changes within the eight weeks prior to a production week. The analyses show that four root causes within the scope of this project mainly cause these two problems. Firstly, the current production plan does not allow process and demand variations (e.g., unreliable production lines, quality issues, changing demand plan). Secondly, the minimum order quantities are set too high such that the production plan is not feasible. Thirdly, the safety-stock does not consist of a sufficient stock to compensate process and demand variations. Lastly, the communication between Cloetta plants and departments is limited and not, clear causing that schedulers do not understand which part of the expected demand is known.

Stakeholders that are involved in this process are identified to manage these individuals and groups, such that maximum support for the change can be obtained. Two groups of stakeholders are identified, being: key important stakeholders and wider stakeholders. The key important stakeholders are defined as the Plant Manager of RSD-S, the Production Manager of RSD-S, the Scheduling Department, the Demand Manager, the Demand Planners, the Supply Chain Manager, and the Supply Chain Planner. These stakeholders must be involved during each sub-question. The wider stakeholders that are defined, on the other hand, can be involved during a sub-question. This group consists of the following stakeholders: employees directly associated with the production processes (Graining, Compressing, Molding, Packaging, and Logistics), Customer Support Manager, Customer Employees, Marketing Director, Marketing Managers, Customer Director, Account Managers, and the Portfolio Manager. Whether and how this group of stakeholders will be managed depends on the exact steps that will be taken during the project.

Design Planning Approach

To tackle the problem that RSD-S faces, the planning environment is decomposed into three smaller steps (Soman, van Donk, & Gaalman, 2007). During the first step, product families are constituted in order to determine the customer order decoupling point for each product family in the second step. This customer order decoupling point is determined based on the product characteristics used to form these product families. Different planning concepts are, after that, assigned to each product family during the third step. These approaches are based on the customer order decoupling point. Most product characteristics found during the first step indicate that Cloetta has to produce its products to stock (e.g., production lead time, and customer order lead time). However, some characteristics found suggest that the production process can be controlled differently, being: modularity of product design, product structure, production lead time, flexibility production process, and information sharing. Based on these characteristics, three product families are formed by using a decision tree (Hoekstra & Romme, 1992). The first group 'flexible production items' consists of SKUs that include only one semi-finished item. This item is produced at the Molding Department of RSD-S with a total average weekly demand (summed over all SKUs) that is above the minimum order quantity. This group can be used to respond to variations of the Molding Process because it is produced every week and is relatively easy to pack. The second group 'flexible packaging items' consists of SKUs that include only one semi-finished item that is produced at a third party and can be stocked within the warehouse of RSD-S, i.e., has a longer shelf-life than products stocked at the buffer. This group can be used to respond to a decrease in semi-finished items supplied from third parties and the production departments. The last group 'fixed production items' consists of SKUs that are not included in one of the other two groups. Therefore, SKUs that include multiple semi-finished items, SKUs of which the semi-finished item faces a low demand, and SKUs that include only semi-finished items from the Graining Department or third parties (that cannot be stocked) are included in this group. Hence, this group is more difficult to steer as multiple production steps are involved. Because the current literature does not specify an exact period that can be used to review these product families (Van Kampen & Van Donk, 2014), it is suggested to review these families in the monthly sales and operations cycle within Cloetta.

The second step (assign production environment) and third step (assign planning models) are performed for each department separately because each process is treated as a stand-alone process. To start with, the Molding Department should use both a make-to-stock (MTS) environment ('flexible production items') and a make-to-order (MTO) environment ('fixed production items' and orders from third parties). By scheduling MTS-orders before fixed production stops (e.g., maintenance) and making use of variable order sizes, it is guaranteed that past process variation does not affect upcoming production orders. Therefore, it is guaranteed that MTO-orders are produced, causing that the packaging process of mixed-products can be continued. The Graining and Compressing Departments should only use the MTO-environment because the Graining Department faces a complex production process, whereas the Compressing Department faces overcapacity. Hence, this department should be in touch with their customers in order to prevent capacity problems. The Packaging Department should use the MTS-environment only, as it is concluded that Cloetta has to produce its products to stock in order to guarantee that a delivery reliability of 99.5% is obtained. To control the inventory at the distribution centers, it is suggested to use the *(R,s,Q)-policy.* In this policy, the inventory is checked every R periods to conclude whether the current inventory level is below the inventory level s. If so, the fixed quantity Q is ordered at the Packaging Department. It is essential to determine the right quantity s, such that the safety-stock can react on demand and process variation. Moreover, it is essential to determine the right quantity Q, such that production orders do not cause too large orders at the production stages. From these quantities can be deviated with 'flexible production items' in case capacity issues are faced at one of the departments. Hence, Schedulers can plan the production orders based on the actual inventory level, which should result in more stability relative to the current approach. Moreover, it is suggested to order the 'flexible packaging items' to stock in order to make use of these products when (internal) suppliers cannot deliver. As a result, the Packaging Department is can pack some SKUs, although the supply is limited.

This new planning process influences the key performance indicators (KPIs) that are currently used within RSD-S. This research suggests to adjust one currently used KPI and to introduce two completely new KPIs as a result of the proposed planning method. The schedule adherence, which measures whether orders are produced on time and in the right quantity, should no longer be used within all production departments. Instead, this KPI should be adapted to four other KPIs, being: volume of orders packed as a fraction of the volume received and scheduled for that week (Packaging Department), volume on stock at the buffer (production, MTS-environment), schedule adherence as a fraction of the semi-finished items received (production, MTO-items), and the amount of SKUs feasibly scheduled that face an inventory level below s as a fraction of all SKUs that face an inventory level below s (Scheduling Department). Moreover, it is suggested to introduce a KPI that measures the costs of the current safety-stock. Hence, Demand Planners cannot store unlimited safety-stock at the distribution centers. Lastly, it is suggested to use a KPI that indicates how much volume is ordered by third parties at RSD-S during the week. As a result, Schedulers can control and steer on the volume ordered by third parties.

Design Implementation Plan

An eight-step plan is designed that can be used to implement the new planning approach throughout the Cloetta organization, as can be seen from Figure 1. The solution should be implemented throughout Cloetta to guarantee that the communication between plants and departments increases. Therefore, orders to or from other Cloetta plants should become more controllable, and information shared between the Scheduling Department and Demand Department should increase. In the first step, stakeholders within Cloetta are prepared for the change. During this step, a sense of urgency is created at these stakeholders, after which the change is communicated. Moreover, a steering-team should be constituted, and a change vision should be drafted. After that, an iterative sequence is started at the second stage up to and including the sixth stage in order to implement a quick change every iteration. During the second stage, an implementation-team is constituted, and an implementation plan is drafted by the steering-team. New stakeholders and implementation steps are added after each iteration. This implementation plan is, after that, communicated to the higher management team, who should agree upon the upcoming change steps. If the implementation plan is approved, the stakeholders involved during the next implementation step should be engaged to participate in this process, i.e., remove barriers at stakeholders to implement the change. When stakeholders are ready to change, the implementation team should test the upcoming change on a small part of the process during step five. Along this step, the Plan, Do, Check, Act (PDCA)-cycle is used such that the right parameters (e.g., order quantities) can be determined ("Deming cycle (PDCA)", 2000), causing that the solution can be implemented in all processes changed during that iteration. After performing this iteration process multiple times, during which the change is fully implemented, it is suggested to guarantee that stakeholders do not relapse to their previous behavior, i.e., stakeholders should stick to the new situation. After that, the change process has to be evaluated during the last step in order to identify problems that need more attention (in future change processes).

Discussion

This project faces two sides, being: the design of a planning method that should reduce the amount of rescheduling, and the design of an implementation plan that can be used to implement the proposed approach throughout the Cloetta organization. Hence, the project was very extensive and contained a lot of information, causing that there was no possibility to dive into any specific subject with too much detail. Therefore, the suggested planning approach is based on literature that indicates how variation can be included in the planning in combination with practical deliberations. However, whether the final model actually increases the stability and reliability of the production plan is not tested by a simulation. The same holds for the order quantity Q and reorder-level s at the Packaging Department, and the maximum order quantities ordered by third parties at the production departments. Moreover, it is not secured that the groups 'flexible production items' and 'flexible packaging items' are large enough to compensate for all variation, and how these product families actually react on this variation. For further research, it is suggested to perform the proposed planning approach in a detailed simulation. If the product families turn out to be too small, it is proposed to include more items by reducing the MOQ or changing the product portfolio within Cloetta.

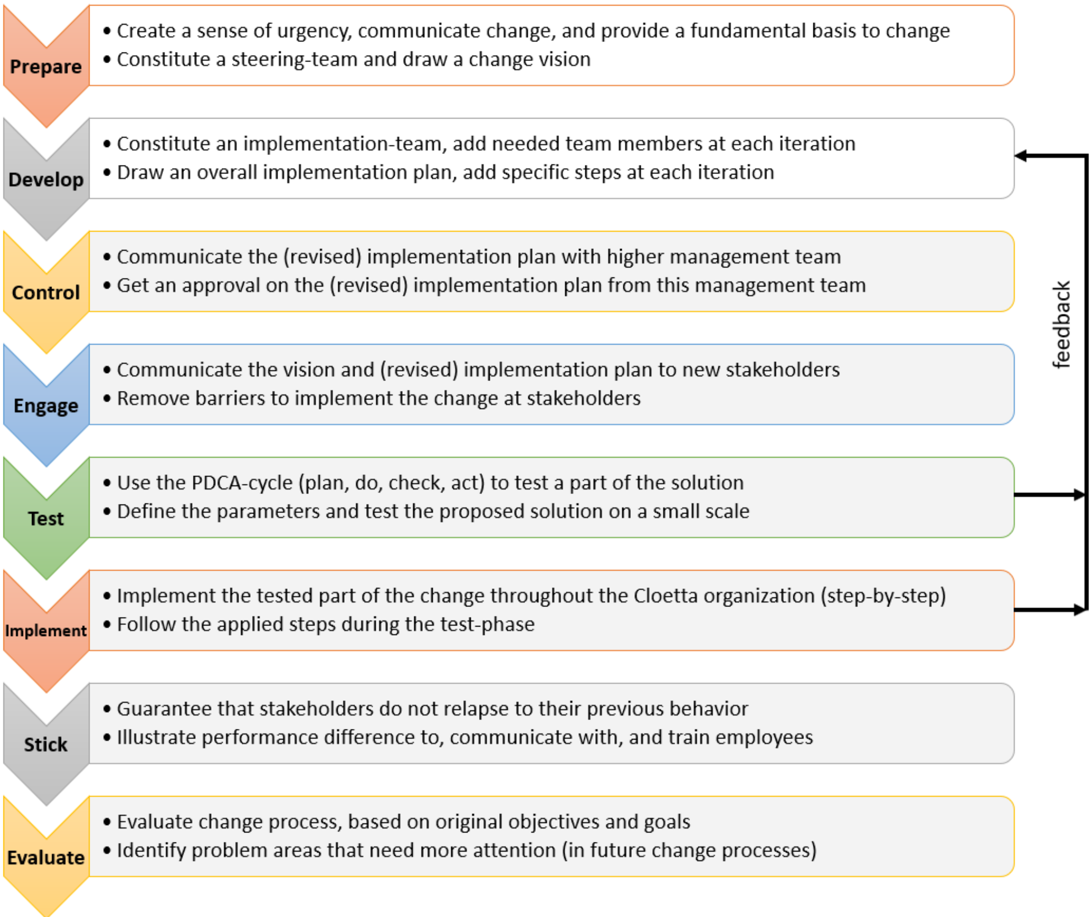

Figure 1: Proposed implementation plan for Cloetta

Preface

By handing-in this Master Thesis, my student career comes, unfortunately, to an end. The past eight years have been a great journey, during which I graduated at Avans Hogeschool Tilburg, lived for five months in New-Zealand, traveled for five months through the southern part of South-America, finished (somewhat surprisingly) my Pre-Master, and now finishing the Master Operations Management and Logistics at Eindhoven University of Technology.

First of all, I would like to thank Pascale Le Blanc for the feedback and useful advice during this Master Thesis project, which brought the quality of this project to a higher level. Moreover, I would like to thank Ad Kleingeld and Ton de Kok for their useful advice. Although our meetings were few, it helped me in increasing the quality of this Master Thesis project as well.

Secondly, I would like to thank all colleagues which I met during my internship at Cloetta. Although the last couple of months were somewhat unusual due to the Corona-virus, it was a time I will not forget. In particular, I would like to thank Sjef Verhooren for the valuable tips given during our weekly meeting. It gave me new insides every week, which helped me to continue the project.

Also, I have been lucky to have so many good friends around me during this journey. You all contributed somehow to my time in either Breda, Tilburg, Eindhoven, or somewhere around the world. In particular, I would like to thank my friends in Eindhoven, who made the study-moments in the library of the TU/e more enjoyable and the Thursday-nights unforgettable.

Last but not least, I would like to thank the ones who are very close to me. Firstly, I would like to thank my parents Pascale and Ton, who made this complete journey possible and gave me continuous support towards it. Moreover, I would like to thank my sister Eliane, especially for the three years at the TU/e. Who had ever thought that we lunched and studied together at the same university? Last but definitely not least, I would like to thank my girlfriend Maaike for traveling New-Zealand and South-America, and supporting me every single minute in the past years.

Olivier van Hoef

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List of Abbreviations and Terms

ATO	Assemble To Order
Buffer	Stock point before Packaging Department
CODP	Customer Order Decoupling Point
DC	Distribution Center
Demand Plan	Expected sales for the upcoming two years rolling per SKU
DP	Decouple Point
ETO	Engineer To Order
KPI	Key Performance Indicator
Mixed-item	SKU that includes multiple semi-finished items
MOQ	Minimum Order Quantity
MTO	Make To Order
MTS	Make To Stock
OEE	Overall Equipment Effectiveness
OMP	Cloetta's material requirements planning-system
OPP	Order Penetration Point
PDCA	Plan, Do, Check, and Act
Production Plan	Finished production schedule that is released to OMP
RSD-S	Cloetta Roosendaal Spoorstraat
Single-item	SKU that includes only one semi-finished item
SKU	Stock-keeping Unit
Volume Plan	Expected production plan for the upcoming two years rolling per SKU, of which the upcoming eight weeks rolling are firmed by the Scheduler while the other weeks are automatically planned by OMP

Chapter 1

Introduction

This Master Thesis gives an overview of the research conducted at Cloetta Roosendaal Spoorstraat (RSD-S) during the end of 2019 and the beginning of 2020, with the objective to find a way how RSD-S can control its production and inventory to increase the stability and reliability of the volume and production plan. The current chapter presents some background information regarding Cloetta (Section 1.1) and RSD-S (Section 1.2) as an introduction of this Master Thesis project. Moreover, some value-adding figures for this research are shown in Section 1.3. These figures indicate the performance of the production lines, forecast accuracy, demand and volume variability, rescheduling of the production lines, and the schedule adherence. Therefore, an initial problem statement is formed (Section 1.4), upon which the research question is based (Section 1.5). The approach that is followed to answer this research question is treated in Section 1.6.

1.1 Cloetta

With the production of candy, chocolate, pastilles, chewing gum, and nuts, Cloetta is one of the leading confectionery companies in Northwestern Europe. Cloetta is founded in 1862 by Bernard, Christoffer, and Nutin Cloetta, who located their first factory in Copenhagen, Denmark. From this location, the three Swiss brothers started manufacturing chocolates and confectioneries. This factory later moved to Stockholm, Sweden. Today, Cloetta's headquarters is still located in Stockholm and owns eight factories that are located in Belgium, Ireland, the Netherlands, Slovakia, and Sweden. These factories produced approximately 102 kilotons of confectionery in 2018, which resulted in annual sales of 6.2 billion SEK, of which 483 million SEK profit. (Cloetta, 2019)

Cloetta's mission is "to bring a smile to your Munchy Moments" with the vision "to be the most admired satisfier of Munchy Moments" (Cloetta, 2019, p. 3). Cloetta aims to achieve this mission by serving local brands in its main markets and expanding with new brands in new markets. Some examples of strong local brands Cloetta serves are Jelly Bean, King, Lakrisal, Lonka, Malaco, Red Band, Sportlife, and Venco. The main markets on which Cloetta focuses are Sweden, Finland, Denmark, Norway, the Netherlands, Germany, and the United Kingdom. (Cloetta, 2019)

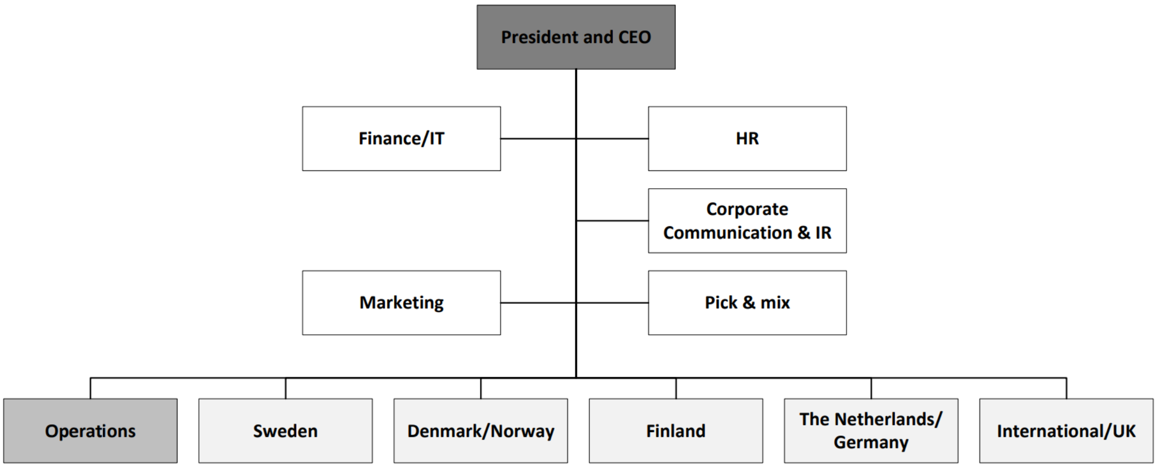


Figure 1.1: Organizational chart of Cloetta

Cloetta's organization is divided into operations, sales markets, and supporting departments, as can be seen from Figure 1.1. Approximately 2,500 employees are working within this organization (Cloetta, 2019). With this structure, Cloetta has created two branches, being: Commerce and Supply. The Commerce branch is responsible for the sales of the products, which orders the needed products at the Supply branch. Hence, the Supply branch is responsible for the production and shipment of the products.

1.2 Cloetta Roosendaal Spoorstraat

This project is executed at RSD-S, which is one of the two factories located in Roosendaal. The factory was opened in 1928, which was the year that Red Band was founded and started its production in this factory. Today, after multiple acquisitions, RSD-S does not only produce the brand Red Band but is within the Cloetta group a medium-sized factory that produces different brands. The brands RSD-S mainly produces are Lakrisal, Malaco, Red Band, and Venco.

Most of the employees located at RSD-S work within the Supply branch of Cloetta. The central departments are Continuous Improvement, Human Safety and Environment, Logistics, Maintenance, Planning, and Production. All these departments report (indirectly) to the plant manager. About 180 employees are working at RSD-S, who produced approximately 17.8 kilotons of confectioneries in 2018, which is about 17.5% of the total production within the Cloetta group (Cloetta, 2019). The production process and product portfolio of RSD-S are explained in Sub-section 1.2.1, after which the planning process within Cloetta is explained in Sub-section 1.2.2.

1.2.1 Production Process and Product Portfolio

The production process within RSD-S consists of the two stages production and packaging, which are decoupled by an intermediate storage facility: the buffer. This process is a typical food-processing process (Van Donk, 2001) and can be labeled as a make-and-pack process (Günther, Grunow, & Neuhaus, 2006). The production stage consists of three main production techniques, being: molding, compressing, and graining. Production starts either at the Molding Department or Compressing Department, after which the semi-finished items are either directly packed or first sugar-coated at the Graining Department and then packed. Some exceptions can be made on semi-finished items that are either produced or packed at third parties, i.e., other Cloetta plants. The Packaging Department consists of multiple packaging lines with each unique features. The production stage and packaging stage are split by an intermediate buffer that faces limited capacity. A visual representation of this process is given in Figure 1.2 and is step-by-step explained in more detail in Appendix A.

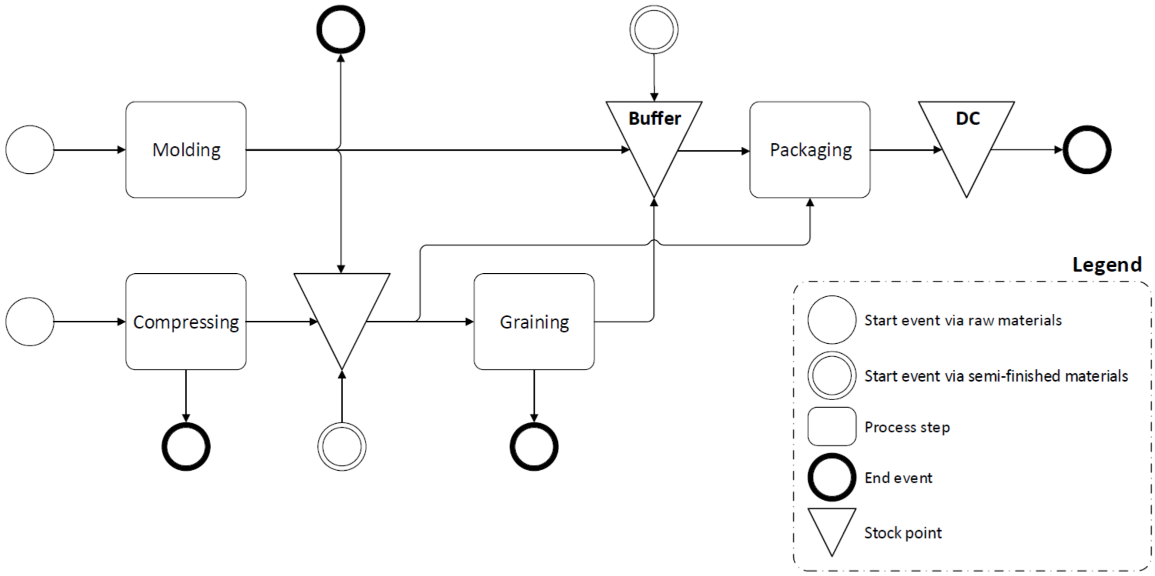


Figure 1.2: Visual representation of the production process at RSD-S

Food processing companies typically produce a moderate number of confectioneries that are, after that, packed within a larger number of stock-keeping units (SKUs) (Méndez & Cerdá, 2002). Comparing this situation to the product portfolio of Cloetta, it can be concluded that the same situation holds, as RSD-S produced approximately 80 semi-finished items in 2019. In contrast, about 260 different SKUs were packed during this year. Differences between these SKUs were mostly related to packaging size, packaging volume, packaging appearance, destination, and the mixture of semi-finished products.

1.2.2 Production Scheduling at RSD-S

All SKUs produced in Roosendaal are currently produced to stock. Within a make-to-stock (MTS) environment, products are engineered and produced without customer interception. Hence, customer orders are directly fulfilled from stock, which results in a low order lead time (Zaerpour, Rabbani, Gharehgozli, & Tavakkoli-Moghaddam, 2009; Tien, 2011). To guarantee that sufficient products are available and, thus, out-of-stocks are prevented, the planning-process within Cloetta consists of multiple steps in which various stakeholders are involved. This process and its performance indicators are step-by-step described in this sub-section.

Demand Department

The first step during the planning process is taken by the Demand Department, which is located in each of Cloetta's markets. These departments are responsible for the demand plan available in Cloetta's material requirements planning system, named OMP. Within this demand plan, the forecast for each SKU is shown on a weekly basis for the upcoming two years rolling. From this time interval, the upcoming eight weeks rolling may not be changed by the Demand Departments in order to give the production facilities the possibility to come up with a feasible production schedule. This forecast is based on information gathered from historical data and information received from Account Managers and customers. Having the demand plan available in OMP, in combination with the defined minimum safety-stocks, minimum order quantities (MOQs), and available production hours, results in a first volume plan. This volume plan represents an expected production plan for the upcoming years rolling, which is used by the Supply-Chain Department.

Supply-Chain Department

The second step is taken by the Supply-Chain Department, which is a central department within the Supply branch of Cloetta. This department is responsible for leveling the needed capacity among Cloetta's factories for the medium and long-term volume plan, i.e., two years rolling till eight weeks rolling. The input for this process is the volume plan available in OMP. As a result of this step, it should be prevented that some factories and production lines are overloaded while others have excess capacity. Hence, it is guaranteed that, based on the forecast available in OMP, all production lines can produce what is needed within the available time-frame, causing that out-of-stock should be prevented.

Scheduling Department

The last step is taken by the Scheduling Department, which is responsible for scheduling the volume plan for the upcoming eight weeks rolling. Of these eight weeks, the upcoming three weeks rolling are fixed, while the other five weeks rolling are firmed by the Scheduler. Two employees are working at the Scheduling Department of RSD-S, of which one is responsible for the schedule of the Compressing and Graining Departments, while the other employee is accountable for the schedule of the Molding and Packaging Departments. Five weeks before production, the schedule for the Compressing and Graining Departments is created. This schedule is based on incoming orders from third parties and orders from the conceptual packaging planning, which is updated daily during these five firmed weeks. As a result of scheduling the Graining Department, demand for the Compressing and Molding Departments becomes available in OMP. Together with the demand of the Packaging Department and third parties, the schedule for the Molding Department can be finished, which is performed during the fourth week before production. At the same time, the schedule of the Packaging Department will be finished, after which the volume plan is released to OMP and cannot be changed anymore. To this fixed plan is referred to as the production plan.

The production orders of the Packaging Department are based on the expected stock level in OMP, the safety-stock level at the distribution centers (DCs), and the MOQs at the Packaging Department, as mentioned before. The expected stock level is calculated by taking the current stock level minus the expected sales stated in the demand plan plus the expected production stated in the volume plan. The safety-stocks, on the other hand, are calculated by taking the average demand of three weeks for that particular SKU. The orders are planned such that the expected stock level is at least equal to the safety-stock and at least larger than the production MOQ. These MOQs are derived by either taking the average demand of three weeks or taking a number that results in at least the minimum order quantity of each semi-finished item at the previous production processes. The MOQ at the Molding Department is set equal to the volume of three drying cabinets, whereas the MOQs of other processes are similar to the batch size. For most SKUs at the Packaging Department, the MOQs are set equal to the average demand.

Call-off Department

Call-off Coordinators are responsible for ensuring that sufficient materials are available on stock in order to make production possible. These materials can be split into two subgroups, being: raw materials and packaging materials. Raw materials are used to produce semi-finished items, whereas packaging materials are used to pack the semi-finished items. The lead times of these materials differ from a few days to 10 weeks. Therefore, it is essential to have an accurate volume plan in order to guarantee that enough materials are on stock. Currently, two Call-off Coordinators are working at RSD-S.

Performance Indicators

Within Cloetta, different key performance indicators (KPIs) are used to measure the performance of each department. At Demand, employees are responsible for the forecast accuracy. This measure indicates the forecast given eight weeks before actual sales compared to the actual sales during that week. Supply-Chain Planners are accountable for the plant-service-level, which indicates the number of out-of-stocks compared to the volume produced by the plant. Schedulers and Call-off Coordinators are responsible for the schedule adherence. This KPI is calculated by comparing the number of orders that are produced on time and in the right quantity compared to all orders that are produced during that week. Orders are produced on time when they are finished within twelve hours before or after the planned finishing time. On the other hand, orders are produced in the right quantity when at least 95% of the quantity scheduled is produced.

1.3 Current Figures

This section presents relevant figures that help to understand the current performance at RSD-S. Figures shown in this section are related to the Overall Equipment Effectiveness (OEE), forecast accuracy, demand and volume variability, rescheduling of the production planning, and the schedule adherence. These measures can be found in Sub-section 1.3.1 up to and including 1.3.5, respectively.

1.3.1 Overall Equipment Effectiveness

The performance of each production line is measured by using the OEE. This measure includes the availability, performance, and quality of a production line, which is calculated by using Formula 1.1.

$$OEE = \frac{Actual\ production\ time}{Planned\ production\ time} * \frac{Actual\ output}{Planned\ output} * \frac{Correct\ products\ produced}{Actual\ output} \tag{1.1}$$

Four production lines are identified as a critical line at RSD-S due to their high load factor, being: molding line NID2, molding line NID3, packaging line 902, and packaging line 903. The OEE of these lines is shown in Figure 1.3 for week 1 up to and including week 39 of 2019. From this figure can be concluded that the performance of each line is variable over time. However, Cloetta uses an average OEE to adapt the production norms in OMP in order to create a more realistic schedule. The actual production time, therefore, always deviates from the scheduled production time, causing that a production plan minute-by-minute is hardly possible.

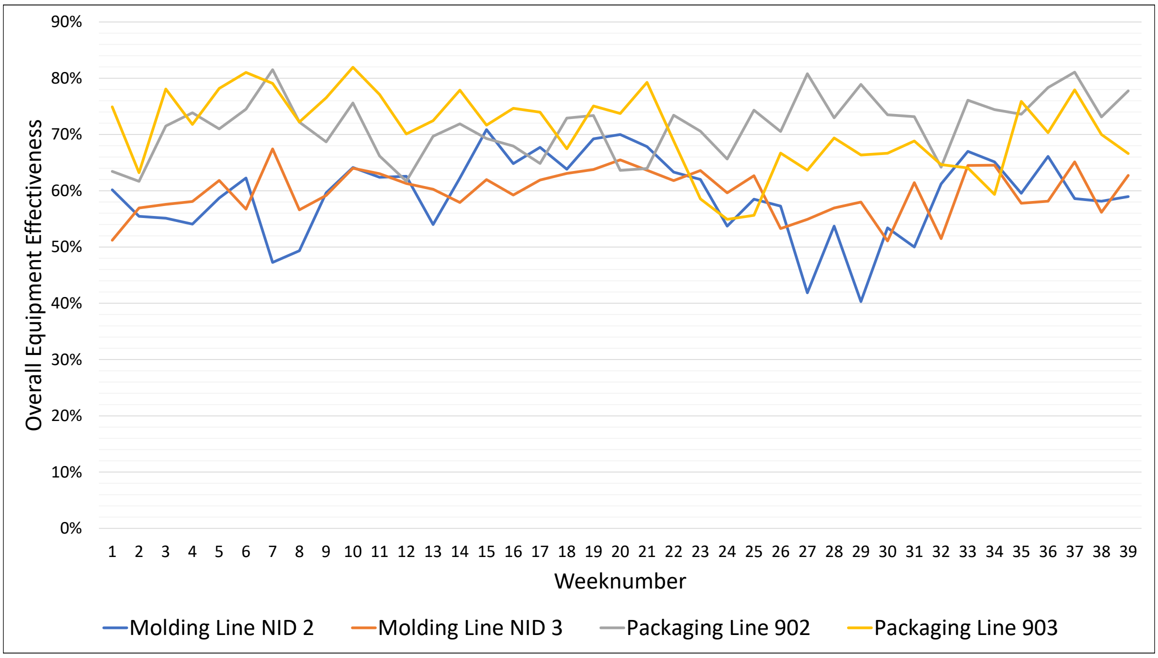


Figure 1.3: OEE per critical production line at RSD-S between weeks 1 and 40

1.3.2 Forecast Accuracy

The accuracy of the forecast given by the Demand Department is measured by using the forecast accuracy. This measure compares the forecast provided eight weeks before the actual sales with the actual sales, which is calculated by using Formula 1.2. In this formula, N refers to all SKUs forecasted within the current product portfolio.

$$Forecast\ Accuracy = \sum_{n=1}^{N} \left| \frac{Forecast\ given\ two\ months\ before\ actual\ sales\ [product\ n]}{Actual\ sales\ [product\ n]} \right| \tag{1.2}$$

To indicate the performance of this measure at Cloetta, Table 1.1 shows the forecast accuracy of the Dutch Market. Per type of customer (group), the percentage of total sales and the forecast accuracy are shown in this table. The percentage of sales represents the net weight sold to that customer (group) between June 2019 and December 2019. Only volume packed at RSD-S is taken into account within this measure. The last column indicates the forecast accuracy of January 2020, which is comparable with the average forecast accuracy according to the Dutch Demand Manager.

From this table, it can be concluded that Dutch supermarkets are responsible for approximately

Table 1.1: Forecast accuracy of January 2020

Type of customer	**Sales %**	**Forecast Accuracy**
Supermarket	24%	75%
Supermarket	15%	80%
Supermarket	13%	80%
Wholesaler	11%	40%
Wholesaler	9%	40%
Non-food	8%	55%
Supermarket	6%	80%
Wholesaler	5%	55%
Supermarket	4%	70%
Wholesaler	4%	40%
Non-food	3%	40%
Supermarket	1%	55%
Non-food	0%	25%

60% of the Dutch volume produced at RSD-S. In contrast, other Dutch customers are responsible for about 40% of the Dutch volume produced. Moreover, it can be concluded that supermarkets face a forecast accuracy of approximately 80%, whereas other customers face a forecast accuracy of about 40%. This lower forecast accuracy could be a result of a longer supply chain, i.e., multiple companies involved, and not sharing their own forecast. When taking into account that approximately 60% of the volume packed in RSD-S is intended for the Dutch market, at least 24% of the total packaging volume within RSD-S (40% of 60%) faces a forecast accuracy of only 40%. Therefore, it makes sense that, due to this low forecast accuracy, the volume plan (eight weeks rolling) of the Packaging Department has to be adjusted multiple times.

1.3.3 Demand and Volume Variability

Cloetta uses a rolling planning horizon of eight weeks in which the Demand Department is not allowed to change the demand plan and in which the plant is responsible for the volume plan, as mentioned before. Two different perspectives are applied to two different products in order to indicate what actually happens during these eight weeks. The two products are referred to as single-item X and mixed-item Y. Single-item X consists of only one molded item that is produced at RSD-S and can, therefore, be labeled as a simple product. Product Y, on the other hand, consists of three semi-finished items, of which two produced at RSD-S and one at Cloetta Turnhout, causing that it can be labeled as a more complicated product.

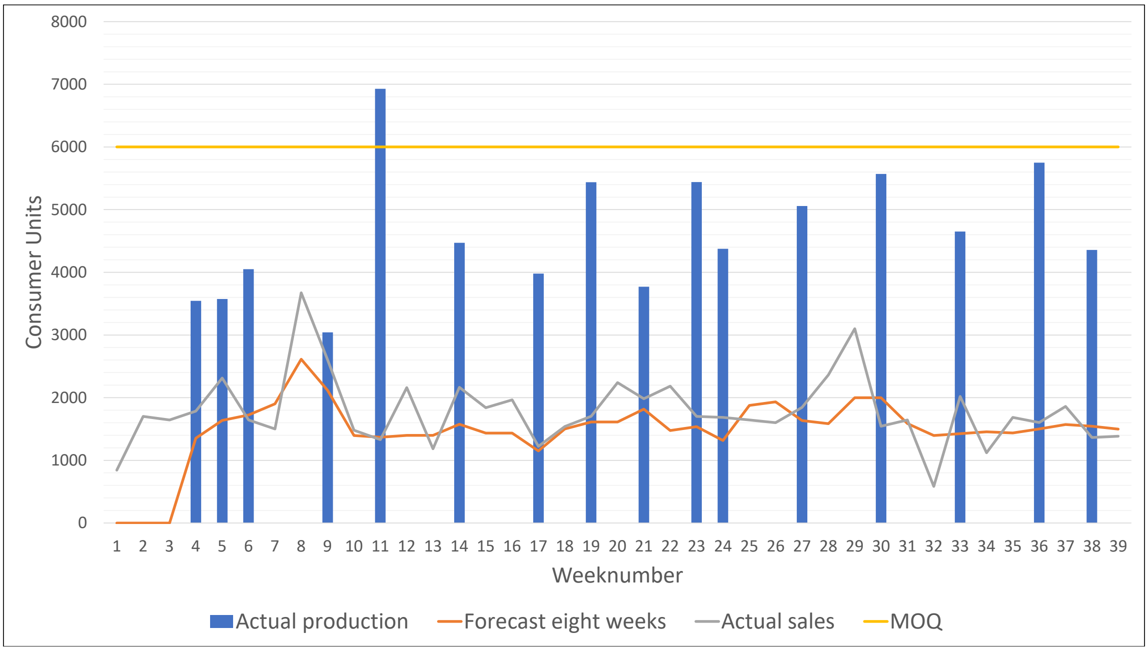
The first perspective shows the actual production volume (including MOQ), the actual sales, and the forecasted sales (eight weeks prior a particular week) for week 1 up to and including week 39 of 2019, as depicted in Figure 1.4a and Figure 1.5a[1]. It can be seen from these figures that single-item X faces a more stable demand pattern compared to mixed-item Y. This deviation could be a result of, for example, promotions in supermarkets. The forecasts related to these demand patterns show, however, a quite similar pattern over time. Notwithstanding, it can be seen that the forecast of single-item X is structural below the actual sales. Moreover, it can be seen that only two times a volume is produced above the MOQs set, which indicates that the MOQs are set too high. Lastly, it can be concluded that the production patterns are both not similar in terms of repetition and volume, which indicates that no repetitive sequence is used.

The second perspective indicates a particular week that is followed over time to see how the expected demand plan, volume plan, and stock level fluctuate prior to a production week, as depicted in Figure 1.4b and Figure 1.5b. It can be seen that in both situations the volume plan changed multiple times over time. Hence, the Scheduler changed the production quantities in OMP. Moreover, it can be seen that the demand plan changed during these eight weeks, of which the demand for single-item X almost doubled. Demand Planners are, however, not allowed to actually change these volumes. Lastly, which is a result of this fluctuating demand plan and volume plan, it can be seen the expected stock level significantly fluctuates over time. Hence, many changes happen during the eight weeks prior to production week.

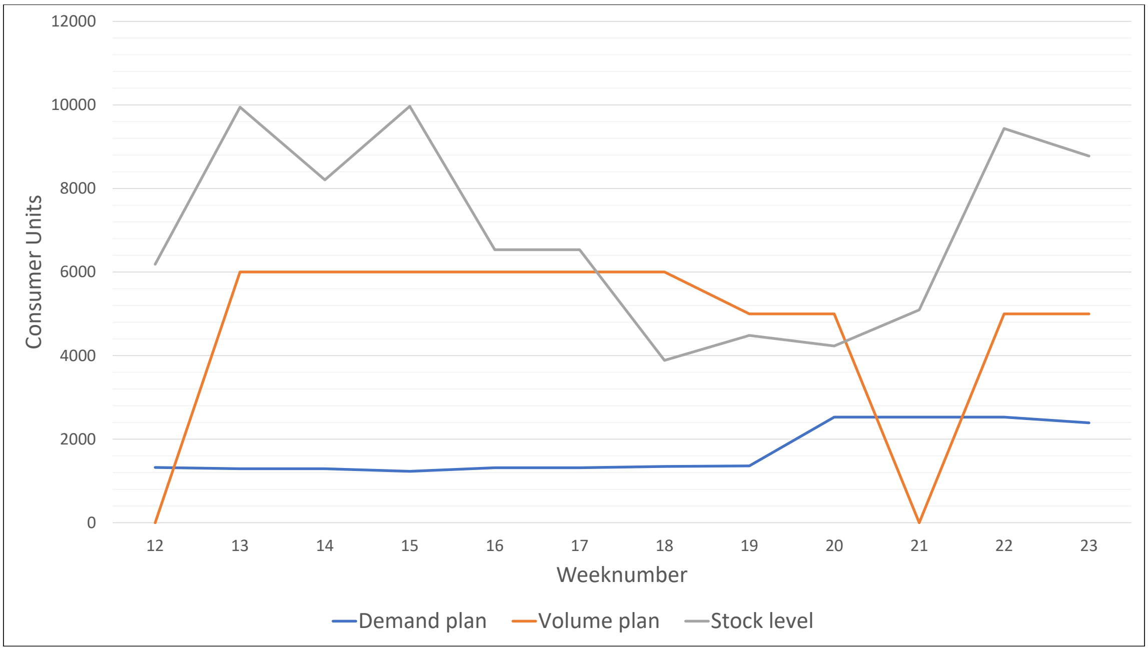
1.3.4 Rescheduling of Production Lines

From the previous sub-section, it can be concluded that rescheduling takes place often in the weeks prior to a production week. This sub-section zooms-in on how this rescheduling actually relates to the production plan. As an example, Figure 1.6 shows the scheduled and actual production at packaging line 905 during week 36 until and including week 41. Figure 1.6a indicates which product families were scheduled at which moment in time per week. Product families, which are based on the outer layer of a candy (e.g., sugared, glazed), are indicated by using different colors in this figure. The color red is used to point out at which moment the machine was set-up. Figure 1.6b indicates how many operators actually worked at this production line, and thus at what times the

[1] Parameters are equal to zero from week 28 because of a new product launch that is a substitute for this product.

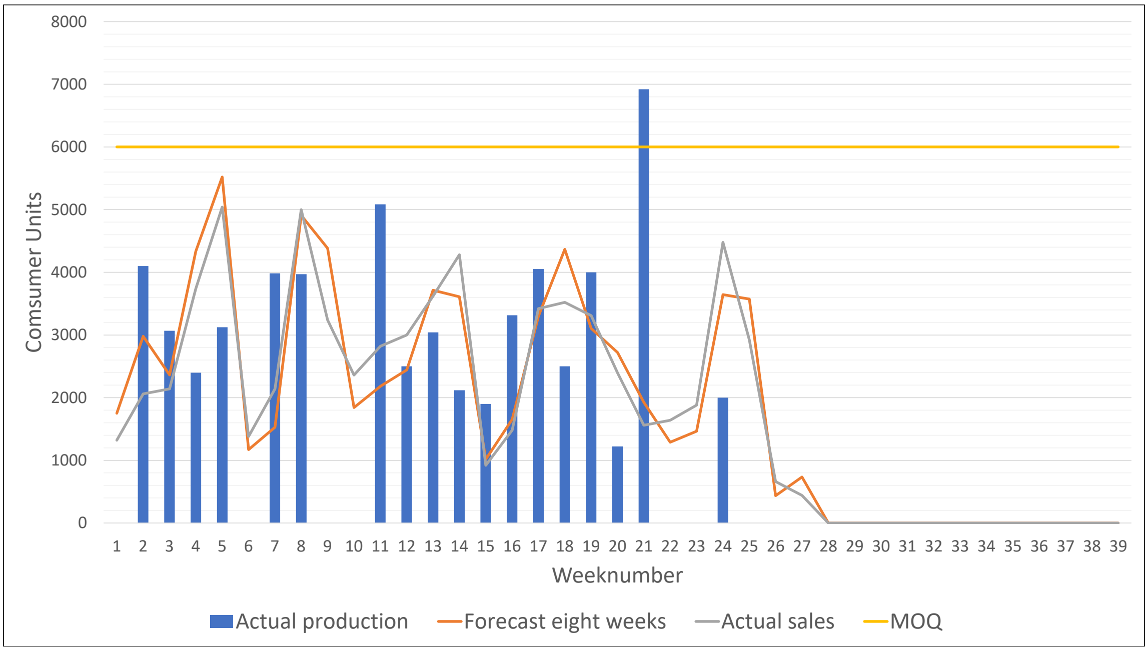


(a) Actual production, forecasted sales and, actual sales

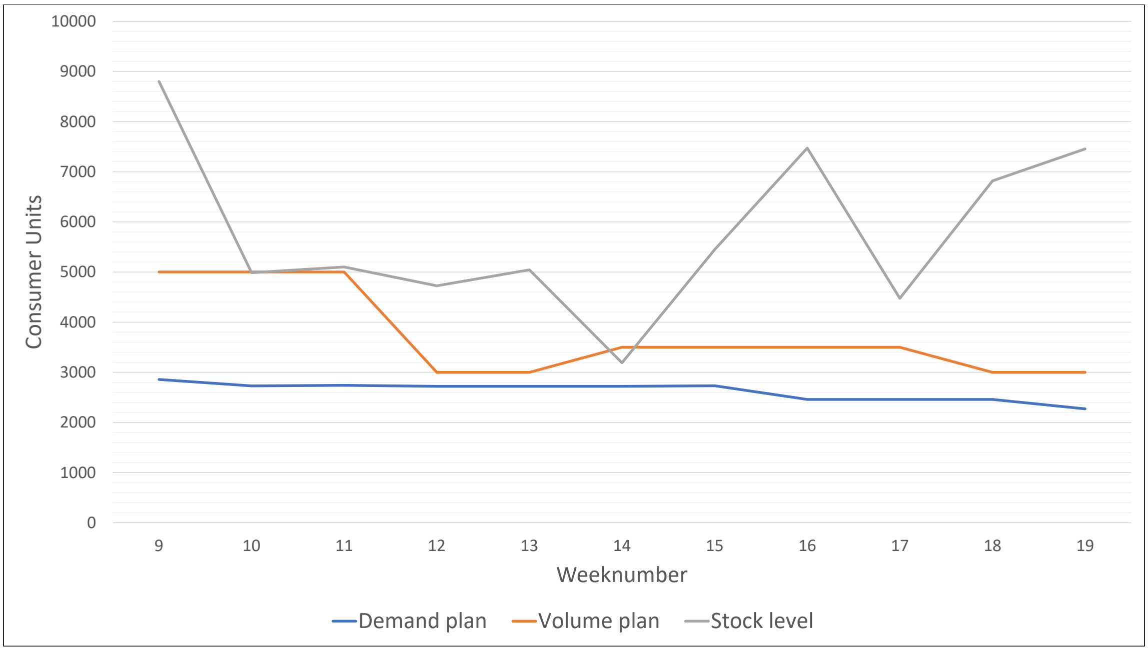


(b) Changes per week in OMP prior to week 24

Figure 1.4: Sales, forecast, and production volume of single-item X between weeks 1 and 40



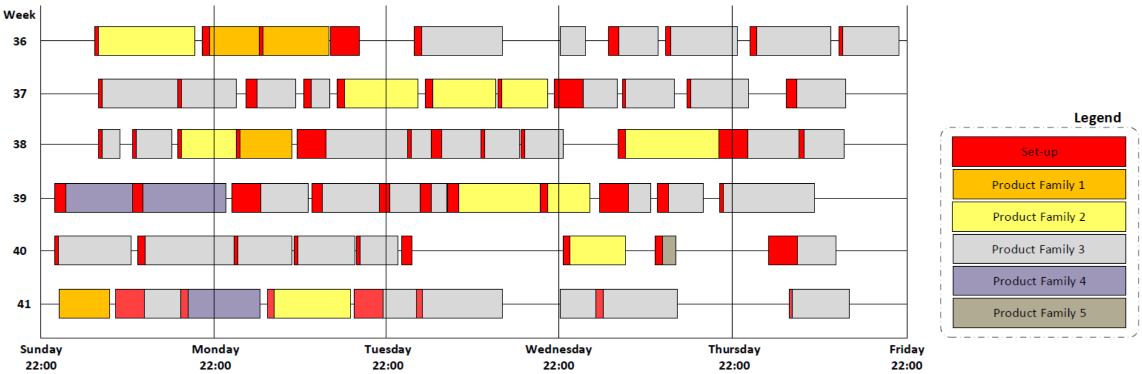
(a) Actual production, forecasted sales, and actual sales



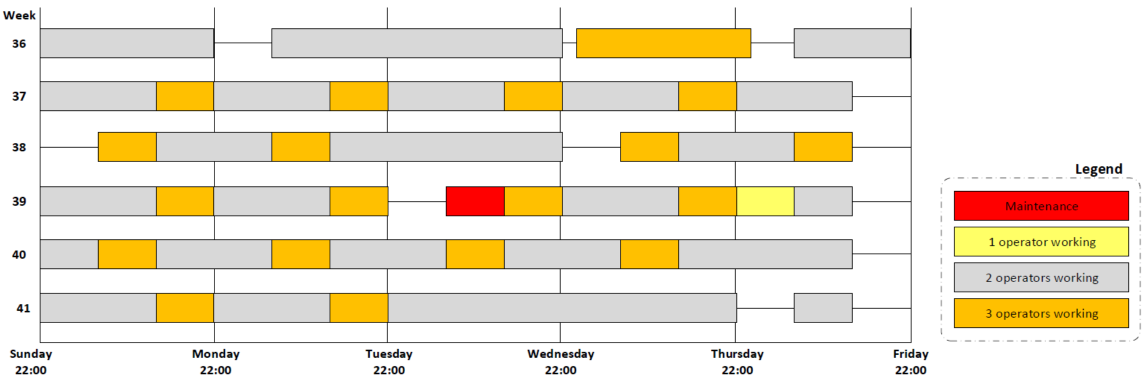
(b) Changes per week in OMP prior to week 20

Figure 1.5: Sales, forecast, and production volume of mixed-item Y between weeks 1 and 40

production line was actually operating. Various conclusions can be drawn from these two figures. Firstly, looking at Figure 1.6a, no regular pattern can be discovered in terms of production times (e.g., starting and finishing the production at fixed times) and family production (e.g., starting and finishing a product family at fixed times during this production period). This irregularity can lead to confusion within the factory and with planning human resources (Soman et al., 2007). Secondly, Figure 1.6b indicates that the same issue can be found for the actual production times. Thirdly, when comparing both figures[2], it can be concluded that production has been occurred on times that actually no production was planned and vice versa. Only during week 39 the production plan was executed within the time scheduled. Hence, it can be seen that the production plan is mostly not completed as scheduled.



(a) Scheduled production



(b) Actual production

Figure 1.6: Actual and scheduled production times at line 905 between week 36 and 41

[2]The figures do not show the identical information because RSD-S does not register when an order is actually started.

1.3.5 Schedule Adherence

The schedule adherence is used, as mentioned earlier, to indicate the percentage of production orders that are produced on time and in the right quantity. From January 2019 till November 2019, the average molding schedule adherence amounted 62.4%, whereas the average packaging schedule adherence amounted 59.6%. It has to be noted that the actual numbers are approximately five percent higher due to registration errors. To give a more precise indication of the schedule adherence, Table 1.2 shows the performance of weeks 36 until and including week 41 at packaging line 905, as used in Figure 1.6 too.

Table 1.2: Schedule adherence at production line 905 between week 36 and 41

Week	**36**	**37**	**38**	**39**	**40**	**41**
Total orders produced	10	11	10	11	9	8
Hit on time	3	4	10	3	4	5
Hit on volume	6	10	10	6	8	7
Hit on time and volume	3	4	10	3	4	5
Schedule Adherence	30%	36%	100%	27%	44%	63%

It can be seen from this table that a schedule adherence of 100% was only accomplished during week 38, while other weeks scored on average 40%. Moreover, it can be concluded that producing an order at another moment in time than scheduled caused more often a lower schedule adherence than producing less volume than scheduled. Comparing these results to Figure 1.6, it can be seen that week 36 was the only week that the scheduled and actual production coincided, which resulted in a schedule adherence of 100%. On the other hand, during the other weeks, the actual production differed from the scheduled production, which resulted in a lower schedule adherence. Hence, the schedule adherence is a good indicator to indicate whether the actual schedule is followed.

1.4 Initial Problem Statement

From the previous sections can be concluded that the volume plan (eight weeks rolling) and production plan are rescheduled multiple times prior to and during a production week by the Scheduler. This rescheduling is a result of (i) a fluctuating expected stock level prior to a production week (ii) that is scheduled to a target number. This target number is the minimum safety-stock defined in OMP. As a result, Schedulers reschedule the volume plan (eight weeks rolling) and production plan to guarantee that the expected stock level is at least equal to the minimum safety-stock, in order to prevent eventual out-of-stocks. Various explanations can be given for this fluctuating stock level. From Sub-section 1.3.1, it can be concluded that the production-line performance fluctuates over time. Hence, RSD-S produces either less or more semi-finished items compared to the actual production plan, causing that the expected inventory level decreases or increases, respectively. On the other hand, Sub-section 1.3.2 indicates that the demand plan fluctuates as a result of the low forecast accuracy. Hence, Cloetta faces either less or more actual sales, causing that the expected inventory level increases or decreases, respectively. Concluding, the volume plan (eight weeks rolling) and production plan have to be rescheduled multiple times prior to and during a production week in order to anticipate on changes in the environment and, therefore, guarantee no out-of-stocks.

1.5 Research Question

Based on the initial problem statement formulated in the previous section, the main research question for this Master Thesis project is defined as follows:

How to design and implement a new planning approach that increases the stability and reliability of the volume plan (eight weeks rolling) and production plan at Cloetta Roosendaal Spoorstraat?

In this question, stability is defined as "a situation in which something is not likely to move or change" and reliability as "the quality of being able to be trusted or believed because of working or behaving well" (Cambridge Dictionary, 2020). Sub-questions are formulated that will be used to answer this research question efficiently. These questions are partly based on the model of Soman, Van Donk, and Gaalman (2004), who suggest to constitute product families that can be used to link specific planning methods (discussed in more detail in Chapter 4). The sub-questions are, therefore, formulated as follows:

1. *Which stakeholders are involved in the planning process and are, therefore, essential during the design and implementation of a new planning method?*
2. *What is the gap between the current and desired situation? What are the root causes that necessitate rescheduling of the production planning?*
3. *Which product characteristics can be used to form product families at Cloetta Roosendaal Spoorstraat? How and how often do the product families have to be revised?*
4. *Which planning method(s) can be linked to each product family that guarantee(s) an increase in the stability and reliability of the volume and production plan?*
5. *Which KPIs can be defined to measure the performance of the new planning approach? How do these KPIs differ from the current KPIs?*
6. *What does the implementation plan of the new planning approach look like in practice, regarding the steps to be taken and stakeholders involved?*

These research questions are answered in Chapter 2 up to and including Chapter 6. The following section presents the research approach that is followed during this Master Thesis project to answer these questions.

1.6 Research Approach

During this Master Thesis project, a planning approach, including an implementation plan, is designed that increases the stability and reliability of the volume plan (eight weeks rolling) and production plan at RSD-S. This result is obtained by following five steps, which are shown in Figure 1.7 and are explained in more detail in this chapter. The first step is to define an initial problem statement. This statement is based on the company description of Cloetta, what the current planning and production process looks like, and how these processes currently perform, as can be seen in the previous chapter. In the second stage, underlying factors that cause the initial problem are identified by using the model of Porras (1987) and by conducting interviews at the most critical stakeholders. These stakeholders are, therefore, identified in Chapter 2. The problem causes are, after that, shown in Chapter 3. To come up with a feasible solution, these root causes are prioritized in the next stage by deciding which elements are within and outside the scope of this project. Based on these causes and the model of Soman et al. (2004), a possible solution will be presented in Chapter 5, which completes step four. This solution is based on a literature review that is summarized in Chapter 4. The same holds for step five, where an implementation approach will be designed that describes how these solutions can be implemented and maintained at Cloetta. This implementation plan is shown in Chapter 6, which is based on the stakeholders identified in Chapter 2 and the models of Kotter (1996), Price and Chahal (2006), and Varkey and Antonio (2010).

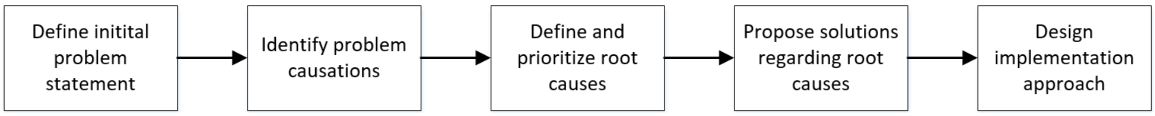


Figure 1.7: Organization of Master Thesis project

Chapter 2

Stakeholder Analysis at RSD-S

When starting a change process, some groups and individuals are either actively involved in the process or are affected by the project's outcome. Such groups and individuals are defined as stakeholders (Freeman, 1984; Project Management Institute, 1996; Newcombe, 2003). Stakeholder analysis is used to identify these groups and individuals and, after that, to indicate how each of them should be managed during the change process (Reed et al., 2009). In this chapter, a stakeholder analysis is performed regarding the situation at RSD-S. As a result, it is possible to obtain information concerning the problems that cause the problem statement mentioned (Chapter 3) and to manage the stakeholders during the change process (Chapter 6). This analysis is performed by first identifying the stakeholders involved (Section 2.1) and, after that, to indicate how each group of stakeholders should be managed during the change process (Section 2.2). The conclusions of both sections are used to answer the first research question (Section 2.3).

2.1 Stakeholder Identification

Stakeholders have to be identified to analyze how groups and individuals can be managed during a change process. Before identifying stakeholders, Prell, Hubacek, and Reed (2009) mention that it is helpful to identify the processes that will be changed during the change process and the subsequent complications that could occur as a result of this change. Based on this statement, Wang, Liu, and Mingers (2015) proposed a method that identifies relevant stakeholders within an organization based on the key activities that are derived from a project's objective. This approach includes the steps:

1. Determine the project's overall objective(s);
2. Search for stakeholders that are involved or affected by this/these objective(s);
3. Break down the objective(s) into a set of critical activities/actions;
4. Continue step two and three until a set of lower-level activities adds no value to the analysis;
5. A complete set of stakeholders can be drawn by merging all stakeholders defined in step 2.

By comparing each step of this model to the information given in this report up to now, it can be concluded that some stages of the above model have already been performed. By comparing Section 1.5 to the model of Wang et al. (2015), it can be argued that the objective can be derived from the stated research question, i.e., increase stability and reliability of production plan. Moreover, it can be argued that the critical activities can be derived from the stated sub-questions, i.e., formulating root causes, forming product families, linking product families, defining KPIs, and implementing the change. These activities are of such level that it is not necessary to break them further down, which also results in the completion of step 4. Hence, it can be concluded that only step 2 has to be performed, which results in the completion of step 5.

To determine the stakeholders that should be involved during this project, Wang et al. (2015) proposed six categories that can be used to define stakeholders. These categories are split into stakeholder groups that are either involved in or affected by the change, as can be seen from Figure 2.1. Moreover, Wang et al. (2015) mention that each stakeholder can be labeled as a key initial stakeholder or a wider stakeholder. Key initial stakeholders are groups or individuals that are essential for achieving the proposed change. Wider stakeholders, on the other hand, consist of the remainder of stakeholders.

The involved				The affected	
Owners who can create, change or destroy the system and who supply the Weltanschauung	**Customers** who are the direct recipients of the output of the system. They may be seen as beneficiaries or victims	**Actors** who perform the activities of the system	**Environmental** groups who are directly necessary for the system, e.g., suppliers of resources	External groups indirectly affected by the systems activities	External groups who indirectly affect the systems activities

Figure 2.1: Stakeholder categorization (adapted from Wang et al. 2015)

Table 2.1 shows all the stakeholders, including the branch and department in which they are working, that can be identified for this project. The stakeholders are defined based on the proposed categories by Wang et al. (2015) and the organizational processes described in Chapter 1. Each stakeholder is assigned a number, which is referred to in the remainder of this chapter. In column four ('group'), each stakeholder is defined as a key initial stakeholder (KIS) or a wider stakeholder (WS). The last column includes the numbers of the sub-questions for which a particular stakeholder could be involved. The figures refer to the sub-questions, as stated in Section 1.5.

It can be concluded from this table that each of the key stakeholders is involved in each sub-question. Wider stakeholders, on the other hand, must only be included in answering some sub-questions. Whether and how a wider stakeholder is managed depends on the exact steps that will be taken during the project. Moreover, the outcome of these steps may indicate whether new stakeholders should be included in this table. The next section analyses how each stakeholder should be managed during this project, which is based on a so-called power/interest matrix.

Table 2.1: Defined stakeholders

Branch	Department	Position		Group	Questions
Commerce	Customer Services	1	CS Support	WS	6
		2	Manager CS	WS	6
	Demand	3	Demand Manager	KIS	2, 3, 4, 5, 6
		4	Demand Planners	KIS	2, 3, 4, 5, 6
	Marketing	5	Marketing Director	WS	6
		6	Marketing Managers	WS	6
	Sales	7	Account Managers	WS	2, 3, 6
		8	Customer Director	WS	2, 3, 6
Supply	Plant RSD-S	9	Call-off Department	WS	2, 3, 6
		10	Graining Department	WS	2, 3, 6
		11	Compressing Department	WS	2, 3, 6
		12	Logistics Department	WS	2, 3, 6
		13	Molding Department	WS	2, 3, 6
		14	Packaging Department	WS	2, 3, 6
		15	Plant Manager	KIS	2, 3, 4, 5, 6
		16	Production Manager	KIS	2, 3, 4, 5, 6
		17	Scheduling Department	KIS	2, 3, 4, 5, 6
	Strategy Deployment	18	Portfolio Manager	WS	6
	Supply Chain	19	Supply Chain Manager	KIS	2, 3, 4, 5, 6
		20	Supply Chain Planner	KIS	2, 3, 4, 5, 6

2.2 Stakeholder Analysis

The power/interest matrix is one of the most commonly used stakeholder analysis by researchers and practitioners (Piercy, 1989; Grundy, 1998; Newcombe, 2003; Olander & Landin, 2005; Chinyio & Akintoye, 2008; Reed et al., 2009; Yang, Shen, Bourne, Ho, & Xue, 2011). In this matrix, stakeholders are classified based on the power they hold and their level of interest regarding the project (Newcombe, 2003). Power is defined as "the ability of individuals or groups to persuade, induce or coerce others into following certain courses of action" (Johnson, Scholes, & Whittington, 2008, p. 160). Interest, on the other hand, is defined as the interest of a stakeholder in either finding a solution during the project or in the solution of the project itself (Olander & Landin, 2005). By classifying stakeholders on both characteristics, the matrix helps to understand which engagement method could be used for each stakeholder (group) (Yang et al., 2011). Moreover, it can be derived from this model who could influence possible future decisions, i.e., stakeholders with a lot of power (Olander & Landin, 2005).

The power/interest matrix is elaborated in Figure 2.2 for the stakeholders that are defined in the previous section. In this figure, each figure within a 'stakeholder' refers to the numbers mentioned in Table 2.1. Different conclusions can be drawn from this stakeholder analysis. Firstly, the plant and production managers of RSD-S (15-16) hold the most power and interest regarding the change. This interest is a result of the extra costs made as a result of rescheduling the production plan daily. Moreover, the Supply Chain Planner and the Scheduling Department (20-17) are interested in the outcome as well, as a good result of the project should cause less rescheduling activities. Secondly, the Demand Manager and Supply Chain Manager (3-19) can influence the outcome of the project but were not involved (enough) during the start of the project. Therefore, their current interest in the project is average. The same holds for the Demand Planners (4), who hold, however, less power compared to the Demand Manager (3). Thirdly, the departments of Marketing and Sales (5-6-7-8) do not hold that much power, as a result of being at the beginning of the scheduling process and, therefore, not influencing the volume and production plan directly. However, these departments would likely want to make every sale actively possible, but cannot always deliver due to insufficient stock available. Hence, Marketing and Sales would like to see a production planning that can be changed over time, such that every deviation from the current forecast can be included in the short-term production plan. The departments could, therefore, resist a more stable production plan. Moreover, the remainder of the stakeholders mentioned in the bottom-right box (9-10-12-13-14) are interested in a stable production plan but do not hold enough power to influence the final production plan. Lastly, the remainder of the stakeholders mentioned in the bottom-left box (1-2-11-18) can be helpful during the change process (e.g., when information is needed), but do not influence the final planning method.

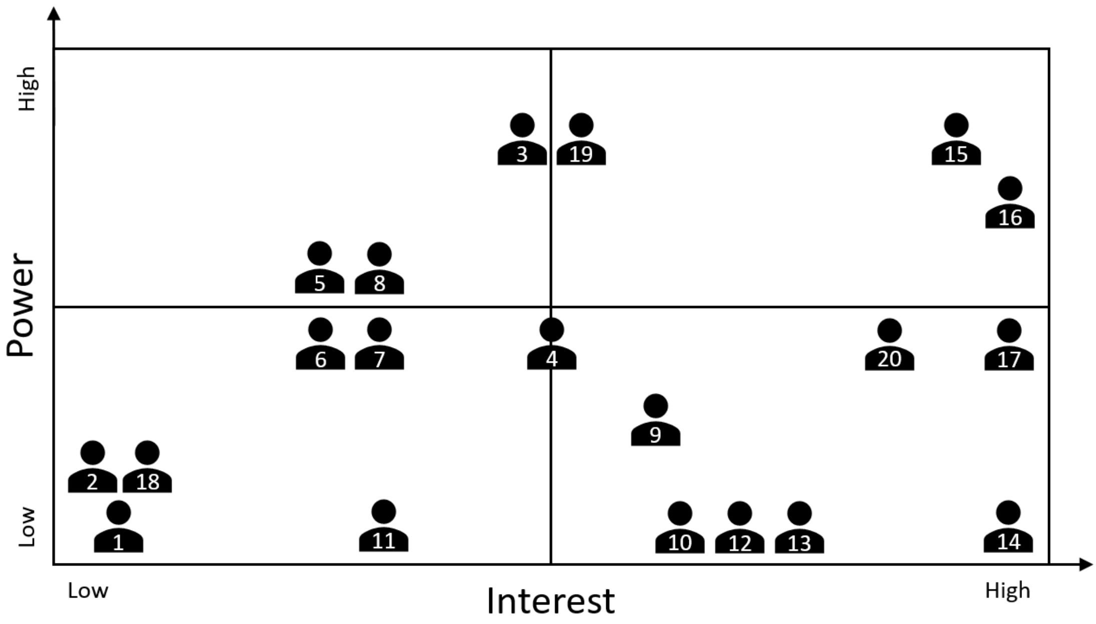


Figure 2.2: Stakeholder analysis at RSD-S

Building on this stakeholder classification, it is possible to define how each stakeholder should be managed during the change process. Grundy (1998) builds on the power/interest matrix by suggesting that stakeholders have to be influenced such that maximum support for the change is created. The author suggests different approaches to maximize support for the change, of which a few are used and, therefore, shown in Figure 2.3. Firstly, it is recommended to either win stakeholders on board or to leave out stakeholders that are placed in the top-left box. Comparing this action to Figure 2.2, it can be concluded that this technique can be applied to the Marketing and Sales Departments (5-6-7-8). Depending on the final solution, i.e., are these stakeholders influenced by or included in the solution, it is necessary to either win them on board (when dealing with the solution) or leave them out of the project (when not dealing with the solution). Moreover, it can be seen that the Demand and Supply Chain managers (3-18) should be either moved to the right or to the bottom. Looking at the importance of these stakeholders for the project, it is necessary to win them on board to guarantee the intended implementation. Secondly, the author suggests to win stakeholders on board that are located in the middle of the matrix in order to build a stronger coalition. Hence, looking to the current case, it can be helpful to include the Call-off Department (9) and Demand planners (4) in the project, which can be obtained by giving them a stake in the outcome. Moreover, Grundy (1998) mentions that project leaders should build a coalition with highly interested stakeholders as well. Hence, a coalition should be built with the Supply Chain Planner and the Scheduling Department (20-17). Lastly, extra stakeholders can be brought in to build a stronger coalition. For example, currently, there are no stakeholders of other plants and eventual stakeholders of the higher management team involved in the project. Hence, these individuals can eventually be brought in to create a stronger coalition and, therefore, to convince the current stakeholders of the project.

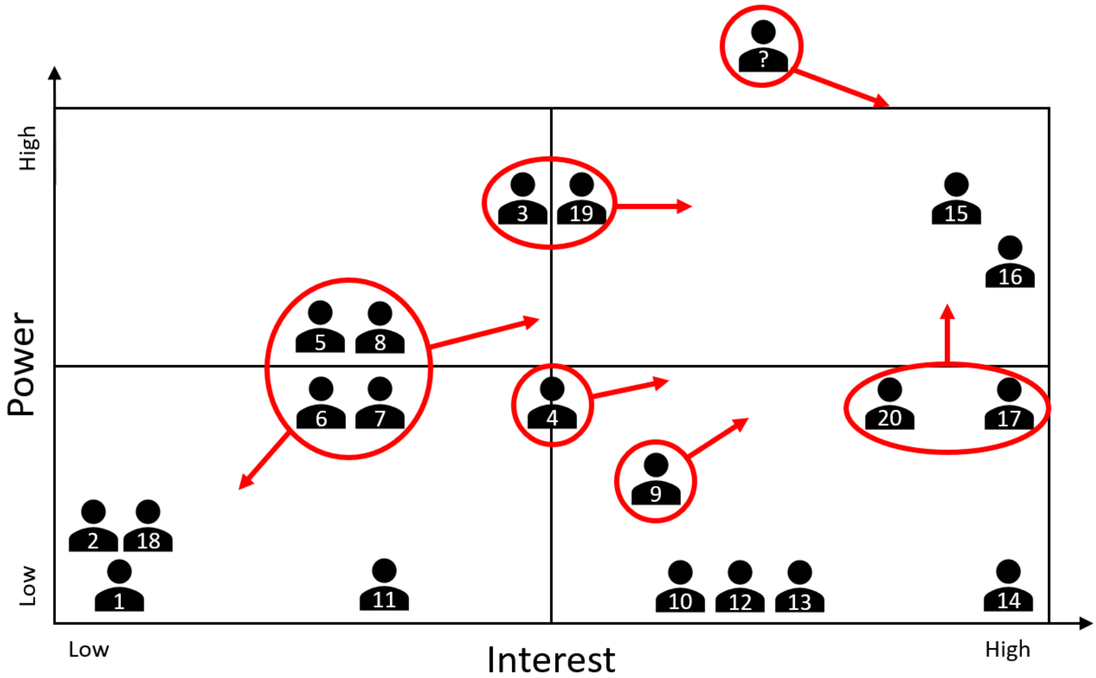


Figure 2.3: Stakeholder management at RSD-S

2.3 Conclusion Stakeholder Analysis at RSD-S

This chapter provides an answer on the first sub-question, which was defined as: Which stakeholders are involved in the planning process and are, therefore, essential during the design and implementation of a new planning method? From this chapter can be concluded that multiple stakeholders are involved in this project. These stakeholders that are involved in this process are identified in order to manage these individuals and groups, such that maximum support for the change can be obtained. Two groups of stakeholders are identified, being: key important stakeholders and wider stakeholders. The key important stakeholders are defined as the Plant Manager of RSD-S, the Production Manager of RSD-S, the Scheduling Department, the Demand Manager, the Demand Planners, the Supply Chain Manager, and the Supply Chain Planner. These stakeholders must be involved during each sub-question. The wider stakeholders that are defined, on the other hand, can be involved during a sub-question. This group consists of the following stakeholders: employees directly associated with the production processes (Graining, Compressing, Molding, Packaging, and Logistics), Customer Support Manager, Customer Employees, Marketing Director, Marketing Managers, Customer Director, Account Managers, and the Portfolio Manager. Whether and how this group of stakeholders will be managed depends on the exact steps that will be taken during the project.

Chapter 3

Problem Analysis

This chapter identifies the root causes that trigger the unstable and unreliable volume plan (eight weeks rolling) and production plan at RSD-S, which problem was defined in Section 1.4. The stream analysis approach of Porras (1987) is used to uncover these root causes, as the author provided a model that includes a structural process to find problems and, after that, link these problems to each other. As a result, one is able to discover the root causes within a process. The model contains four steps to come to this result, being:

1. Collect data and generate problem statements by interviewing employees, administering questionnaires, observing organizational processes, and analyzing company records;
2. Categorize problems by placing them in an organizational dimension within the stream chart. These dimensions are used to get an understanding of where the problems occur within the process. Problems that have much overlap should be combined such that unique issues remain;
3. Identify problems that either cause other problems or have no clear relationship with other problems. After that, connect the problems that have a relationship by using arrows;
4. Analyze the stream chart and identify problems that are caused by deeper problems (symptoms), problems that drive many other problems (core problems), and problems that are not affected by other problems (fundamental core problems). Through this categorization process it is possible to identify problem stories, which exists of multiple problems that describe a more complex problem within an organization.

The above four steps are described and applied to RSD-S in this chapter. The first step, in which data related to the initial problem statement is collected, is performed in Section 3.1. After that, the collected data is categorized and linked by using a stream chart (Section 3.2). From this stream chart, problem stories are distracted in Section 3.3. The implications that these problems bring for Cloetta are, after that, discussed in Section 3.4. However, not each problem can be solved during this project. Section 3.5 indicates, therefore, which problems are within and outside the project's scope. Lastly, in Section 3.6, an answer on the second sub-question is given, which concludes the problem analysis.

3.1 Data Collection

Porras (1987) mentions four ways through which information can be gathered, being: analyze company records, perform interviews, administer questionnaires, and perform observations. The author mentions that questionnaires can be used when a large number of people has to be reached. However, the amount of data that can be collected via this tool is limited. It was, therefore, decided to interview employees that influence the volume and production plan. Moreover, company records are analyzed, and observations are performed at RSD-S.

Employees that have been interviewed work within the Supply and Dutch/German branch of Cloetta. Other branches are not included, as these branches can be compared with the Dutch/German branch or do not influence the production planning at RSD-S. The employees interviewed for this investigation are based on the stakeholders that were linked to sub-question 2 in Table 2.1. Hence, the following employees are interviewed:

- Account Managers [2 out of 10]
- Dutch Demand Manager [1]
- Dutch Demand Planner [1 out of 2]
- Plant Manager RSD-S [1]
- Production Manager RSD-S [1]
- Schedulers/Call-off coordinators RSD-S [3]
- Senior Supply Planner RSD-S [1]
- Supply Chain Manager [1]
- Team-leader Logistics RSD-S [1]
- Team-leader Production RSD-S [4 out of 5]

Multiple interview types can be used in quantitative research, which are, for example, structured, semi-structured, and unstructured interviews (Baumbusch, 2010). Semi-structured interviews are used for this research, as these interviews give the possibility to ask more in-depth questions when needed, but guarantee a similar structure during each conversation. Therefore, it is possible to compare the given answers and to use them in the model proposed by Porras (1987). Appendix B.1 shows the drafted interview questions, and Appendix B.2 shows some examples of the interview quotes used to define problems.

Observations have been performed by comparing the actual production process and the corresponding production plan for two weeks. During this phase, it was observed that especially the packaging stage suffers from an unstable production planning. This unstable plan is a result of semi-finished items that are not available at the buffer, causing that the production schedule has to be revised in order to continue the packaging process. Semi-finished items are not available as a result of different causes. For example, semi-finished items are not received on time from third parties or production departments, or semi-finished items contain quality issues. When rescheduling the packaging planning, it is possible to switch the sequence of production orders, set-up a production line that is not occupied at that moment, or send operators home. In the first two cases, either too much or too few operators may be available due to different process specifications. Hence, extra operational costs have to be made as a result of employing or fire-up temporary workers.

Analyses have been performed on the information and data shown in Chapter 1, from which different conclusions are drawn. The most important conclusion drawn is that the expected stock level fluctuates prior to a production week, while it is scheduled to be at least equal to a fixed number: the safety-stock. Hence, Schedulers have to reschedule the production plan in order to guarantee that the expected stock level is again at least equal to the safety-stock. The fluctuating stock level has two core causes. Firstly, the current production plan is not executed as scheduled, causing that less or more products are produced than planned. Secondly, the demand plan changes within the eight weeks prior to a production week, causing less or more products to be sold. As a result, the expected stock level either increases or decreases. Lastly, the minimum safety-stock is calculated by taking the average demand of a SKU, causing that any sales fluctuations are not taken into account. Moreover, the safety-stock level is based on an average demand of three weeks, while semi-finished items from the Graining Department already have a throughput time of five weeks. Concluding, the fluctuating expected stock level is scheduled to a stock level, the safety-stock, which cannot anticipate on any demand or volume fluctuations.

As a result of the above three analyses, twenty-seven problems have been identified that influence the volume and production planning. These problems are located in a stream analysis, which is depicted in the next section. Moreover, these problems are linked to each other in order to identify the root causes.

3.2 Stream Analysis

The most crucial step introduced by Porras (1987) is the completion of the stream analysis. This diagram shows each problem identified in the previous section, which are positioned in one of the four dimensions, and are connected to each other after that. As a result, the second step and third step mentioned at the beginning of this chapter are completed. The four dimensions used within this stream analysis are:

- Production: this column contains problems related to the production environment of RSD-S (e.g., production lines, carrying-out production planning, operator planning);
- Volume and production plan: this column contains problems related to the volume plan stated in OMP and the production plan used at the production;
- Demand plan: this column contains problems related to the demand plan stated in OMP, including the factors that influence the forecast;

- Communication: this column contains problems related to the communication that streams between departments and production plants.

The stream analysis drafted is shown in Figure 3.1. Problems that are related to each other are linked by using arrows. By doing so, symptoms (no arrows leaving a problem), core problems (no arrows arriving at a problem), and fundamental core problems (not connected to other problems) can be identified. Two problem stories are identified from this point, as can be seen from this figure, which are explained in the next section.

3.3 Problem Stories

Two problem stories can be recognized by grouping the problems identified in the previous section, being: the current production plan is not fulfilled as scheduled, and the expected demand plan changes prior to a production week. Both stories consist of multiple problems and are, therefore, one by one explained in this section.

The first story, which is depicted by using red lines in Figure 3.1, is about not fulfilling the current volume plan during the eight weeks rolling (11). Two problems cause that this plan cannot be followed as intended, being: the production plan is not executed as released (19), and the volume plan received at week eight cannot be scheduled within one week (15). Therefore, the expected stock level fluctuates overtime prior to a production week (13). In combination with scheduling this expected stock level to be at least the minimum safety-stock, which does not include extra stock to manage such fluctuations (14), the current volume plan (eight weeks rolling) has to be rescheduled in order to keep the actual inventory level at the minimum safety-stock level (10). Moreover, it can be seen from this story that the production plan directly has to be rescheduled in case that this plan is not executed as released (19), which step is performed to guarantee that as much as possible inventory levels are at least equal to the minimum safety-stock during that week. Both problems mentioned cause extra handling at the Scheduling Department and, therefore, increased operational costs.

The two problems mentioned above, problems 15 and 19, face multiple core problems. The first problem, volume plan received in week eight cannot be scheduled within one week (15), results on the one hand from automatically planning the volume plan such that the expected inventory levels are at least equal to the minimum safety-stock in week 9 (24). The volume of each packaging order is based on the MOQs set in Cloetta's system. These packaging orders cause, on the other hand, an overload at the previous production departments (16), which is a result of setting these MOQs equal to the average demand of three weeks (26). As this demand can cause a too high production volume, i.e., preferred to pack this item every week, the packaging plan is rescheduled to be at least equal to the minimum safety-stock, causing the production volume to decrease. This action is, in most cases, applicable because the MOQs cause that the current production order is larger than the minimum safety-stock.

The second problem that results in a volume plan (eight weeks rolling) that is not fulfilled as planned, the production plan is not executed as released (19), is caused by three different problems. Firstly, production orders can be labeled as priority order to prevent eventual out-of-stocks (18). Production orders are, therefore, shifted to guarantee earlier production. Secondly, information regarding delayed deliveries from other Cloetta plants and third parties is received later than preferred (22). As a result, production orders are already released at the moment that purchase orders are postponed. The reason for obtaining this information too late is a result of limited communication between third suppliers and RSD-S (23). Lastly, RSD-S does not pack its products as scheduled (7). Not following this plan is, on the one hand, a result of semi-finished items that are not on time or in the right quantity delivered at the buffer (5), which is caused by either the production processes within RSD-S (6) or shipments from other third suppliers (4). Not receiving semi-finished goods on time and in the right quantity from the processes within RSD-S results from quality issues (2), unreliable production lines (1), and production norms that are not matching the actual production times (3). If semi-finished items are available at the buffer, unreliable production lines (1), product quality issues (2), and not sufficient operators available (8) cause that products are not packed on time or not in the right quantity too. The reason that operators are sometimes not available results from the problem that semi-finished items are not available at the buffer (5), causing that other SKUs, which include other operator requirements, are packed than scheduled.

The second story, which is depicted by using green lines in Figure 3.1, indicates that the Demand Plan actually changes within the eight weeks prior to a production week (12), which causes the expected stock level prior to a production week to fluctuate too (13). Therefore, the volume plan (eight weeks rolling) has to be rescheduled (10), due to planning the order sizes such that the expected inventory level is at least equal to the minimum safety-stock (14). The most significant problem that causes this fluctuating demand plan is the low forecast accuracy (27), causing that actually more or fewer confectioneries are sold to Cloetta's customers (17). This low forecast accuracy is caused by two underlying problems. Firstly, customers of Cloetta are allowed to confirm their promotions within the last weeks prior to the actual sales (20). As these promotions do significantly influence the demand, it has a large impact on the volume within the demand plan. Secondly, the communication between some customers of Cloetta and the Demand Department is somewhat limited (9). Therefore, Cloetta does not actually know when the customer will order and how much the customer will order. Another core problem that has to do with the fluctuating demand plan is the transparency of the demand plan (25). Schedulers at RSD-S do currently not know which part of the demand plan is reliable and which part is not. Moreover, Demand Planners and Schedulers do not communicate when the demand plan remarkably changes. Hence, Schedulers make a production scheduled without actually knowing the information behind the number. The last core problem that causes a fluctuating demand plan results from products launched from projects, NPDs, or re-allocations that are not communicated on time (21), causing that the changes within the system are performed within the eight weeks prior to a production week. Hence, the demand plan increases as a result of these introductions.

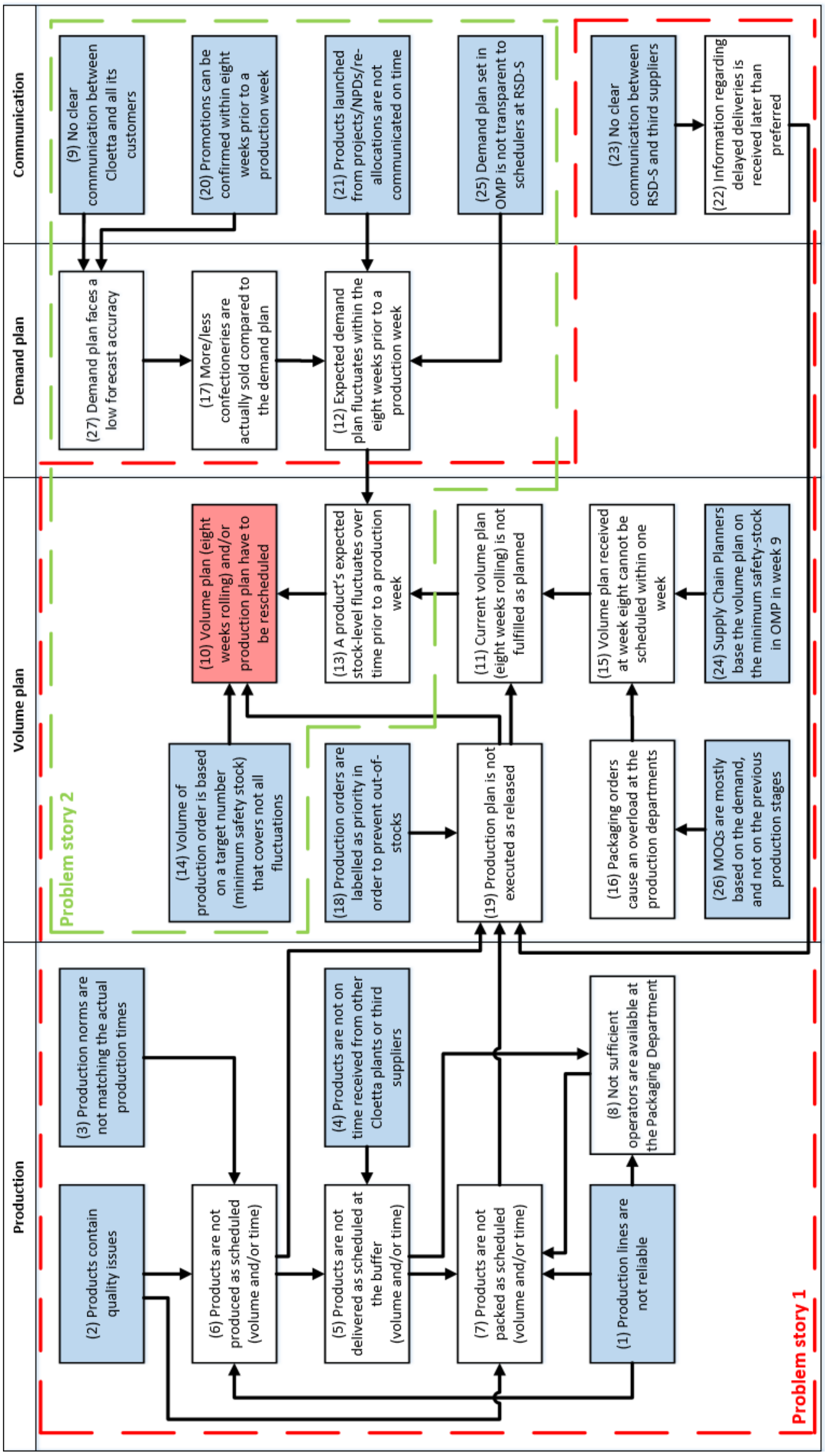


Figure 3.1: Stream analysis including problem stories 1 and 2

3.4 Implications Current Planning Method

To indicate that the problem mentioned in the previous section is actually a problem for Cloetta, this section indicates the costs associated with this problem. Namely, the previously mentioned problems cause extra operational costs within Cloetta. These costs are mostly related to non-value-adding steps performed during the planning process. The exact costs of these non-value-adding steps are, however, hard to determine because these steps are rooted in the current process within Cloetta. Therefore, it is suggested to indicate the exact costs of each change step during the implementation process. Hence, this topic is discussed in more detail during Chapter 6. On the other hand, it is possible to indicate what kind of non-value-adding steps are currently performed within some departments.

The first department highlighted is the Scheduling Department. At RSD-S, Schedulers spend a lot of their time to reschedule the volume plan (eight weeks rolling) and the production plan. The volume plan is rescheduled in order to guarantee that the production plan fits the capacity available, and to guarantee that the expected stock level is at least equal to the minimum safety-stock. On the other hand, the production plan is controlled and rescheduled multiple times during the production week to guarantee that the volume is produced that was scheduled. Both steps result in a lot of non-value-adding handling during the week. The second example highlighted includes all the production departments. Currently, team-leaders of these departments are constantly occupied with controlling the current production plan, especially the team-leader of the Packaging Department. Packaging orders are, namely, rescheduled on a daily basis as a result of semi-finished items that are not available at the buffer. Hence, the team-leader of the Packaging Department is constantly engaged in checking which semi-finished items are available at the buffer, which operators are available to produce, and which production lines are available to pack. These actions include a lot of handling because the needed information is currently not directly available.

The last department highlighted is the Supply Chain Department. This department compares once a month the available capacity with the expected demand, which process consists of, on some points, very detailed calculations. As the demand plan can fluctuate strongly over time, these calculations have to be executed again during the next month. Hence, these calculations are on some points meaningless because the figures behind the analyses can completely change during the next month, which thus includes some non-value-adding steps. Probably some more departments within Cloetta are occupied with these non-value-adding steps as a result of the problems mentioned. However, as this project only focused on the processes within RSD-S, it is hard to determine which departments actually face the same problems. Hence, this investigation should be included within the implementation plan proposed in Chapter 6 too.

3.5 Scope of Project

Multiple core problems cause that the current volume plan (eight weeks rolling) and production plan have to be rescheduled, as stated in Section 3.3. However, not every cause can be addressed within this project because these factors can either not be influenced or are not within scope. Figure 3.2, therefore, indicates which problems are within the scope of this project (not crossed out blocks) and outside the scope of this project (crossed out blocks). Moreover, this figure indicates which problems can actually be changed (green blocks) and cannot be changed but have to be taken into account in the solution (red blocks). To start with, four core problems can be changed and are within the scope of this project. Firstly, the target number to which the expected inventory level is scheduled (14) can be designed differently. Secondly and thirdly, communication between Cloetta plants (23) and departments (25) can be set-up more transparent. Lastly, order quantities can be defined differently compared to the current MOQs (26).

Six problems cannot be changed, on the other hand, but have to be taken into account within the new planning approach. The first problems are related to variation that can be reduced but always will remain, being: unreliable production lines (1), quality issues (2), not on time received semi-finished items (4), and priority production orders (18). Secondly, planning the volume plan such that the expected safety-stocks are at least equal to the minimum safety-stock in OMP (24) can always result in a demand that is larger than the capacity available for that week. Lastly, due to the increasing power of supermarkets and retailers (Dobson, Clarke, Davies, & Waterson, 2001), Cloetta has to allow that customers can confirm their promotions within the eight weeks prior to a production week (20). Hence, the proposed solution should allow some variation. The last group of core problems includes problems that can be changed but are not within the scope of this project. Ensuring the right production norms (3), have better communication during product launches (21), and communicate more between customers (9) are, thus, standalone projects, which can be performed alongside this project. Concluding, some of the underlying problems can be changed (within or outside this project), while most of the problems have to fit within the new planning approach.

3.6 Conclusion Problem Analysis

This chapter provides an answer to the second sub-question, which was formulated as: What is the gap between the current and desired situation? What are the root causes that necessitate rescheduling of the production planning? From this chapter can be concluded that the volume plan (eight weeks rolling) and production plan are currently scheduled such that the expected stock level is at least equal to the minimum safety-stock. However, this expected stock level fluctuates significantly prior to a production week, which cannot be covered by the safety-stock. The volume plan (eight weeks rolling) and production plan are, therefore, rescheduled to guarantee enough stock available at the DCs such that out-of-stock are prevented. This fluctuating expected stock level is caused by two larger underlying problems. Firstly, the production plan is not executed as released. This problem is caused by multiple root causes, of which some relate to variation that cannot completely

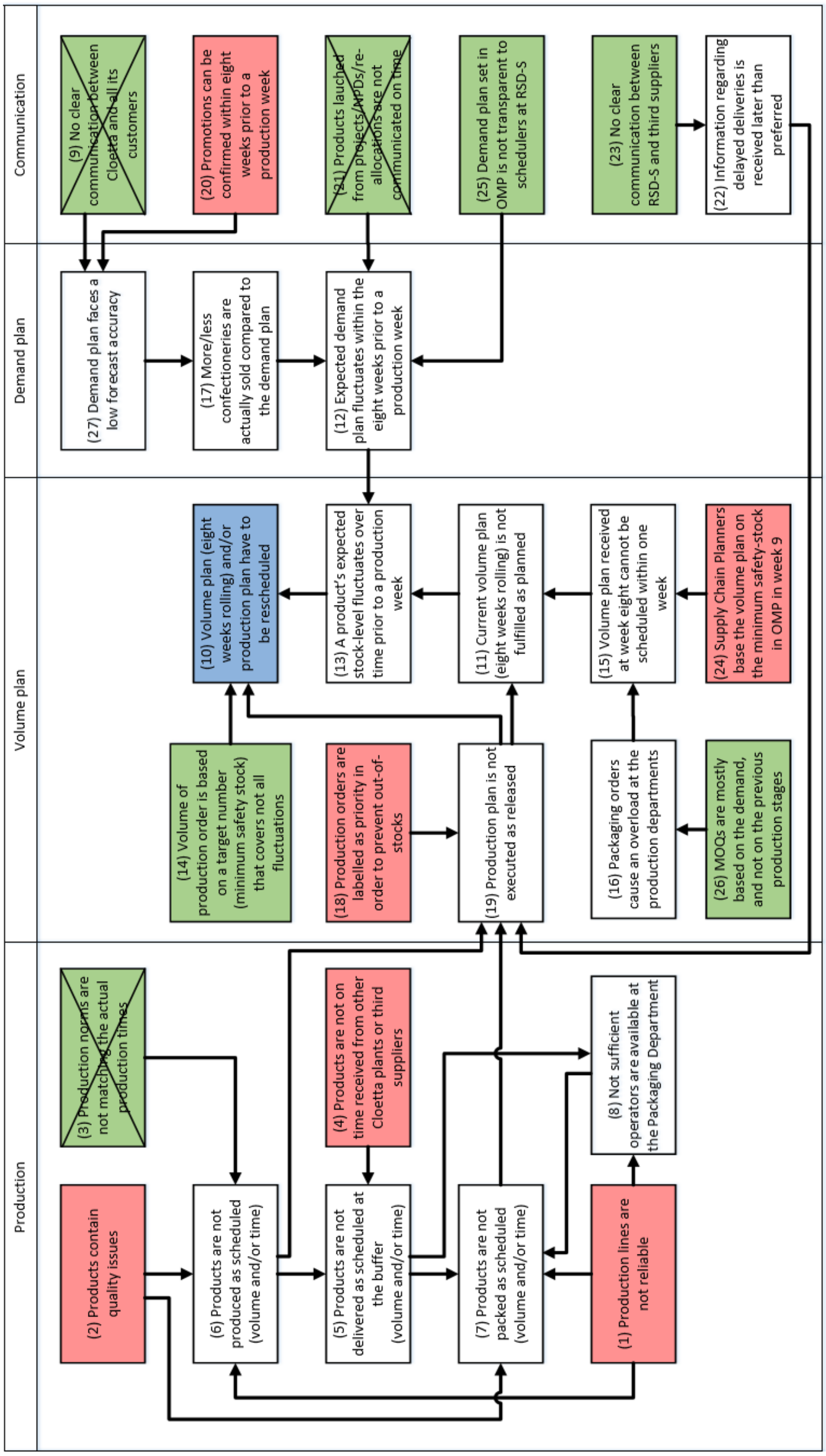


Figure 3.2: Symptoms that are in scope and out of scope during the project

be taken away (i.e., quality issues, unreliable production lines, not on time received semi-finished items), causing that the new planning method should allow this kind of variation in the planning. Root causes that can be included during this process are, on the other hand, MOQs that are set too high, and the limited and not transparent communication between Cloetta plants. The second problem that causes the fluctuating expected stock level is the demand plan that changes within the eight weeks prior to a production week. This problem is caused by multiple root causes too, of which the root cause 'demand plan is not transparent toward Schedulers at RSD-S' is included within this project. A root cause that, on the other hand, cannot be solved but should be included as variation in the solution, is the fact that customers of Cloetta can confirm their promotions within the eight weeks prior to a production week, which significantly influences the demand plan. Concluding, the desired situation, in which Schedulers do not have to reschedule the volume plan (eight weeks rolling) and production plan, can be obtained by, on the one hand, allowing demand and process variation and, on the other hand, by finding a solution for some root causes. As a result, various stakeholders throughout the Cloetta organization should spend less time on non-value-adding steps regarding the planning process.

Chapter 4

Literature Review

A more controlled production and inventory policy is needed within Cloetta to avoid rescheduling of the current volume plan (eight weeks rolling) and production plan. To come up with a workable solution, this project faces two challenges that consist of two separate subjects. Firstly, a planning method has to be found in which a fluctuating expected stock level does not influence the current volume plan (eight weeks rolling). Possible solutions to this problem are shown in Section 4.1. Secondly, the new way of working has to be integrated within the current planning cycle at Cloetta. Therefore, a need and readiness for change have to be created among all stakeholders involved. Possible plans to implement a new planning approach are, therefore, stated in Section 4.2. Both sections indicate an overview of the essential literature found. A more comprehensive explanation of each model can be found in the Literature Review (van Hoef, 2020).

4.1 Planning Concepts

The decomposition of an environment is an often-used technique to tackle challenging problems (Akkerman & van Donk, 2009). Accordingly, this section represents a guideline on how a scheduling problem can be revised in multiple, small steps, and which techniques can be used in designing a scheduling concept. The guideline followed is suggested by Soman et al. (2004), who introduced a top-down approach that consists of three main steps to come to a new scheduling procedure, as can be seen from Figure 4.1. In this model, the first step is used to determine the position of the Customer Order Decoupling Point (CODP) for each product family, which is explained in more detail in Sub-section 4.1.1. Product families are formed by comparing and selecting different product and process characteristics (Sub-section 4.1.2). In the second step, a production and inventory policy is set-up for each product family. Subjects such as order acceptance policies and lot sizes are treated at this level. In the last step, the third stage, the detailed weekly planning is created and controlled. These last two steps are explained in conjunction in Sub-section 4.1.3. A final conclusion is drawn in Sub-section 4.1.4.

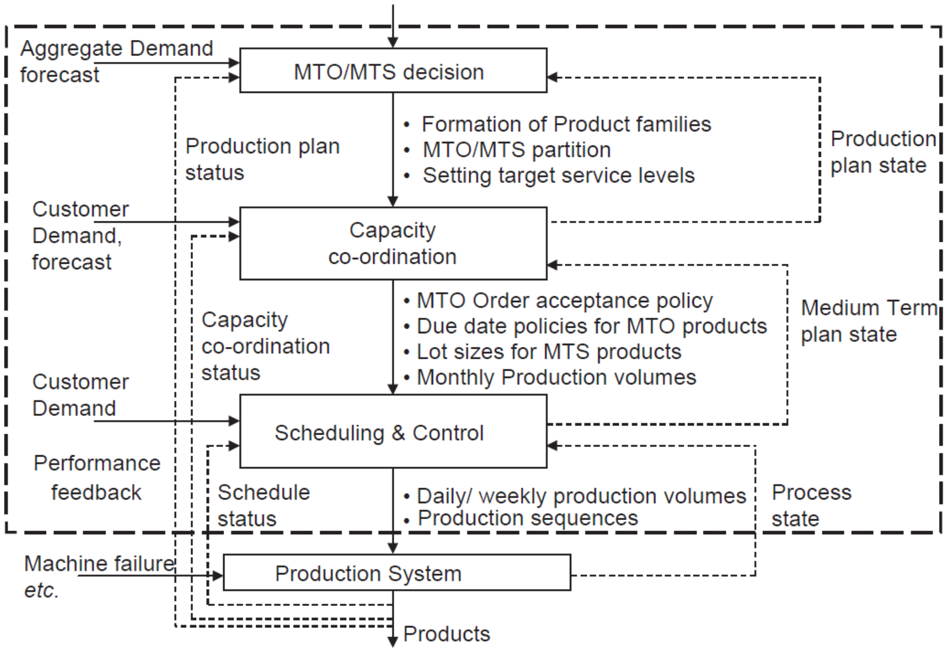


Figure 4.1: Hierarchical planning approach (adapted from van Soman et al. 2004)

4.1.1 Production Environments

Production environments differ in terms of when and for who a product is engineered and produced. This distinction is characterized by the position of the Customer Order Decoupling Point (CODP). The CODP "separates the customer order part of the activities (to the right of the DP) from the activities that are based on forecasting and planning (to the left of the DP)" (Hoekstra & Romme, 1992, p. 5). This point can be characterized as (i) the point that separates forecast-driven activities from order-driven activities, (ii) the inventory location from where customers are served, and (iii) the point where forecast-driven actions are not influenced by variable customer demand (Van Donk, 2000). Hence, the process steps before the decouple point are performed based on the forecast and are, thus, made to stock (push-based), whereas process steps after the DP are performed based on a customer order and are, therefore, made to order (pull-based). The CODP is also referred to as the Order Penetration Point (OPP) (Zaerpour et al., 2009).

Multiple production environments can be distinguished by positioning the DP at different locations within a production process, as can be seen from Figure 4.2 (Olhager, 2003). The dotted lines in this figure indicate the upstream process, which is the part of the process where products are made to stock. On the other hand, the solid lines indicate the downstream process, which is the part of the process where products are made to order. By positioning the OPP at different locations, four commonly used environments can be classified, being: make-to-stock (MTS), assemble-to-order (ATO), make-to-order (MTO), and engineer-to-order (ETO) (Olhager, 2003). ETO environments are, however, not commonly used within food processing environments, as they are mostly used in processes in which high value, customized products are produced (Hicks, Mcgovern, & Earl, 2000). MTS, ATO, and MTO environments are, on the other hand, often used in food processing industries. Moreover, a combination of these three production environments, the so-called hybrid production environment, is commonly used within food processing industries too. Hence, the CODP is within a hybrid production environment determined for each product family separately (Ghalehkhondabi, Sormaz, & Weckman, 2016).

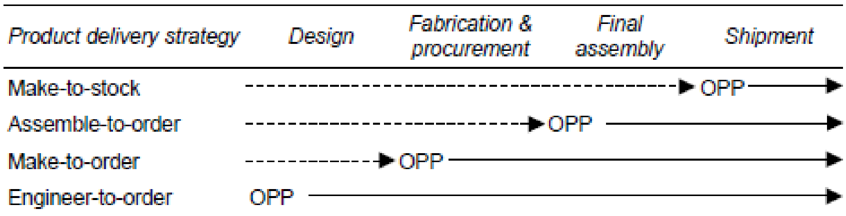


Figure 4.2: OPP under different manufacturing environments (adapted from Olhager 2003)

4.1.2 Product Classification

Products are classified to understand which CODP should be linked to a particular product family, as mentioned before. Van Kampen, Akkerman, and van Donk (2012) performed a classification literature review, from which it was concluded that the current literature shows different product classification models. The authors proposed, therefore, a framework that can be used to define product classes as aimed for, which can be seen from Figure 4.3. It can be concluded from this figure that both the aim (1) and the context (2) of the project influence the characteristics chosen. After that, the characteristics (3) influence the technique chosen, as it depends on how these characteristics can be processed. Van Kampen et al. (2012) mention that classification techniques can be either judgemental or statistical. With judgemental techniques, it is possible to capture the opinion of operational managers, while statistical models are purely based on data. Lastly, it can be seen that the technique chosen (4) and the context of the project (5) influence the product classes. Hence, this framework can be used when identifying product classes.

Using this framework for the situation at Cloetta, the following can be concluded. This Master Thesis project aims to increase the stability and reliability of the production plan. Therefore, the aim of classifying product groups should be to find a suitable production strategy per product group. The context of the project is a typical food processing process, in which semi-finished items are processed first, then temporarily stored, and finally packed in single or mixed SKU (Soman et al., 2004). In the remainder of this chapter, different techniques and corresponding characteristics are treated that relate to this aim and context. The models found are split into quantitative and qualitative models. Moreover, it is discussed how often product families have to be revised.

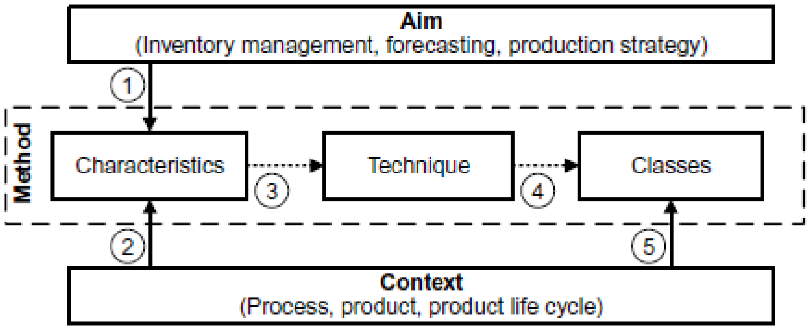


Figure 4.3: Framework for SKU classification (adapted from van Kampen et al. 2012)

Quantitative classification models

One of the oldest classification models found in the literature is the ABC-analysis proposed by Silver and Peterson (1985). This method is one of the most commonly used classification models by researchers and practitioners (Van Kampen et al., 2012). The authors split all SKUs into three groups, from which the first group, group A, represents the products that account for 80% of the total sales. This group should represent about 20% of all products. The next class, group B, represents the products that account for the following 15% of the sales. This class should represent about 30% of all products. Hence, the last group, group C, represents the last 50% of the products, which should account for approximately 5% of the sales. This approach is based on the Pareto-analysis (Pareto, 1906). The aim of splitting all SKUs into three groups is that one can focus on a small number of products, group A, which represents most of the sales volume and, hence, has the most impact on the customer (Van Kampen et al., 2012). The authors mention that products within group A can be produced MTS, whereas products within group B and group C can be produced MTO. This approach decreases the total production costs compared to a pure MTS-environment.

Multiple researchers have adjusted the traditional ABC-analysis by including different characteristics, of which some examples can be seen from Table 4.1. However, more characteristics cannot be added to the models of Silver and Peterson (1985), Federgruen and Katalan (1999), Schönsleben (2004), and Perona, Saccani, and Zanoni (2009). The model of Flores, Olson, and Dorai (1992) certainly does show that more characteristics can be included within the ABC-analysis. Nevertheless, it is not possible to include in this model that when, for example, one characteristic is met, a product has to be classified within a specific group. Moreover, the ABC-analysis is built such that the products have to be positioned in one of the three groups, while probably more product-groups are preferred within some situations. Therefore, Hoekstra and Romme (1992) suggest a qualitative approach to position the location of the CODP. Therefore, characteristics that could be taken into account in such qualitative methods within the food industry are discussed below.

Table 4.1: Overview of adjusted ABC-analysis

Author(s)	Characteristic(s)	Explanation
Flores et al. (1992)	Multiple criteria	Use the analytic hierarchy process to integrate multiple criteria into the classic ABC-analysis
Federgruen and Katalan (1999)	Customer requirements	Non-customer-specific products are produced to stock, whereas other products are produced to order
Schönsleben (2004)	Demand variability	Products that face a stable demand pattern are produced to order, whereas other products are produced to stock
Perona et al. (2009)	SKU and semi-finished item, and volume and amount of orders	SKUs and semi-finished items with a high sales volume are produced to stock, whereas other SKUs and semi-finished items are produced to order

Qualitative classification models

Product characteristics can influence the position of the decoupling point directly (Van Donk, 2000, 2001). Table 4.2 summarizes, therefore, different general characteristics and characteristics that are related to the food-industry that influence the location of the CODP. These characteristics can be used within a decision tree to come to the final product families (Van Kampen & Van Donk, 2014). The authors consider a decision tree useful, as it is objective, includes the characteristics needed, and is easy to understand by all stakeholders. A production environment is, after that, linked to each product family. This environment is chosen based on the characteristics that are represented in the decision tree. Hence, by using a qualitative approach to determine the location of the CODP, it is possible to use as many characteristics and product families as needed.

Revise product families

Irrespectively of using a quantitative or qualitative approach to determine the location of the CODP, the product families formed have to be revised at some point, because the characteristics used are based on data at a single moment in time. However, Van Kampen and Van Donk (2014) state that the current literature gives no insight into when the product portfolio has to be revised. The authors performed, therefore, a case study in which they concluded that a SKU should not too often be re-classified, as this influences both the internal and external procedures. Therefore, Van Kampen and Van Donk (2014) suggest to base the classification interval on five characteristics, being; demand predictability, product perishability, effort to adapt a classification, increased competitiveness or reduced risks, and product life cycle. Depending on the values of these characteristics, an applicable

Table 4.2: Overview of characteristics that can be used to form product families

Subject	Authors	Characteristics
Market Characteristics	Fuller, Oconor, and Rawlinson (1993); Fuller et al. (1993); Van Donk (2000, 2001); Olhager (2003); Van Kampen et al. (2012)	Correlation between customer behavior, delivery reliability, delivery time, heterogeneity of customers, numerousness of customers, order size, predictability of demand, product volume, product customization, seasonality of the volume, and specify of demand
Process characteristics	Van Donk (2000, 2001); Olhager (2003)	Controllability, lead times and costs, flexibility of production process, production process, risk of obsolescence, sequence-dependent set-up times, sharing information, and value added and costs of stock-keeping
Product characteristics	Fuller et al. (1993); Olhager (2003); Van Kampen et al. (2012)	Customization opportunities, handling and storage requirements, modularity of product design, product structure, relations to other products, and substitutability

reclassification interval should be chosen. Next to this study, no other studies are found in the current literature that state how often a product portfolio has to be revised, which is, thus, a gap in the current literature.

4.1.3 Schedule Hybrid Production Environments

From the models mentioned in the previous section, only Perona et al. (2009) directly indicate which production policy should be assigned to which product family. However, the authors do not mention any other production policies except the ones that are used. This section, therefore, introduces different replenishment policies that can be used within MTS-environments, and scheduling policies that can be used within hybrid environments. These scheduling policies include MTO acceptance policies. Therefore, this section helps to identify the trade-offs that have to be made during the second stage of the model of Soman et al. (2004).

Make-to-stock replenishment policies

Lots of inventory control policies are distinguished within the current literature. De Kok and Inderfurth (1997) mention that inventory management in stochastic environments is mostly built on reorder-level policies or periodic order-up-to policies. Silver, Pyke, and Peterson (1998) mention that four of them are the most commonly used ones, which are explained in Table 4.3. From these systems, the *(s,Q)-system* system has the advantage that it easy to understand by stakeholders, which causes fewer failures. The *(s,S)-system*, on the other hand, has the advantage that one always starts with the same inventory level after a new batch is ordered. Low production quantities can occur as a result of the *(R,S)-system*, which is a disadvantage. An advantage of this system, on the other hand, is that inventory is checked regularly, causing that more stability is guaranteed and fewer coordination efforts are needed. Lastly, the *(R,s,S)-system* has the advantage that it prevents low order quantities as a result of the parameter s.

Table 4.3: Overview of inventory replenishment policies (based on Silver et al. 1998)

System	**Review**	**Order quantity**	**When to order**
(s,Q)-system	Continuously	Fixed Q	Q products are ordered as soon as the actual inventory level drops below s
(s,S)-system	Continuously	Variable Q	Up to S products are ordered as soon as the actual inventory level drops below s
(R,S)-system	Periodically	Variable Q	Up to S products are ordered every period
(R,s,S)-system	Periodically	Variable Q	Up to S products are ordered every period if the actual inventory level is below s

From this table can be concluded that no inventory replenishment system is distinguished that reviews the inventory level periodically and orders a fixed quantity. Different authors, therefore, propose an *(R,s,Q)-system*, in which every period R the current inventory level is controlled. If this inventory level is below level s, a fixed quantity Q is ordered (Janssen, Heuts, & De Kok, 1998; Kiesmüller, De Kok, & Dabia, 2011; Tempelmeier & Bantel, 2015; Bowo Kuncoro, Aurachman, & Santosa, 2018).

De Kok and Inderfurth (1997) conclude that a constant replenishment cycle shows the best performance regarding planning stability. Moreover, the authors mention that the reorder point s does not affect the nervousness of the production planning. However, the lot size Q, the minimum reorder quantity S-s, and the length of the stability horizon R do affect the stability of the planning. Moreover, Heisig (2001) mentions that nervousness is caused by setting the lot size approximately equal to the forecasted demand per period. Besides, when facing an *(s,S)-policy*, a lot size similar to a multiple of the forecasted demand causes nervousness in the planning.

Schedule concepts in hybrid environments

Hybrid production systems include mostly two components to come to a production schedule: the interruption strategy that determines when to switch from MTS- to MTO-products, and a production strategy that determines which MTS-products to produces when not facing MTO-orders (Federgruen & Katalan, 1999). One of the first models that combines both MTO- and MTS-orders is the model of

Williams (1984) (Federgruen & Katalan, 1999; Beemsterboer, Land, & Teunter, 2016). The author suggests to produce MTS-products in fixed batch sizes, of which the production order is triggered when the current inventory level drops below a specified inventory level (*(s,Q)-policy*). The author gives priority to the orders with the largest weighted waiting time. These waiting times are weighted as the author prioritizes MTO-orders above MTS-orders in order to prevent that MTO-orders are produced after the actual shipment date. Beemsterboer et al. (2016), however, mention that using fixed MTS production quantities is not preferable because MTS-orders can be used to react to situations in which there is either a high or low MTO-demand. When facing a high demand of MTO-orders, causing less capacity is available, it is possible to shorten on MTS-products. On the other hand, when facing a low demand of MTO-orders, causing that more capacity is available, it is possible to produce more inventory to stock. Therefore, both situations supplement each other when facing overall enough production capacity available. The authors indicated by a simulation that savings increase as a result of flexible MTS lot sizes.

Günther et al. (2006) introduced the block planning, which is mostly applicable in make-and-pack environments. In this planning, each "block represents a pre-defined sequence of production orders of variable size, where each production order corresponds to a unique product type" (Günther et al., 2006, p. 3713). The size of each production order depends on the demand during that period. Hence, a particular product is not scheduled for the upcoming block when no demand is faced. Two types of block planning exist, being: rigid and flexible block planning. When applying a rigid block planning, the length of an entire block corresponds to the length of, for example, a week or a month. On the other hand, a flexible block planning has no linked finishing times and period boundaries but is based on the succession of blocks. These blocks may start earlier than proposed.

Soman et al. (2007) proposed a five-step framework that indicates which products, how much of each product, and in which sequence the products have to be produced. These steps can be used to make a short-term production plan, in which the objective is to minimize the overall make-span while ensuring that MTO due-dates are achieved. Moreover, this model uses variable order sizes for MTS-orders too, in order to anticipate on either over-capacity or under-capacity. This framework was composed during a case study in which a company in the food industry faced approximately the same issues as Cloetta does (e.g., frequent rescheduling).

The last method introduced is the Repetitive Flexible Supply (RFS) planning, which is presented by Glenday and Sather (2014). This planning states that companies should use stock levels that have an upper and lower bound regarding MTS-items, and production schedules that are fixed over time in terms of hours to fill these buffers. Two different periods are, therefore, included within the fixed schedule. Firstly, periods are assigned in which MTS-items are produced within a repeated fixed time frame. Within these periods as much volume is produced as possible. When producing little inventory during this period due to, for example, break-downs, buffer-inventory is used to still ship products to the customers. During the next period, this inventory level should be supplemented again. Within the second period, SKUs are produced that have to be produced to order, which could be a result of, for example, a low production volume.

4.1.4 Conclusion Planning Concepts

The decomposition of an environment is an often-used technique to tackle challenging problems (Akkerman & van Donk, 2009). Soman et al. (2004), therefore, suggest a top-down approach that splits a planning environment into multiple small steps to come to a new procedure, of which the first two steps are further highlighted in this literature review. During the first step, a decision is made on whether products are produced within an MTO, MTS, or ATO production environment. This decision is made by forming product groups based on product characteristics. Either quantitative and qualitative approaches can be used to constitute these product families. Comparing the models and characteristics introduced, it is suggested to use a qualitative approach at Cloetta. Therefore, if needed, multiple characteristics can be included, multiple product families can be formed, and a product can be placed within a product family when at least one characteristic is met (Van Kampen & Van Donk, 2014). Moreover, it is suggested to differentiate SKUs and semi-finished items, as proposed by Perona et al. (2009). Therefore, another production strategy can be assigned to SKUs that face a low volume while its semi-finished items face a high production volume compared to products in which both the SKU and semi-finished items face a low production volume. Cloetta should indicate the best period to revise their product families, as not much insight regarding this topic is given in the current literature (Van Kampen & Van Donk, 2014)

During the second stage in the model of Soman et al. (2004), an organization has to determine an order acceptance policy, due date policy, and lot sizes. From the make-to-stock policies mentioned, it can be concluded that one has to decide whether a continuously or periodically review period is preferred, and whether a fixed or variable order-up-to quantity is used. Regarding the situation at RSD-S, it is suggested to use a periodical system because it gives the Scheduling Department the possibility to make an optimal schedule for the Molding Department. Moreover, it is suggested to work with a fixed order-up-to quantity because it prevents small and large production orders. However, RSD-S should deviate from these quantities during MTS-production when facing production variability (Soman et al., 2007; Beemsterboer et al., 2016). Therefore, it is suggested to stop MTS-production at fixed times in order to guarantee that upcoming production orders are not affected by past variation (Glenday & Sather, 2014).

4.2 Organizational Change

Change Management is getting more and more critical within companies to guarantee alignment between internal factors (e.g., new technologies) and external environments (e.g., new legislation, increased competition) that change faster than before nowadays (Nguyen, Henry, & Mitsloan, 2003; Price & Chahal, 2006; Almanei, Salonitis, & Tsinopoulos, 2018). Not every change is, however, fundamentally equal. Balogun, Hailey, and Gustafsson (2016) distinguished four types of change, which are characterized by the nature of the change and the end result of the change, as can be seen from Figure 4.4. The nature of the change describes how the change is implemented, which can be either step-by-step (incremental) or all-at-once (big bang). The all-at-once approach is mostly applied in situations in which, for example, a company faces a crisis causing that a rapid change is necessary. During an incremental change, on the other hand, a slower implementation process is followed. The end result of the change describes in what sense the fundamental part of the organization has to be changed. During a transformation, the mission and the purpose of a company are redefined as a first step. After that, the management team can translate the company's mission and purpose to how the company should shift in terms of business mode, culture, structure, procedures, etc.. Hence, fundamental changes have to be implemented within the organization. When realigning an organization, on the other hand, current processes are changed without changing the fundamental part of the organization, as explained before. This could, however, still include major change processes. Using these two characteristics (nature and end result), it is possible to define four change-types, being: evolution, adaption, revolution, and reconstruction change (Balogun et al., 2016).

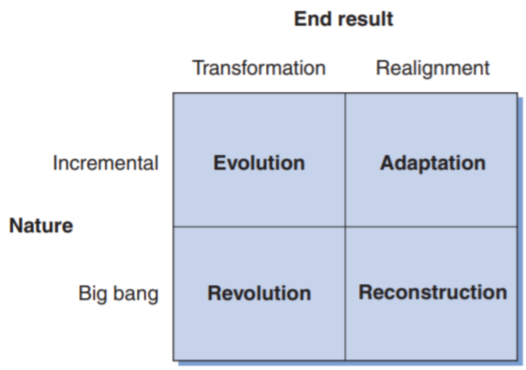


Figure 4.4: Types of change (adapted from Balogrun et al. 2018)

Successfully implementing a change is, however, easier said than done, as approximately 65% of the change projects fail (Kwahk & Kim, 2008; Amis & Aïssaoui, 2013). Kotter (1996) mentions that these unsuccessful implementations are mostly a result of common mistakes that are made during the change process itself. The author, however, implies that most of these mistakes are actually avoidable. To prevent such mistakes when implementing a change, it is essential that change managers draw up a clear implementation plan, and use this as a step-wise approach during the change process. The current literature shows different frameworks that can be used to lead change processes. Sub-section 4.2.1 shows, therefore, different implementation models. It can be concluded from these models that creating a readiness for change is essential in order to start the change. More attention to this subject is, therefore, given in Sub-section 4.2.2. A final conclusion is drawn in Sub-section 4.2.3.

4.2.1 Models for Managing Change

Many different change models are discussed in the current literature. Almanei et al. (2018) mention that these models can be classified into two major groups, being: rational models (e.g., the model of Lewin (1947)) and social process models (e.g., the model of Kotter (1996)). Rational models are the ones that follow a systematic and logical process that consist of several steps. Such models can be used in circumstances in which a change is implemented on a small scale with clear and agreed goals. Social process models, on the other hand, pay more attention to the social process of change (e.g., how to guarantee that people adapt to the new change). Some models of each category are discussed below. These models were selected based on the applicability to the problem that Cloetta faces. Hence, these models include both steps in which a readiness for change is created and steps in which the change is implemented throughout the Cloetta organization.

One of the oldest and most fundamental change models, i.e., used as basis is many organizational change models, is the model of Lewin (1947) (Bakari, Hunjra, & Niazi, 2017; Hussain et al., 2018). Lewin suggests a three-stage model, being: unfreeze, transform, and refreeze. During the first stage, in which one unfreezes the present organizational state, the need for change is explained to all stakeholders. By doing so, readiness for change should be created. During the second stage, this unfreezed habitual behavior (way of working) is changed into a new desired behavior. Hence, the change is implemented during this phase. During the last stage, the new way of working is refreezed, meaning that stakeholders stick to the implemented change. As a result, stakeholders should not relapse to their previous behavior. It can be seen from these three steps that all steps focus on the human aspect during a change process. This model was one of the first ones that included these aspects in a change model (Amis & Aïssaoui, 2013; Weiner, 2009). Though this model explains the basic process of change management, it does not explicitly explain what steps and actions should be taken to either unfreeze, change, or refreeze the behavior of relevant stakeholders. These steps are explained in more detail in other models that are discussed below.

Another commonly used model is the model of Kotter (1996). The author proposed an eight-step plan that can be used during company-wide change processes, as can be seen in Figure 4.5. These steps are set such that the eight actions to prevent common mistakes, as mentioned by Kotter (1996), are used (as much as possible) during the implementation process. Comparing the model of Lewin (1947) to that of Kotter (1996), it can be stated that a large part of the model of Kotter (the first four steps) is related to the unfreeze-stage of Lewin (Almanei et al., 2018).

Price and Chahal (2006) also developed a framework that can be used during a change process, which consists of the following steps:

1. Prepare the organization for the change;
2. Develop a change vision and an implementation plan, assemble an implementation team;
3. Check the implementation plan with and get approval from the higher management team;
4. Engage individuals to start the change;
5. Implement the change;
6. Evaluate the change process.

Figure 4.5: Kotter's eight-step change process (adapted from Nguyen et al. 2003)

The model of Price and Chahal (2006) is somewhat comparable with the model of Kotter (1996). However, more emphasis is put on the practical side of the change process. For example, approval from the management team has to be gathered to implement the change, which is in most companies reasonable to do so in order to continue the change process. On the other side, it can be mentioned that this model does not emphasize that the change has to stick after the implementation process, which is an essential aspect of the models of both Lewin (1947) and Kotter (1996).

Another model that puts more emphasis on the practical aspect of the change process is the model of Varkey and Antonio (2010). In this model, the implementation phase is more concrete compared to the other frameworks, as can be seen from Figure 4.6. Varkey and Antonio (2010) suggest to use the Plan Do Check Act (PDCA) methodology during the pilot stage, as can be seen from Figure 4.6. The PDCA method is an ongoing cycle of four steps that is always performed in the same sequence ("Deming cycle (PDCA)", 2000). During the first step, which is the Plan stage, one has to review the current situation, gather data, and plan the improvement steps. This information is, after that, used during the Do stage in order to implement the improvement steps on a trial basis. The trial basis is used to determine whether the current plan works and to understand whether problems occur during the process, which is done during the Check stage. If any issues arise, the current plan will be adapted and, after that, implemented during the Act stage. As a result, all four steps are performed, after which one starts again at the Plan stage for further improvement. By following the PDCA methodology, one optimizes current processes during every cycle.

In addition, Hayes (2018) mentions that a change process develops either reactive or self-reinforcing. During a reactive sequence, the subsequent step is challenged by earlier performed stages. Hence, when a performed step shows slightly a different outcome as foreseen, the next steps have to be adjusted in order to obtain the initial outcome. Self-reinforcing processes, on the other hand, "occur when a decision or action produces positive feedback that reinforces earlier events and supports

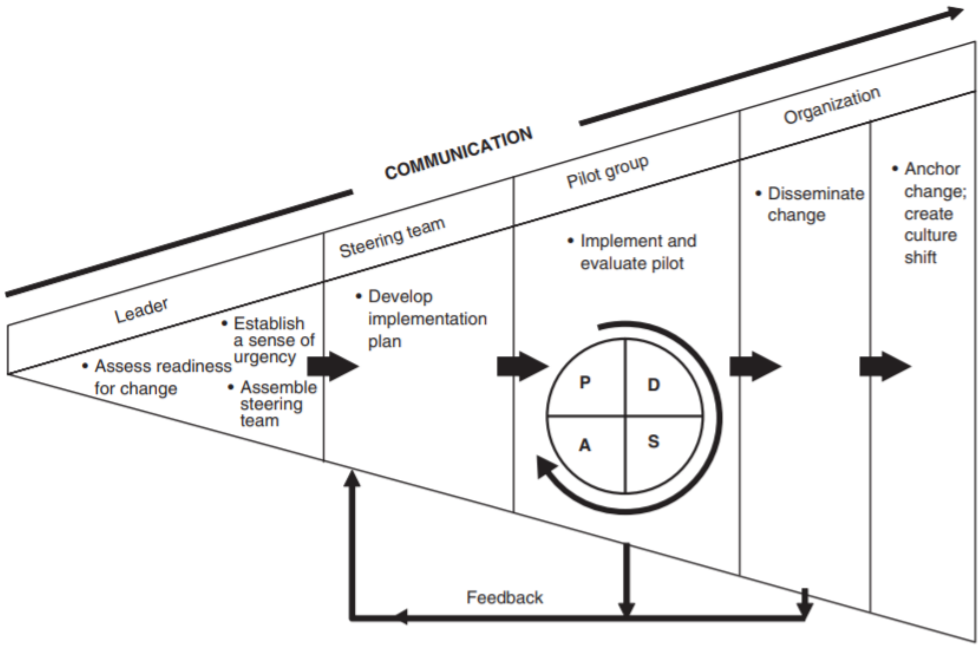


Figure 4.6: A framework for change management (adapted from Varkey et al. 2010)

the direction of change" (Hayes, 2018, p. 8). Sydow, Schreyögg, and Koch (2009) mention that a self-reinforcing process exists of three phases. During the first phase, the pre-formation phase, there are only a few constraints when making a decision. These decisions, however, trigger which options can be chosen during the second stage, because some decisions omit subsequent options. During this second phase, the formation phase, self-reinforcing processes take place, which causes a sequence in the pattern of events. As a result, the possible options that can be implemented decrease. As a result, the actions follow one path during the third phase, which is the lock-in phase. During this phase, flexibility has been lost as a result of a fixed decision pattern.

4.2.2 Readiness to Change

All models mentioned in the previous sub-section show that aligning stakeholders is the first necessary step before actually implementing the change. Lewin (1947) was one of the first authors who included the unfreeze phase in his model, such that managers give attention to the awareness to change before actually starting a change process (Armenakis, Harris, & Mossholder, 1993). Since then, more change models have paid attention to this part of the change process. Readiness for change is, according to a literature study performed by Rafferty, Jimmieson, and Armenakis (2013), most commonly defined as "organizational members' beliefs, attitudes, and intentions regarding the extent to which changes are needed and the organization's capacity to successfully make those changes" (Armenakis et al., 1993, p. 681). These beliefs, attitudes, and intentions regarding the change are not automatically present when starting the change (Smith, 2005). As a result, the change will likely fail because of not giving attention to the preparation of stakeholders for the change. Therefore, readiness for change is an essential part of successfully implementing a change (Weiner, 2009; Scaccia et al., 2015). This sub-section will, therefore, address in more detail how change managers can guarantee that employees are ready to change.

Smith (2005) mentions that it is important to follow three steps to create a readiness for change. The first step is about creating a sense of urgency to start the change. During this step, it is essential to emphasize the difference between the current and the desired future state. As a result, people should get dissatisfied with the current state. During the second step, people must get involved in the change process by communicating the change to all employees. It has to be guaranteed that the social energy regarding the change becomes positive. Smith (2005) mentions that mutual trust and respect have to be generated during this step in order to obtain this result. Oreg, Vakola, and Armenakis (2011) mention that a change is more likely to happen when employees trust their manager. The last step is to provide a fundamental basis for achieving the change. To do so, stakeholders should commit to the change, and it should be clear what an employee's new role will be in the new situation.

Holt, Armenakis, Feild, and Harris (2007) mention that whether someone is actually able to change can be assessed by using either qualitative (e.g., interviews) or quantitative (e.g., questionnaires) methods. Unless higher quality information (i.e., more change-specific information) is gathered using qualitative measures, quantitative measures are appropriate to use for such situations. When collecting this information, it is suggested to indicate whether someone demonstrates behavior that is indicated in Table 4.4. Therefore, by taking away the barriers expressed by Kotter and Schlesinger (1979) and Armenakis and Harris (2002), and aligning the attributes expressed by Holt et al. (2007), it should be guaranteed that someone is ready to change.

Table 4.4: Overview of characteristics that can be used to guarantee readiness to change

Authors	**Characteristics to guarantee readiness to change**
Kotter and Schlesinger (1979)	Not understand how the change affects them, feeling of losing value as a result of the proposed change, assess the change differently compared to change managers, and feeling of not possessing the needed skills
Armenakis and Harris (2002)	Does not understand the difference between the current and proposed situation, not convinced that the proposed change can be achieved, not convinced that the proposed change is the best one to implement, belief that not enough support is available, and feeling that their self-interest is affected
Holt et al. (2007)	The authors mention that four attributes have to be aligned to create a readiness to change, being: the context of the change, the content of the change, the steps followed during the change, and the individual attributes present during the change

4.2.3 Conclusion Organizational Change

Change Management is getting more and more critical within companies to guarantee alignment between internal factors and external environments, which change faster than before nowadays (Nguyen et al., 2003; Price & Chahal, 2006; Almanei et al., 2018). Commonly made mistakes that can actually be avoided during a change processes make, however, that approximately 65% of the implementation processes fail (Kotter, 1996; Kwahk & Kim, 2008; Amis & Aïssaoui, 2013). Many authors have, therefore, proposed a model to manage a change process. The model of Lewin (1947) can be seen as one of the most fundamental change models in the current literature, which is as well used as a basis in the models proposed by Kotter (1996), Price and Chahal (2006), and Varkey and Antonio (2010) too. It can be seen that all models start with preparing the organization for the change. This step is crucial for Cloetta too, as only stakeholders within RSD-S know about the change currently. Therefore, it is essential to follow the steps provided by Smith (2005) in order to actually prepare the organization for the change. Moreover, change managers should understand whether stakeholders see barriers on their way to implement the change in order to increase someone's readiness to change (Kotter & Schlesinger, 1979; Armenakis & Harris, 2002; Holt et al., 2007). Besides, it can be seen that the models of Kotter (1996) and Varkey and Antonio (2010) focus on ensuring that stakeholders do not relapse to their previous behavior after the change has implemented. As well this step is essential for Cloetta, as the current way of working is an everyday process causing that employees could relapse to their previous behavior more easily. The model of Price and Chahal (2006) includes, on the other hand, a step in which the change process is evaluated. This step can be used within Cloetta too, in order to explore further optimization processes. Lastly, Varkey and Antonio (2010) included the PDCA-cycle in their process to test the solution on a small scale before actually implementing it. This step could add value in case that no blueprint planning solution will be found in the next chapter.

Chapter 5

Design of Production Planning

The decomposition of an environment is an often-used technique to tackle challenging problems (Akkerman & van Donk, 2009). Accordingly, this chapter represents a guideline on how the scheduling problem at Cloetta can be revised by following multiple, small steps. During this process, the first two steps of the model of Soman et al. (2004), which is shown in Figure 4.1, are used to come to a final solution. This chapter, therefore, starts with defining the product characteristics that are applicable to RSD-S (Section 5.1). By using these characteristics, Section 5.2 indicates which product families can be formed, which production environment is linked to each product family, and which capacity co-ordination policies are related to each product family. As this new planning has an impact on the currently used KPIs within Cloetta, Section 5.3 indicates which KPIs should be used in the new situation. The conclusions of each section are used to answer on sub-questions 3, 4, and 5 (Section 5.4).

5.1 Product Characteristics Applicable at RSD-S

Some characteristics that were mentioned in Section 4.1.2 are applicable to the processes within Cloetta. Therefore, the current section indicates which characteristics are actually relevant to Cloetta and how these characteristics affect the production process within RSD-S. To start with, the characteristics delivery time to the customer, reliability of orders delivered on time at the customer, and production lead time within RSD-S are highlighted. The delivery time of customer orders is about 24 to 48 hours (depending on the customer). The production lead time is currently at least three weeks, due to the frozen production horizon. Moreover, this production lead time is not stable over time as a result of the fluctuating line performance. Therefore, RSD-S has to produce its products to stock in order to guarantee that products are delivered within the promised lead time. Moreover, customers expect Cloetta to deliver with a reliability of at least 99.5%, which makes it even more critical to have enough inventory on stock to avoid eventual stock-outs. It can, therefore, be concluded that the Packaging Department of RSD-S has to produce its products to stock in order to guarantee satisfied customers.

Another characteristic that is important for Cloetta is the predictability of demand, which is within Cloetta expressed as the forecast accuracy, as stated in Sub-section 1.3.2. When looking at the Dutch market, which accounts for approximately 60% of the total volume packed at RSD-S, some large variations can be seen between the forecast accuracies of each customer (group). Dutch supermarkets that order products produced at RSD-S (60% of Dutch volume) have a forecast accuracy of about 80%. All other Dutch customers that order products produced at RSD-S (40% of Dutch volume) have a forecast accuracy of about 40%. Van Donk (2000, 2001) mentions that such unreliable forecast accuracies result in a more downstream customer order decouple point in order to guarantee that incorrect forecasts have no impact on the current production plan. Hence, safety-stocks in DCs have to be increased for products with a low forecast accuracy, which is a result of an increased variation that occurs from the unreliable demand during the lead time.

The demand pattern of customer orders (customer behavior) is a characteristic that is applicable to Cloetta too. Supermarkets that order at Cloetta generally face a stable base-stock demand pattern. Promotions on top of these base-stock sales do cause, however, a more fluctuating demand pattern. Other customers face a somewhat fluctuating demand pattern too because these customers order only full trucks at Cloetta in order to reduce costs. Therefore, these patterns show no demand for some time, after which a peak in the demand pattern can be seen as a result of a single order. Hence, it is recommended to produce every SKU to stock too, in order to guarantee that these fluctuations do not result in fluctuations in the production process. Moreover, this characteristic causes an increase of the safety-stock in DCs too, as a result of an increased variation. This increase depends on the demand pattern a product faces.

The above characteristics explain why RSD-S has to pack all its SKUs to stock. There are, however, some characteristics that indicate that the production process can be controlled differently, being:

- Flexibility of production process: the Packaging Department is flexible because set-up times are rather short within RSD-S, and operators are mostly able to operate multiple machines. The Molding Department, on the other hand, is not flexible as a result of the different drying times. Hence, it is not always possible to easily switch between production orders because this could result in a shortage of drying cabinets. Moreover, the Graining Department is not flexible as this department has to cope with drying times and semi-finished items received from other departments too. Lastly, the Compressing Department can be seen as flexible as a result of overcapacity. Hence, it should be guaranteed that the planning of the Molding Department and Graining Department does not have to be changed;

- Information sharing: the information shared between Cloetta's customers and Cloetta is sometimes limited, which can be concluded from the forecast accuracies too. Information shared between production stages, on the other hand, is not limited. Hence, these departments can communicate more effectively compared to Cloetta and its customers;

- Modularity of product design: SKUs at the Packaging Department consist mostly out of similar semi-finished goods. To indicate this similarity, as already mentioned earlier, RSD-S produced

260 different SKUs in 2019, which were assembled by using 80 different semi-finished items. Hence, the similarity of semi-finished items can be used to create more flexibility in the process;

- Product structure: the product portfolio at RSD-S can be split into single and mixed products. Single-products consist of only one semi-finished item, whereas mixed-products consist of multiple semi-finished items. Therefore, single-items are less complicated to produce compared to mixed-items, because all semi-finished items have to be available in order to continue the production process of mixed-products. Hence, it is less complicated to steer single-items;
- Production lead time: each SKU within Cloetta has a different production lead time. This difference is a result of having semi-finished items that have to pass different production steps and semi-finished items that are produced by third parties. Hence, products with a shorter lead time are easier to control.

From the characteristics mentioned above, it can be concluded that the production processes before the Packaging Department can be controlled differently. Therefore, it is chosen to treat every production step as a stand-alone process instead of considering all processes as one production process. As a result, it has to be assumed that the customer of each production step is the subsequent process step (e.g., Cloetta's customer is the customer of the Packaging Department, while the Packaging Department is the internal customer of, amongst others, the Molding Department). The most important reason to consider each process step individually is that eventual downtime at the production lines does not have to affect the packaging schedule directly. Hence, the flexibility of the Packaging Department is used to compensate for variation in the previous processes. The modularity of the product design helps in this process too, as it can be used to decide later which and how much SKUs are actually packed from the semi-finished items produced. It is possible to make this distinction between the production processes because of the unlimited shared information between the departments. With this knowledge, it is possible to design a new planning approach for RSD-S in the next section.

5.2 Production Planning

The first two stages of the model of Soman et al. (2004) are used, as stated before, during the design phase of a new planning approach for RSD-S. Therefore, this section starts with defining the product families in Sub-section 5.2.1. The remaining steps of the model are then performed for each department separately, beginning at the Molding Department (Sub-section 5.2.2), then the Graining Department and Compressing Department (Sub-section 5.2.3), and lastly the Packaging Department (Sub-question 5.2.4).

5.2.1 Product Families

Product families are established in this section based on performed data analyses and the characteristics modularity of product design, product structure, and production lead time. Moreover, this analysis takes into account that RSD-S can use the flexibility of its packaging process and the fact that information can easily be shared between departments in order to respond to the problems mentioned in Section 3.3 (e.g., variation in the production process). The following characteristics are, therefore, used to make a distinction between the SKUs produced at RSD-S:

- Mixed-products: mixed-products are more complicated to produce compared to single-products because all semi-finished items have to be delivered at the buffer to continue the packaging process of mixed-products. Hence, it is more complicated to store and control these semi-finished items;
- Semi-finished items produced at RSD-S: semi-finished items that are produced within RSD-S can be regulated more easily. Moreover, the production lead time of semi-finished items produced at RSD-S is mostly shorter than the lead time of semi-finished items ordered at third parties;
- Semi-finished items produced at third parties that can be stored in the warehouse: semi-finished items that are ordered at third parties and can be stored in the warehouse of RSD-S have mostly a longer shelf-life than semi-finished items stored at the buffer. Hence, these items can be used in circumstances that the production process at RSD-S faces a low line performance, causing that less semi-finished items are delivered at the buffer;
- Semi-finished items produced at the Molding Department: the Molding Department has a shorter production lead time compared to other production departments. Hence, this process can react faster on demand changes;
- Semi-finished items that face an average demand above the MOQ: the summed demand over all SKUs is taken to determine whether the average demand of a semi-finished item is above or below the MOQ. The summed demand is taken as most SKUs itself do not guarantee an average demand above the MOQ. Therefore, these semi-finished items are produced every week, causing that it is less complicated to control these items.

The above distinctions are used to draft a decision tree (Figure 5.1). From this tree can be concluded that three product-groups are defined. To indicate the size of these groups, the forecast of week 7 up to and including week 17 in 2020 is used below. The three groups that are used during the next stages consist of:

1. 'Flexible production items': this group consists of SKUs that include only one semi-finished item (single-product) that is produced at the Molding Department of RSD-S with a total average weekly demand (summed over all SKUs) that is above the MOQ. As mentioned earlier, the MOQ of the Molding Department is currently based on the volume that fits within three drying cabinets. Therefore, approximately 53% of the total packaging volume consists of products from this group. In case of increasing this boundary to six drying cabinets, which is a situation in which the semi-finished items are produced every week, the total packaging volume of this group decreases to approximately 45%. Hence, this group includes about half of the packaging volume. This group is, thus, easy to control and can, therefore, be used to

respond to the variation of the Molding Process, which is discussed in more detail in Sub-section 5.2.2;

2. 'Flexible packaging items': this group consists of SKUs that include only one semi-finished item that is produced at a third party and can be stored within the warehouse of RSD-S, i.e., has a longer shelf-life than products stocked at the buffer. This group currently includes 7% of the packaging volume, but can possibly be increased in the future by shifting the product portfolio. Hence, this group is easy to control and can, therefore, be used to respond to variation from the Molding Department, which is discussed in more detail in Sub-section 5.2.4;

3. 'Fixed production items': this group consists of SKUs that are not included in one of the above groups. Therefore, mixed-SKUs, SKUs of which the semi-finished item faces a low demand, and SKUs that include at least one semi-finished item from the Graining Department or third parties (that cannot be stocked) are included in this group. This group takes care of, depending on the boundary set at the Molding Department, approximately 40%-48% of the total packaging volume. Hence, it is more challenging to steer this group, causing that the semi-finished items should be produced as scheduled.

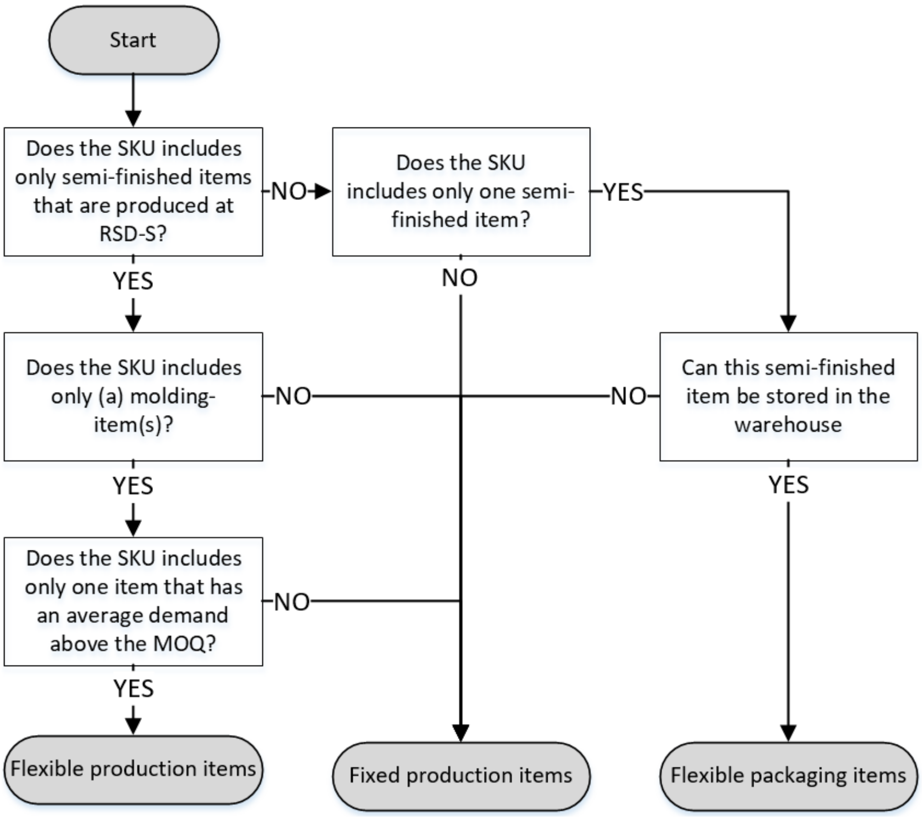


Figure 5.1: Product family classification procedure

The next sections use these groups to define the production environment(s) and capacity regulations per production department. As mentioned before, these product groups should be revised at some point. However, the current literature does not specify an exact period that can be used for this process (Van Kampen & Van Donk, 2014). Therefore, it is suggested to include this decision in the current sales and operations planning cycle within Cloetta. As a result, the product groups are revised once a month. In case this period seems either too short or too long, it is suggested to adapt this period. Hence, a period that works best for Cloetta should be found by trial and error.

5.2.2 Proposed Situation at the Molding Department

The first department highlighted is the Molding Department. RSD-S should use two different production environments within this department, such that a situation is created in which operators know which semi-finished items can be produced in higher or lower quantities when facing an increased or decreased line performance, respectively. Therefore, it is suggested to produce 'fixed production items' and orders from third parties within a make-to-order environment, while 'flexible production items' should be produced to stock. For example, a production order DropFruit Duo, which is an item that is produced every week, consists of both MTO-items (used in mixed-item SKUs) and MTS-items (used in single-item SKUs). From this order, MTO-items have to be produced, whereas MTS-items can be produced. Therefore, it is guaranteed that SKUs that include 'fixed production items' can be processed at the Packaging Department. This situation is adopted from Soman et al. (2007) and Beemsterboer et al. (2016), who suggest to use flexible lot-sizes for MTS-items in order to increase the line-performance.

To schedule these two production environments at the Molding Department, the following approach is suggested to use within RSD-S (Soman et al., 2007):

1. Generate a list of MTS-orders ('flexible production items') and MTO-orders ('fixed production items' and third parties), which are received from the Packaging Department and third parties;

2. Schedule orders such that set-up times are minimized. During this step, it has to be taken into account that feasibility is guaranteed regarding the drying times. Moreover, it has to be guaranteed that the MTS-items are scheduled before the fixed stops during the week (e.g., change from week to weekend products on NID2), as can be seen in Figure 5.2;

3. Check the feasibility of the production plan. If any idle time is available, it is possible to fill the planning with extra 'flexible production items'. On the other hand, if the current plan is not feasible, lot-sizes of semi-finished items within this group have to be decreased such that the planning is feasible. It has to be taken into account that it is still possible to reach the order up-to level s, which is discussed later. These actions have to be performed in consultation with the Packaging Department.

Scheduling MTS-orders before the fixed stops is adopted from the RFS-planning (Glenday & Sather, 2014). In this planning, the authors used fixed time-slots to indicate when to switch from the current order to the next one. Hence, downtime at the production lines results in lost quantities of the order currently produced, but should not affect the production orders that are produced later that week. Consequently, the MTS-orders are used to compensate earlier break-downs, causing that MTO-orders do not suffer from break-downs. As these MTS-orders appear every week, any lost production can be compensated during the next cycle.

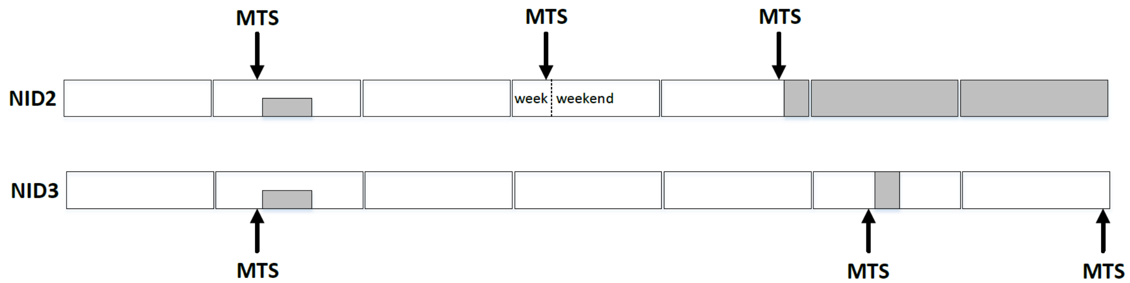


Figure 5.2: Fixed activities during the week at both molding lines

An important caveat pertains to the MTO-orders of third parties, i.e., other Cloetta plants. RSD-S should avoid that order sizes fluctuate significantly over time as this demand pattern results in a peak behavior at the production lines. Hence, a weekly maximum order size has to be set, and all plants should communicate more transparently which order sizes are expected. Therefore, it is suggested to involve all plants within Cloetta during the implementation process in order to obtain the highest performance, which is discussed in more detail in Chapter 6.

5.2.3 Proposed Situation at the Graining and Compressing Departments

The Graining Department faces more complexity than the Molding Department. On the other hand, the Compressing Department faces more available capacity compared to the Molding Department. Therefore, it is advised to use the MTO-environment within both departments. Hence, 'fixed production items' and production orders from third parties are produced as soon as the production orders arrive. It is important to note that this environment could result in peak behavior at the Graining Department. The Scheduler of this department should, therefore, communicate transparently with the Packaging Department and third parties about the availability of capacity. In case of capacity constraints at this department, it is advised to contact these customers to discuss which quantities could be rescheduled to the next week. In case of overcapacity, Schedulers should contact the customers whether it is possible to produce some semi-finished items to stock.

To schedule orders within the Compressing Department and Graining Department, the following approach is suggested to use within RSD-S (Soman et al., 2007):

1. Generate a list of MTO-orders ('fixed production items' and third parties);
2. Schedule orders such that set-up times are minimized. During this step it has to be taken into account that feasibility is guaranteed regarding the drying times;
3. Check the feasibility of the production plan. If any idle time is available, it is possible to

fill the planning with more products. To do so, the departments have to contact their customers whether some products can be produced to stock. If the current plan is infeasible, the departments have to contact their customer to discuss which production order(s) can be omitted;

5.2.4 Proposed Situation at the Packaging Department

As already concluded in Sub-section 5.2.1, all products within the Packaging Department have to be produced within an MTS-environment. Therefore, an inventory policy has to be defined to control these products. Looking to the inventory policies distinguished in Sub-section 4.1.3, it can be concluded that a decision has to be made whether a fixed quantity is replenished or an order up-to level is used. Regarding the situation at RSD-S, it is preferred to use fixed packaging quantities to prevent either too large or too small production orders. Hence, the capacity at the molding and graining lines should be better regulated. Moreover, it has to be defined whether a continuous or periodical review system is used. A periodical review system is preferred within Cloetta in order to be able to make a weekly schedule at the molding lines, which is needed as a result of the different drying times. Therefore, the inventory *(R,s,Q)-policy* is suggested, in which the inventory is checked every R periods to conclude whether the current inventory level is below the inventory level s. If so, the fixed quantity Q is ordered at the Packaging Department.

The re-order level s should be determined by taking the average demand of a cycle plus the safety-stock, which is based on the production lead time plus re-order time R (Silver et al., 1998). The production lead time varies per SKU, which should be based on the semi-finished item that faces the longest lead time. The safety-stock includes extra stock to guarantee delivery when the actual demand is larger than the average demand, or when the actual volume produced is less than the expected production volume. In order to guarantee that enough stock is available during such situations, Cloetta should include the sales variation, production lead time variation, and the forecast accuracy in the safety-stock, which results in an increased safety-stock. To reduce this stock level, it is suggested to start separate projects that reduce the variation of these variations. Choosing the correct stock level is extremely important for Cloetta to guarantee that fluctuations during the production lead time do not cause a rescheduled production plan. Hence, the increased safety-stock allows more variation within the processes and is necessary to guarantee that the delivery reliability of 99.5% is obtained within Cloetta, as discussed in Section 4.1.2.

Re-order quantity Q at the Packaging Department, on the other hand, has to be set such that the packaging orders do not cause a too large demand at the suppliers of the Packaging Department, i.e., the Molding Department, Graining Department, and third parties. The re-order quantity that works the best for Cloetta has to be found via a simulation, although a lower and upper-bound can be defined. The lower-bound is equal to the MOQs of the previous production stages. The upper-bound, on the other hand, is such that the quantity set does not result in peak behavior at previous production stages. These values have to be found during the implementation phase, which is discussed in more detail in Chapter 6.

Next to the inventory control policy, it has to be decided how the packaging orders are prioritized in case the demand is higher than the available capacity. The following steps are, therefore, suggested to use within RSD-S to schedule orders within the Packaging Department (Soman et al., 2007):

1. Generate a list of SKUs that have a current inventory level below the target level s;
2. Schedule orders such that set-up times are minimized. This step is somewhat equal to the block planning, as similar products have to be scheduled in a sequence to reduce set-up time (e.g., similar product structure) (Günther et al., 2006);
3. Check the feasibility of the current packaging plan. If any idle time is available in the plan, it is possible to fill this time with extra 'flexible production items' or 'flexible packaging items'. On the other hand, if the current plan is not feasible, it is possible to decrease the lot sizes of the products within these groups. During this step, it has to be guaranteed that at least the order up-to level s is obtained;
4. If the current plan is feasible and no idle time is left in the system, it is possible to release the production orders to the Molding Department, Graining Department, and third parties.

Some preconditions have to be given in addition to the above plan. Firstly, it is essential to determine the packaging orders on the actual stock level in step one. As a result, Schedulers are not dependent on an expected value that consists of information that is not reliable and, therefore, fluctuates prior to a production week. Secondly, Schedulers should freeze the production size at the moment it is scheduled. Hence, some SKUs face a longer period in which the volume is frozen than other SKUs. Therefore, it is essential to decrease the lead time of SKUs from third parties in order to reduce the inventory at the DCs. These two points result in a situation in which Schedulers have to trust the setting of parameter s, which should guarantee that no out-of-stock will happen during the production lead time.

A third precondition that should be given regarding the above plan is that it could still be possible that the current plan is not feasible because suppliers of the Packaging Department do not have enough capacity to produce the semi-finished items needed. It could, therefore, be possible that the current packaging plan has to be rescheduled again. In such cases, it is suggested to perform step three again until the packaging schedule is feasible at each production department. In case that all orders sizes of the 'flexible production items' and 'fixed production items' are set such that the inventory level is equal to level s and the current plan is still not feasible, it is suggested to contact the Demand Department to determine which order quantities can be further decreased. Therefore, it should be possible to produce the current plan.

The last precondition that should be given is the controllability of the production plan. Currently, only Schedulers have all information available to decide what operators should do when the current plan is not executed as scheduled. Therefore, team-leaders have to contact the Scheduling Department to determine the subsequent actions in such cases. To prevent this situation, it is suggested to make the buffer-operators leading in controlling the planning. To do so, the Scheduling

Department should provide a list of packaging-orders for that week, which results from step four of the above plan. Regarding 'flexible production items' and 'flexible packaging items', the list should indicate what has to be produced and what can be produced. It is suggested to order the 'flexible packaging items' to stock in order to make use of these products when (internal) suppliers cannot deliver. As a result, the Packaging Department is able to pack although the supply is limited. Moreover, the list should specify on which production line the SKUs should be produced, and which production orders should be bundled to minimize the set-up time. To prevent that operators use too much confectioneries for the single-item products, it is suggested to work with two separate areas at the buffer. One area can be used to store semi-finished items that are received as MTO-item, while the other area can be used to store items that are accepted as MTS-item. When a batch is received that includes both MTO- and MTS-items, it is suggested to fill the MTO-area before the MTS-area in order to guarantee that sufficient confectioneries are available for mixed-products. Hence, it is recommended that Schedulers should train the buffer operators to control the production plan.

5.3 Key Performance Indicators

This section defines whether the proposed planning approach has an impact on the current KPIs within RSD-S. KPIs are used within companies to control and communicate the performance of the overall business performance and to identify gaps in the performance of these particular processes (Ishaq Bhatti & Awan, 2014; Franceschini, Galetto, & Maisano, 2019). Hence, all KPIs have to be in line with the overall business objective. Moreover, these KPIs should indicate whether the proposed planning approach is performed as intended. Cloetta aims to serve its customers on time at the lowest production costs possible. Hence, out of stocks should be prevented and production lines should be fully occupied. To guarantee that the new planning approach is in line with this objective, it is suggested to adjust one currently used KPIs and to introduce two new KPIs. Table 5.1 describes these KPIs per department in which they are used.

The mentioned KPIs have to be added or changed due to different reasons. Firstly, the KPI costs of safety-stock has to be added to guarantee that not too much safety-stock will be stored, i.e., counterpart of ensuring that sufficient inventory is on stock. Secondly, the schedule adherence should no longer be used by all departments, because this KPI is on some points in contradiction with Cloetta's business objective, which is to deliver all orders on time. Namely, in case RSD-S focuses only on the schedule adherence, Schedulers should choose to follow the current plan while this could actually result in less production volume and, thus, eventual out-of-stocks. Moreover, the schedule adherence is currently not controllable by all departments who use it, i.e., depending on previous production processes, which results in less dedication to the KPI (Kleingeld, Van Tuijl, & Algera, 2004). Besides, this KPI does not include variability caused by the production lines, which is included in the new planning approach. Some other KPIs should, therefore, be used that are in line with Cloetta's objective and are controllable by the department, which thus depends on the department that they are used at.

Table 5.1: Proposed key performance indicators

Department	Previous KPI	Proposed KPI
Demand Department	-	Costs of safety-stock
Packaging Department	Schedule adherence	Volume of orders packed as a fraction of the volume received and scheduled for that week
Production departments (MTS-items)	Schedule adherence	Volume on stock at the buffer (upper and lower bound)
Production departments (MTO-items)	Schedule adherence	Schedule adherence as a fraction of the semi-finished items received
Scheduling Department	Schedule adherence	Amount of SKUs feasibly scheduled that face an inventory level below s as a fraction of all SKUs that face an inventory level below s
Scheduling Department	-	Semi-finished items ordered by third parties as a fraction of the volume that may be ordered

The Packaging Department should measure if all semi-finished items are packed that are received at the buffer and scheduled for that week. Therefore, it should be guaranteed that all semi-finished items received that week are packed in the right SKUs. The production departments should use two KPIs, one for MTS-orders and one for MTO-orders. The KPI of the MTS-orders should measure the stock at the buffer, which should be compared with a lower-bound and upper-bound (Glenday & Sather, 2014). The lower-bond should guarantee that sufficient semi-finished items are on stock in order to ensure that all SKUs can be packed to its inventory level s. The upper-bound, on the other hand, should guarantee that sufficient space is available at the buffer to stock these items. The performance of MTO-orders should still be measured by the schedule adherence, because these semi-finished items have to be on time and in the right quantity at the subsequent production line to continue production. However, to guarantee that the Graining Department can control its KPI, the schedule adherence should be measured as a fraction of the semi-finished items received. Hence, an order that is not finished on time as a result of semi-finished items that are not received on time is not included in this KPI. The Scheduling Department should guarantee that the right SKUs are feasibly scheduled for the upcoming week, i.e., SKUs that have an actual inventory level below s. The last KPI should ensure that not too much semi-finished items are ordered by third parties, causing that peak orders can be seen at the production lines.

The targets set for each KPI should be determined by RSD-S. However, it is suggested to set specific and challenging goals in order to obtain a higher performance (Locke & Latham, 2002). These targets should be set in consultation with the departments, as higher goal commitment results in higher task performance. Besides, the managers should give feedback on the current performance regarding these targets in order to increase the department's functioning. As all KPIs are based on department performance, the feedback should be given as well on department level in order to increase the performance of the team (DeShon, Kozlowski, Schmidt, Milner, & Wiechmann, 2004).

5.4 Conclusion Design of Production Planning

This chapter provides an answer on sub-questions 3, 4, and 5. The third sub-question was formulated as: Which product characteristics can be used to form product families at Cloetta Roosendaal Spoorstraat? How and how often do the product families have to be revised? From this chapter, it can be concluded that most product characteristics indicate that Cloetta has to produce its products to stock. Some characteristics mentioned in the current literature, however, suggest that the production process can be controlled differently, being: modularity of product design, product structure, production lead time, flexibility production process, and information sharing. Based on these characteristics, three product families are formed by using a decision tree (Hoekstra & Romme, 1992). The first group 'flexible production items' consists of SKUs that include only one semi-finished item (single-product) that is produced at the Molding Department of RSD-S with a total average weekly demand (summed over all SKUs) that is above the MOQ. This group can be used to respond on variation of the Molding Process because it is produced every week and is relatively easy to pack. The second group 'flexible packaging items' consists of SKUs that include only one semi-finished item that is produced at a third party and can be stocked within the warehouse of RSD-S, i.e., has a longer shelf-life than products stocked at the buffer. This group can be used to respond to a decrease in semi-finished items supplied from third parties and the production departments. The last group 'fixed production items' consists of SKUs that are not included in one of the other two groups. Therefore, mixed-SKUs, SKUs of which the semi-finished item faces a low demand, and SKUs that include only semi-finished items from the Graining Department or third parties (that cannot be stocked) are included in this group. This group is more difficult to steer as multiple steps are involved. As the current literature does not specify an exact period that can be used to review these product families (Van Kampen & Van Donk, 2014), it is proposed to review these families in the monthly sales and operations planning cycle within Cloetta.

The fourth sub-question was formulated as: Which planning method(s) can be linked to each product family that guarantee(s) an increase in the stability and reliability of the volume and production plan? From this chapter, it can be concluded that it is preferred to treat every production process separately. Hence, the customer of each step is the subsequent process step. Accordingly, the first two steps of the model of Soman et al. (2004) are applied to each production department within RSD-S. Regarding the Molding Department, it is advised to work with both an MTS-environment ('flexible production items') and an MTO-environment ('fixed production items' and orders from third parties). The MTS-environment is used as a buffer when facing a decreased or increased line-performance. As a result, it is guaranteed that MTO-orders are produced, causing that the packaging process of mixed-products can be continued. The Graining and Compressing Departments should use the MTO-environment only because the Graining Department faces a complex production process, whereas the Compressing Department faces overcapacity. The Packaging Department should use the MTS-environment only, as it is concluded that Cloetta has to produce its products to stock in order to guarantee that a delivery reliability of 99.5% is obtained. To control the inventory at the DCs, it is proposed to use the *(R,s,Q)-policy*. In this policy, the inventory is checked every R periods to conclude whether the current inventory level is below the inventory level s. If so, the fixed quantity Q is ordered at the Packaging Department. It is essential to determine the right quantity s, such that the safety-stock can react on demand variation. Moreover, it is essential to determine the right quantity Q, such that production orders do not cause too large orders at the production stages. Hence, Schedulers can plan the production orders based on the actual inventory level, which should result in more stability relative to the current approach. Moreover, it is proposed to order the 'flexible packaging items' to stock in order to make use of these products when (internal) suppliers cannot deliver. As a result, the Packaging Department is able to pack although supply is limited.

The fifth sub-question was formulated as: Which KPIs can be defined to measure the performance of the new planning approach? How do these KPIs differ from the current KPIs? It can be concluded from this chapter that the schedule adherence should no longer be used within all production departments. Instead, four new KPIs should be used, being: volume of orders packed as a fraction of the volume received and scheduled for that week (Packaging Department), volume on stock at the buffer (MTS-environment), schedule adherence as a fraction of the semi-finished items received (MTO-items), and the amount of SKUs feasibly scheduled that face an inventory level below s as a fraction of all SKUs that face an inventory level below s (Scheduling Department). Moreover, it is proposed to introduce a KPI that measures the costs of the current safety-stock. Hence, Demand Planners cannot store unlimited safety-stock at the DCs. Lastly, it is proposed to use a KPI that indicates how much volume is ordered by third parties at RSD-S during the week. Therefore, Schedulers can control and steer on the volume ordered by third parties.

Chapter 6

Design of Implementation plan

Approximately 65% of change processes fail as a result of common mistakes that are made during the implementation process (Kotter, 1996; Nguyen et al., 2003; Price & Chahal, 2006; Almanei et al., 2018). This chapter, therefore, proposes an implementation plan that can be used by the management team of RSD-S to implement the change throughout Cloetta. Making common mistakes should be avoided by using this implementation plan, which is shown in Section 6.1. In this section, a combined implementation plan is outlined that includes steps from different models that were discussed in Section 4.2. Therefore, an answer to the last research question can be given in Section 6.2.

6.1 Implementation Plan

An implementation plan is proposed in this section that can be used by the management team of RSD-S to implement the solution described in the previous chapter throughout Cloetta, i.e., in each market and production site of the Cloetta organization. Implementing the change throughout Cloetta should guarantee that the communication between plants and departments increases. Therefore, orders to or from other Cloetta plants should become more controllable, and information shared between the Scheduling Department and Demand Department should increase. Moreover, Cloetta currently uses one overall scheduling process that is used at each production site. Hence, the solution should be implemented throughout Cloetta in order to avoid that differences arise between production plants. As a result of this change, the stakeholders defined in Chapter 2 remain equal in terms of positions but multiply in terms of the number of employees involved. However, some (executive) managers should be included to give more power to the change (i.e., guarantee that stakeholders will change), which is discussed later.

A combination of the models discussed in the literature review (Section 4.2) is proposed as one change model that can be used at Cloetta. A combined model is advised to guarantee that all aspects applicable during the change process of Cloetta are covered. The model of Price and Chahal (2006) is used as a basis during this process because all steps are directly applicable to Cloetta. Some of these steps are comparable to the steps from other models discussed in the literature review. Hence, the information of each model that is applicable to that specific step is used to give substance to that step for Cloetta. However, as already mentioned, some steps are not included in the model of Price and Chahal (2006) that are included in other models discussed, but are applicable to the situation at Cloetta. Therefore, it is proposed to adjust the model on five points. Firstly, it is proposed to split-up step one of the model of Price and Chahal (2006) into the three steps mentioned by Smith (2005). Hence, this step is changed into the three stages (i) create a sense of urgency, (ii) involve stakeholders in the change process, and (iii) provide a fundamental basis for the change process. As a result, more attention should be paid to create a readiness for change within the Cloetta organization as a whole, which is needed as the change has not yet been communicated to other plants. Secondly, the model of Price and Chahal (2006) includes no pilot test, but the model of Varkey and Antonio (2010) does. As the solution proposed for Cloetta cannot be implemented as a blueprint, i.e., all steps and parameters are already known before implementation, it is proposed to include this pilot step before the implementation step. Hence, the solution and its parameters are outlined on a small scale before actually changing the process throughout Cloetta.

The third adjustment is to use the PDCA-cycle during the pilot test, as proposed by Varkey and Antonio (2010). This cycle should help by finding an exact solution for Cloetta. Moreover, a fixed iterating cycle is used during the trial and error process, by which it is more clear for stakeholders which step is currently executed. The fourth change is to use an iterative process that starts at the development stage and ends at the implementation stage. Varkey and Antonio (2010) use this loop to implement a smaller part of the total change at each iteration. Therefore, quick wins can be achieved during the implementation process, which guarantees that readiness to change increases and, therefore, motivation to change too (Kotter, 1996). The author mentions that quick wins result, therefore, in a faster transformation compared to a situation in which no short-term wins are used. The feedback of the pilot stage and the implementation stage are used to determine the next quick win in the change process. Hence, this change process can be seen as a self-reinforcing process, i.e., positive feedback from previous steps reinforces subsequent process steps (Hayes, 2018). Lastly, Price and Chahal (2006) did not include the refreeze stage of Lewin (1947), which is the last step in the models of Kotter (1996) and Varkey and Antonio (2010) too. Therefore, it is proposed to include this step between the implementation step and evaluation step, so that Cloetta can guarantee that stakeholders do not relapse to their previous behavior after the change is implemented.

As a result of the above adjustments to the model of Price and Chahal (2006), the implementation process at Cloetta comprises eight stages. These stages, including the overall purpose of each stage, are represented in Figure 6.1. This implementation plan is explained per step in more detail below.

Step 1: Prepare

The first step during the implementation process at Cloetta is to prepare the organization for the upcoming change. During this step, it is essential to communicate the change throughout Cloetta, as currently only employees within RSD-S know about the proposed solution. As a result, stakeholders should become ready to start the change, which should result in the formation of a

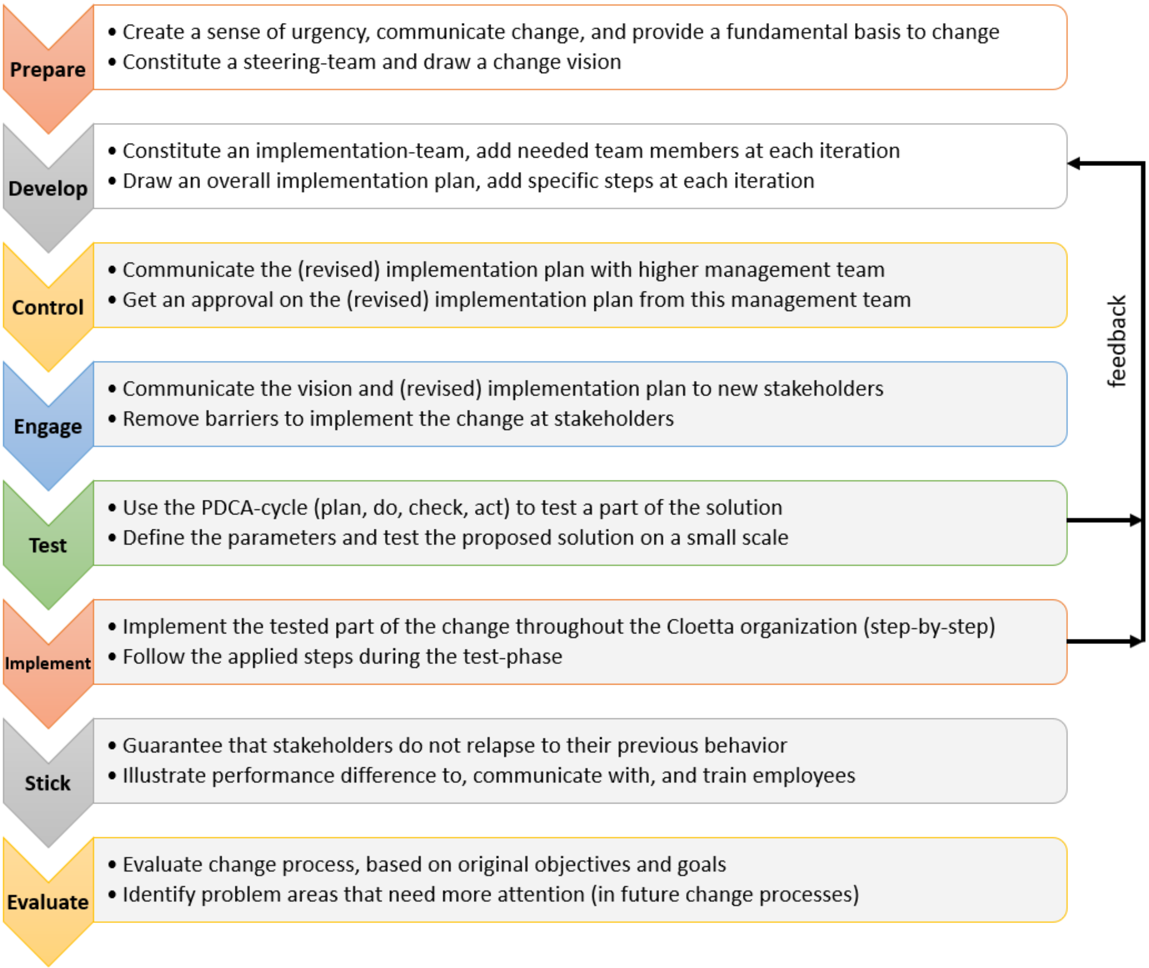


Figure 6.1: Proposed implementation plan for Cloetta

guiding coalition (Kotter, 1996). This coalition consists of stakeholders that are ready to start the change, which is needed to help with implementing the proposed change. Kotter (1996) mentions that the coalition should consist of stakeholders with different positions, expertise, credibility, and leadership to guarantee the highest effect. To come to this point, the three steps defined by Smith (2005) are used during this stage.

The first step is to create a sense of urgency why the current planning process has to be changed within Cloetta. To create a sense of urgency to change, the difference between the current state and the future desired state should be highlighted. Therefore, stakeholders should become unsatisfied with the current state (Smith, 2005). Translating this to the situation at Cloetta, it is advised to emphasize that the current procedure results in a lot of exact calculations (e.g., long-term capacity calculations, short-term scheduling) based on unreliable information (e.g., demand forecast). Hence, different stakeholders are occupied with steps that do not add value (e.g., scheduling a particular production week that should be rescheduled again next week), which results in higher operational costs than actually necessary. By implementing the proposed change, this type of steps should decrease and, therefore, Cloetta's operational costs should decrease. However, it is not clear how much the exact savings will be throughout the Cloetta organization, as this project has only focused on the processes within RSD-S. Therefore, it is proposed to draw an indication together with all stakeholders what will change within the plants and markets as a result of the proposed solution, in order to increase the urgency to change.

To increase the sense of urgency to change, it is highly suggested to give more power to the statement of why Cloetta should change. Varkey and Antonio (2010) mention that, therefore, an executive manager within the organization should take ownership of the project. Moreover, Kotter (1996) suggests that middle and lower level management should communicate this urgency throughout the company. During this process, managers should demonstrate respect and be as transparent as possible in order to increase their trustworthiness (Price & Chahal, 2006). Based on these recommendations, it is suggested to the plant manager of RSD-S to communicate the change to his/her superior(s) until one of Cloetta's executive managers is involved in the process (e.g., Cloetta's President Operations). From this point, it is recommended to spread the change throughout Cloetta via middle and lower level management. It is essential to guarantee that every stakeholder in each plant and market, as defined in Chapter 2, is informed during this process. Namely, a consequence of not involving these stakeholders could be that these employees actually resist to implement the change. As a result of this first step, all stakeholders within Cloetta should understand why the current planning process has to be changed.

The second step within the model of Smith (2005) is to communicate the change and, therefore, guarantee participation and involvement of the stakeholders in the project. This step should, thus, connect the urgency to change to the solution for this problem. The author mentions that communicating the change should be performed as early as possible in the process, i.e., before the change actually starts, in order to avoid a lack of trust at the implementation team. It is proposed to communicate the change towards the same stakeholders as the urgency to change is communicated to. A large pitfall when communicating the change throughout the organization is that someone's readiness for change could decrease as a result of different factors (as discussed in Sub-section 4.2.2). One of the most important factors that could occur during this step is that one thinks that (s)he will lose value as a result of the proposed change (Kotter & Schlesinger, 1979). This lost value could be a concern for stakeholders that are directly involved in rescheduling the planning and do not understand what their function will be if the implementation of the new planning process is finished. Another essential factor that can occur during this step is that stakeholders might feel that the change will cost them more than it will actually bring them (Kotter & Schlesinger, 1979). This feeling could be a concern for stakeholders that are not directly involved in making the production planning within Cloetta (e.g., Demand Department). Therefore, it is proposed to make the positive effect this change has on their daily processes visible for them. If it has no direct impact on their job, it should be made clear why this change is essential for Cloetta as an organization. Hence, it is crucial to keep in touch with the different stakeholders in order to have an idea about their readiness for change during this step. The different factors mentioned in the literature review that can decrease someone's readiness for change should be taken into account during this step. As a result of this step, stakeholders should become involved in the change process.

The last step is to provide a fundamental basis for the change process (Smith, 2005). This foundation should help in providing a basis on which decisions are based during the process. A steering-team should be constituted within Cloetta to decide what the foundations of the project will be (Varkey & Antonio, 2010). The authors mention that this team should plan, coordinate, and monitor the progress of the change. Kotter and Cohen (2002) mention that individuals within the steering-team should have relevant information, credibility regarding other stakeholders, connections and authorization within Cloetta, and managerial skills. It is proposed to include at least one member of the management team of RSD-S within the steering-team, as (s)he has more knowledge regarding this project. Moreover, it is proposed to include (executive) managers in this team, because these stakeholders could have more authority and managerial skills.

A first step of the steering-team is to set-up a change vision that can be used as a basis for decisions that are made during the process (Kotter, 1996; Price & Chahal, 2006). This vision should refer "to a picture of the future with some implicit or explicit commentary on why people should strive to create that future"(Kotter, 1996, p. 68). According to Kotter, a vision for change should serve three purposes, being: give a general direction, motivate stakeholders to take actions, and coordinate actions of stakeholders. Price and Chahal (2006) mention that the feedback from the previous steps should be used to set-up the vision, because this feedback gives managers often a feeling which directions can be followed during the change process.

A second step of the steering-team is to set-up a directive that indicates the role of each stakeholder during and after the change process, which is an essential step for the change process at Cloetta (Smith, 2005). As the analyses show that some stakeholders currently perform steps that add little or no value, it should be made clear what their task(s) will be after the change process. Otherwise, when not performing this step, these employees could resist the change because they are afraid of, for example, being fired after implementing the change as a result of less work that has to be done. Smith (2005) mentions that training employees could be a powerful tool to increase someone's readiness for change at this stage. Cloetta could train employees such that they can perform new skills, and thus (partly) can perform other tasks, or could train employees such that they can execute projects that further optimize Cloetta's business processes. For example, Schedulers could prepare buffer-operators to steer the production planning. Therefore, this step should help in, as mentioned above, making stakeholders understand that their value for the organization will not decrease as a result of the change.

Step 2 and 3: Develop and Control

The second step and third step in the implementation process at Cloetta are the development and control stages, during which an implementation plan and implementation-team are set and controlled by the steering-team. Both stages are executed multiple times during the change process. The first time performing both stages is after finishing the preparation stage, during which an implementation plan and implementation-team have to be set for the first time. The other times performing these stages is after finishing the implementation phase, i.e. when the implementation cycle starts again. At this point, the current implementation plan is revised, specified for the next step, and controlled again. Moreover, the implementation-team can be adapted such that the stakeholders needed during the upcoming stage are included.

The implementation plan is always the first part that should be taken into account during the development stage. When this stage is performed for the first time, the steering-team should propose an overall implementation plan that can be used throughout the change. This implementation plan should roughly indicate which phases can be distinguished during the change, including short-term and long-term goals, who is responsible for executing these phases, which budget is available during each phase, and what the time-scales are to achieve each stage (Price & Chahal, 2006; Varkey & Antonio, 2010). Moreover, it should be indicated which outcomes are communicated to the stakeholders and in what way, and how these stakeholders can give feedback on these outcomes. When the development stage is executed after starting the iterative process again, this implementation plan should be changed based on the information gathered during the previous test and implementation stages. Moreover, the next implementation step should be specified in more detail during this step. It is essential that this step does not deviate from the original change process (e.g., another change process), and that the change step is clear for each stakeholder, in order to guarantee their readiness for change. Kotter (1996) mentions that it is essential to introduce more change steps directly after a quick win. Moreover, as a result of the first quick win, the following steps can include larger change projects. However, Kotter (1996) mentions that the steering-team should guarantee that unnecessary interdependencies are reduced during larger projects, i.e., reduce the elements that have to be changed as a result of changing one element. In both situations, the (revised) implementation plan should be communicated with the executive management team in order to get approval on the new plan during the control stage.

The implementation-team should, after that, be assembled (when executing the development stage for the first time) or adapted (when performing the development stage after starting the iterative process again) by the steering-team. The implementation team is responsible for actually implementing the change within Cloetta. Kotter (1996) and Price and Chahal (2006) mention that the most effective implementation teams consist out of employees who (i) have shared objectives regarding the change, (ii) are trusted by the employees they have to work with, (iii) occupy different positions within Cloetta, (iv) have the power and expertise to implement the change, i.e., can take steps without waiting for authorization, (v) and have the leadership to steer the project. As mentioned before, these stakeholders should be relevant for the next step. Kotter (1996), therefore, states that more stakeholders should be added to the implementation-team when larger projects are started in order to decrease the workload per team-member.

Step 4: Engage

The fourth step is to engage stakeholders to participate in the change. To do so, the steering-team should communicate the adapted implementation plan to the stakeholders, in particular to the stakeholders that will be affected during the next change step. By doing so, stakeholders should get the same understanding of the goal and direction of the change. Kotter (1996) mentions that, when communicating this plan, the steering-team should keep it simple (e.g., a picture), use multiple sources (e.g., meetings, memos, newspapers), repeat the message multiple times, and be consistent. Moreover, the author mentions that it is highly important to have a two-way communication (give-and-take) instead of an one-way communication (just give). Hence, the steering-team should clarify that feedback can be given on the information presented.

Stakeholders develop a feeling regarding the change as a reaction to this step (Price & Chahal, 2006). Stakeholders could perceive barriers on their way to actually implement the change, causing that their readiness to change will decrease (Kotter, 1996). Therefore, it is essential that the feelings of each stakeholder are understood during this step, so that the implementation-team understands how a stakeholder will behave during the change. Barriers are, for example, current targets, not cooperative leaders, and internal regulations. Hence, the implementation-team has to understand what someone's barriers are and have to look at how these barriers can be taken away. The level of resistance regarding the change should be decreased as a result of this step. This decrease is important to work alongside stakeholders during the change process, instead of enforcing the change (Price & Chahal, 2006).

Step 5 and 6: Test and Implement

During the test and implementation phase, a part of the solution is tested on a small scale and, thereafter, implemented throughout all processes changed during that iteration. During the pilot test, the PDCA-cycle is used to understand what the best procedure is to actually implement the change and to understand what parameters and values (e.g., order-up quantity Q) have to be used within the changing process (Varkey & Antonio, 2010). Moreover, the pilot test is used to understand how people behave as a consequence of the implemented change, and to increase the performance of the total outcome. The results of the test-phase should be spread with the steering-team and stakeholders in order to increase the readiness for change.

After successfully finishing the test phase, and thus successfully implementing the pilot test, the tested part can be implemented for all processes that will be changed during that iteration. Varkey and Antonio (2010) mention that it is essential to maintain a high urgency to change during the implementation phase in order to reduce the chance that someone's readiness to change decreases. All the steps performed during the pilot test should be performed during the implementation stage too. Continues support from top management must be gained during this process in order to avoid that the change will be stopped over time (Price & Chahal, 2006). Hence, the steering-team and implementation team have to keep a positive outlook, and have to stick to the implementation plan as confirmed by the management team. Moreover, it is crucial to guarantee that potential conflicts that occur during the change will be solved, in order to keep the readiness for change as high as possible (Price & Chahal, 2006). Any problems that occur should be registered by keeping in touch with the different stakeholders.

The change for Cloetta mentioned in the previous chapter can be implemented via different steps that should be initiated by the steering-team. However, it is suggested to start with implementing a part of the solution at RSD-S without including other factories and departments, as this has two advantages. Firstly, only stakeholders within RSD-S have to be included in the implementation team, which makes it more compact and, therefore, easier to control. Secondly, after receiving the first results of the tests, it is possible to show the advantages of such a planning system to other Cloetta plants. Therefore, barriers to implement the change should decrease at other plants, causing that the readiness to change should increase. This step could be seen as the first iteration of the implementation process. During this iteration, it is suggested to only change processes within RSD-S that have no connection to third parties. Hence, it is suggested to start with scheduling confectioneries that are not intended for third parties and to begin scheduling SKUs that do not include confectioneries from third parties. For these confectioneries two locations should be created at the buffer, as described in the previous chapter. Moreover, regarding the SKUs included, a value Q should be determined at the Packaging Department that does not result in peak behavior at the production departments. It is suggested to start this trial at a few production lines within RSD-S. After that, when the right process is found, the change can be implemented throughout each process at RSD-S. In the next iteration, a market or plant can be included in the change. It is suggested to start with a market or plant that has a close relationship with RSD-S. After that, a new location or market should be included in the change process during the next iteration. This process should be repeated until all markets and locations are included in the process. It is crucial during this process that results are continuously shared with all locations and markets in order to increase the readiness for change.

Step 7: Stick

After the change is implemented throughout the Cloetta organization, it makes sense to guarantee that stakeholders do not relapse to their previous behavior. Kotter (1996) and Varkey and Antonio (2010) mention that, therefore, the steering-team should guarantee that stakeholders stick to the new way of working. Kotter (1996) mentions some key elements that should ensure that the changed process will stick to the organization. Firstly, prove that the current results are superior to the previous results. Hence, compare and, after that, show the results of the previous method to the results of the current method. Secondly, the organization should keep communicating about the new method, in order to guarantee that the previous method slowly disappears. Lastly, make new decisions that are based on the new process. When new decisions are based on the previous process, this process will reassert itself. Moreover, Varkey and Antonio (2010) mention that Cloetta should train the current employees in order to guarantee that they understand the new process. During this training, the core values of the new situation should be explained to the stakeholders. Lastly, Varkey and Antonio (2010) mention that processes and equipment that was used during the previous process but are no longer needed during the current process should be discontinued or modified such that they can (not) be used in the new process.

Step 8: Evaluate

During the last step, the change process is evaluated on the original objectives and goals (Price & Chahal, 2006). As a result of this step, it is possible to identify problem areas that can be addressed (during a next change process). Price and Chahal (2006) suggest to compose an evaluation team that does not contain members who were represented in the implementation team. Moreover, the authors propose to include middle managers into the evaluation team, as such managers are most often in the best position to review the change process.

6.2 Conclusion Design of Implementation Plan

This chapter provides an answer to the last sub-question, which was formulated as: What does the implementation plan of the new planning approach look like in practice, regarding the steps to be taken and stakeholders involved? From this chapter, it can be concluded that RSD-S should follow eight steps to implement the solution throughout the Cloetta organization. The solution should be implemented throughout Cloetta to guarantee that the communication between plants and departments increases. Therefore, orders to or from other Cloetta plants should become more controllable, and information shared between the Scheduling Department and Demand Department should increase. Moreover, Cloetta currently uses one overall scheduling process that is used at each production site. Hence, the solution should be implemented throughout Cloetta in order to avoid that dissimilarities arise between production plants.

The model proposed for Cloetta is a combination of the models designed by Kotter (1996), Smith (2005), Price and Chahal (2006), and Varkey and Antonio (2010). This model consists of eight steps, of which step 2 up to and including step 6 are iteratively performed during the change process. During the first step, a sense of urgency to change is created, after which the change is communicated throughout the Cloetta organization. These steps are essential as currently only stakeholders within RSD-S know about the change, whereas readiness for change should be created within the entire organization. Moreover, a steering-team should formulate a change vision for Cloetta during this step, and the team should indicate the new role of each (group of) stakeholder(s) during and after the change process. These steps have to be performed to guarantee a basis on which decisions are made during the change process. During the second step of the change process an implementation plan is developed and an implementation-team is constituted. This plan and team are controlled by the management-team during the third step. From these steps on an iterative cycle begins, in which small changes are implemented throughout the Cloetta organization. Quick changes are used to stimulate change and to show that it is possible to achieve improvements within the current way of working (Kotter, 1996). Stakeholders that have to participate during the upcoming cycle have to be engaged within the next step. To do so, barriers that stakeholders experience to implement the change should be removed by the steering-team. When stakeholders are ready to engage in the upcoming change step, a part of the solution is tested on a small scale and, after that, implemented throughout the Cloetta organization during the steps five and six, which are the last steps of the iterative process. During the pilot-test, the PDCA-cycle is used to understand what the best procedure is to implement the change and to understand what parameters have to be used within the change processes. After successfully finishing the pilot test, this tested part can be implemented for all processes that will be changed during that iteration. When the change is fully implemented throughout the Cloetta organization, it is essential to guarantee that the stakeholders do not relapse to their previous behavior. Hence, the steering-team should train stakeholders to get used to the new process during step seven. The last step of the process consists of an evaluation process in which the change is evaluated on potential failures made during the process. Problem areas are identified as a result of this step, which can be addressed during a next change process. Concluding, by following these eight steps, the change can be implemented throughout the Cloetta organization to reduce the non-value-adding planning steps.

Chapter 7

Conclusion and Discussion

The main findings of this Master Thesis project are summarized and discussed in this chapter. Section 7.1 summarizes the answers on the sub-questions stated in Section 1.5, after which an answer can be given on the main research question: '*How to design and implement a new planning approach that increases the stability and reliability of the volume plan (eight weeks rolling) and production plan at Cloetta Roosendaal Spoorstraat?*'. The terms stability and reliability are explained in detail in Section 1.5. Lastly, Section 7.2 discusses the limitations of this research and recommendations for future research.

7.1 Conclusion

Which stakeholders are involved in the planning process and are, therefore, essential during the design and implementation of a new planning method?

Stakeholders that are involved in this process are identified in order to manage these individuals and groups, such that maximum support for the change can be obtained. Two groups of stakeholders are identified, being: key important stakeholders and wider stakeholders. The key important stakeholders are defined as the Plant Manager of RSD-S, the Production Manager of RSD-S, the Scheduling Department, the Demand Manager, the Demand Planners, the Supply Chain Manager, and the Supply Chain Planner. These stakeholders must be involved during each sub-question. The wider stakeholders that are defined, on the other hand, can be involved during a sub-question. This group consists of the following stakeholders: employees directly associated to the production processes (Graining, Compressing, Molding, Packaging, and Logistics), Customer Support Manager, Customer Employees, Marketing Director, Marketing Managers, Customer Director, Account Managers, and the Portfolio Manager. Whether and how this group of stakeholders will be managed depends on the exact steps that will be taken during the project.

What is the gap between the current and desired situation? What are the root causes that guarantee that the production planning has to be rescheduled?

From the analyses provided in this Master Thesis project, it can be concluded that the volume plan (eight weeks rolling) and production plan are currently scheduled, such that the expected stock level is at least equal to the minimum safety-stock. However, this expected stock level fluctuates significantly prior to a production week, which cannot be covered by the safety-stock. The volume plan (eight weeks rolling) and production plan are, therefore, rescheduled to guarantee enough stock available at the DCs such that out-of-stocks are prevented. The desired situation, in which Schedulers do not have to reschedule the volume plan (eight weeks rolling) and production plan, can be obtained by, on the one hand, allowing demand and process variation in the planning and, on the other hand, by finding a solution for three root causes. The first root cause is that the minimum order quantities are set too high such that the production plan is not feasible. Secondly, the safety-stock does not consist of sufficient stock to compensate process and demand variation. Lastly, the communication between Cloetta plants and departments is limited and not clear, causing that schedulers do not understand which part of the expected demand is known.

Which product characteristics can be used to form product families at Cloetta Roosendaal Spoorstraat? How and how often do the product families have to be revised?

Most product characteristics indicate that Cloetta has to produce its products to stock. Some characteristics mentioned in the current literature, however, suggest that the production process can be controlled differently, being: modularity of product design, product structure, production lead time, flexibility production process, and information sharing. Based on these characteristics, three product families are formed by using a decision tree (Hoekstra & Romme, 1992). The first group 'flexible production items' consists of SKUs that include only one semi-finished item (single-product) that is produced at the Molding Department of RSD-S with a total average weekly demand (summed over all SKUs) that is above the MOQ. This group can be used to respond to variations of the Molding Process, because it is produced every week and is relatively easy to pack. The second group 'flexible packaging items' consists of SKUs that include only one semi-finished item that is produced at a third party and can be stocked within the warehouse of RSD-S, i.e., has a longer shelf-life than products stocked at the buffer. This group can be used to respond to a decrease in semi-finished items supplied from third parties and the production departments. The last group 'fixed production items' consists of SKUs that are not included in one of the other two groups. Therefore, mixed-SKUs, SKUs of which the semi-finished item faces a low demand, and SKUs that include only semi-finished items from the Graining Department or third parties (that cannot be stocked) are included in this group. This group is more difficult to steer as multiple steps are involved. As the current literature does not specify an exact period that can be used to review these product families (Van Kampen & Van Donk, 2014), it is suggested to review these families in the monthly sales and operations planning cycle within Cloetta.

Which planning method(s) can be linked to each product family that guarantee(s) an increase in the stability and reliability of the volume and production plan?

Different models are assigned to the Packaging Department and each production department within RSD-S, as they are treated as stand-alone processes. The Molding Department should use both an MTS-environment ('flexible production items') and an MTO-environment ('fixed production items' and orders from third parties). The MTS-environment is used as a buffer when facing a decreased or increased line-performance. As a result, it is guaranteed that MTO-orders are produced, causing that the packaging process of mixed-products can be continued. The Graining and Compressing Departments should use the MTO-environment only because the Graining Department faces a complex production process, whereas the Compressing Department faces overcapacity. The Packaging Department should only use the MTS-environment, as it is concluded that Cloetta has to produce its products to stock, in order to guarantee that a delivery reliability of 99.5% is obtained. To control the inventory at the DCs, it is suggested to use the *(R,s,Q)-policy*. In this policy, the inventory is checked every R periods to conclude whether the current inventory level is below the inventory level s. If so, the fixed quantity Q is ordered at the Packaging Department. It is essential to determine the right quantity s, such that the safety-stock can react on demand variation. Moreover, it is essential to determine the right quantity Q, such that production orders do not cause too large orders at the production stages. Hence, Schedulers can plan the production orders based on the actual inventory level, which should result in more stability relative to the current approach. Moreover, it is suggested to order the 'flexible packaging items' to stock in order to make use of these products when (internal) suppliers cannot deliver. As a result, the Packaging Department is able to pack although the supply is limited.

Which KPIs can be defined to measure the performance of the new planning approach? How do these KPIs differ from the current KPIs?

This research proposes to adjust one currently used KPI, and to introduce two completely new KPIs as a result of the proposed planning method. The schedule adherence should no longer be used within all production departments. Instead, four new KPIs should be used, being: volume of orders packed as a fraction of the volume received and scheduled for that week (Packaging Department), volume on stock at the buffer (MTS-environment), schedule adherence as a fraction of the semi-finished items received (MTO-items), and the amount of SKUs feasibly scheduled that face an inventory level below s as a fraction of all SKUs that face an inventory level below s (Scheduling Department). Moreover, it is suggested to introduce a KPI that measures the costs of the current safety-stock. Hence, Demand Planners cannot store unlimited safety-stock at the DCs. Lastly, it is suggested to use a KPI that indicates how much volume is ordered by third parties at RSD-S during the week. In this way, Schedulers can control and steer on the volume ordered by third parties.

What does the implementation plan of the new planning approach look like in practice, regarding the steps to be taken and stakeholders involved?

An eight-step plan is designed for Cloetta that can be used to implement the new planning approach throughout the Cloetta organization (Kotter, 1996; Price & Chahal, 2006; Varkey & Antonio, 2010). The solution should be implemented throughout Cloetta to guarantee that the communication between plants and departments increases. Therefore, orders to or from other Cloetta plants should become more controllable, and information shared between the Scheduling Department and Demand Department should increase. In the first step of the proposed model, stakeholders within Cloetta are prepared for the change. During this step, a sense of urgency is created at these stakeholders, after which the change is communicated. Moreover, a steering-team should be constituted, and a change vision should be drafted. After that, an iterative sequence is started at the second stage up to and including the sixth stage in order to implement a quick change every iteration. During the second stage, an implementation-team is constituted, and an implementation plan is drafted by the steering-team. New stakeholders and implementation steps are added after each iteration. Next, this implementation plan is communicated to the higher management team, who should agree upon the upcoming change steps. If the implementation plan is approved, the stakeholders involved during the next implementation step should be engaged to participate in this process, i.e., remove barriers at stakeholders to implement the change. When stakeholders are ready to change, the implementation team should test the upcoming change on a small part of the process during step five. During this stage, the PDCA-cycle is used such that the right parameters (e.g., order quantities) can be determined ("Deming cycle (PDCA)", 2000). When the right solution is found, this solution can be implemented in all processes changed during that iteration. After performing this iteration process multiple times, during which the change is fully implemented, it is suggested to guarantee that stakeholders do not relapse to their previous behavior, i.e., stakeholders should stick to the new situation. After that, the change process has to be evaluated during the last step in order to identify problems that need more attention in future change processes.

7.2 Discussion and further research

This project faces two sides, being: the design of a planning method that should reduce the amount of rescheduling, and the design of an implementation plan that can be used to implement the proposed approach throughout the Cloetta organization. Hence, the project was very extensive and contained a lot of information, causing that there was no possibility to dive into any specific subject with too much detail. This situation brings the following limitations and related recommendations.

Proposed planning approach

The proposed planning approach is based on the literature that indicates how variation can be included in the planning in combination with pragmatic deliberations. However, whether the final model actually increases the stability and reliability of the production plan is not tested by a simulation. The same holds for the order quantity Q and reorder-level s at the Packaging Department, and the maximum order quantities ordered by third parties at the production departments. Moreover, it is not secured that the groups 'flexible production items' and 'flexible packaging items' are large enough to compensate for all variation, and how these product families actually react on this variation. For future research, therefore, is suggested to perform the proposed planning approach in a detailed simulation. If the product families turn out to be too small, it is proposed to include more items by reducing the MOQ or changing the product portfolio within Cloetta.

The product families in the planning approach and, therefore, the models used are based on the current Dutch market portfolio. It is assumed that this portfolio is somewhat comparable to the product portfolios of other markets. Moreover, it is assumed that this product portfolio will not change in terms of percentages regarding the product families formed. In cases these assumptions prove to be wrong, it is advised to Cloetta to take a second look at the product characteristics mentioned. Therefore, new product families have to be formed such that the current production approach can be used, i.e., guarantee a group of MTS-products that can be used to react to the process variation. Moreover, the current literature does not indicate how long the period should be between reviewing these product families. Further research is needed to come-up with more precise models that indicate how this time-frame should be identified.

The current product families are constituted such that all semi-finished items within the Graining Department are produced to order. This situation could still result in a situation in which the production planning has to be rescheduled when variations in the process occur. However, there are almost no semi-finished items that face an average demand above the MOQ currently. Moreover, most of these items are packed in mixed-SKUs. In case that either the average demand increases or the MOQ decreases in the future, it could be possible to produce some items to stock. Therefore, the current decision tree should be adapted to that situation. Until that time, it is essential to oversee which production orders are expected in order to react to eventual capacity constrains. Therefore, this department should be in contact with its customers all the time.

Focus on flexibility

Cloetta is extremely focused on numbers, while most of these numbers are not reliable. Therefore, it is proposed to Cloetta to focus on being flexible instead of focusing on these numbers. For example, the Supply Chain Department should not focus on whether the current volume plan fits within the capacity available, but they should focus on how Cloetta plants are able to react as late as possible on changes in the volume plan. Therefore, Cloetta is able to react as late as possible on customer demand. Hence, it is suggested for further research to indicate how Cloetta is able to respond later on customer demand and to focus less on unreliable numbers.

Problems not included in this project

In Section 3.5 a distinction is made on which problems are within and outside the scope of this Master Thesis project. The problems 'production norms are not matching the actual production times', 'no clear communication between Cloetta and its customers', and 'products launched from projects/NPDs/re-allocations are not communication on time' are not included in this research. However, these problems are worth an investigation on its own. Hence, it is recommended to Cloetta to tackle these problems in order to further increase the stability and reliability of the production plan. Moreover, one of the largest problems that causes the variable expected stock level, the low forecast accuracy, is labeled as a problem that cannot be changed, causing that the new planning approach has to allow this variation. An increased forecast accuracy, however, could result in less variability at the production processes. Therefore, it is highly recommended for further research to start projects that result in a better understanding of customer behavior, which results in an increased forecast accuracy.

Design of planning approach and implementation plan

The planning approach and implementation plan are both found by merging different components of models found in the current literature. However, during the literature review no models are found that summarize such components and, therefore, can be used to select different elements to come to either a new planning approach or implementation plan. Hence, it is recommended for further research to propose such models, resulting in the ability for practitioners to come up with either a new planning approach or implementation plan without performing an extensive literature review.

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Appendix A

Production Process of RSD-S

This appendix explains in more detail the production processes of RSD-S per department.

Molding

During the molding process, a liquid mixture is molded into a corn starch mold on one of the two molding lines, which are labeled as NID2 and NID3. This mixture is made from different ingredients that are mixed and cooked before the molding process starts. After molding the mixture, the liquid has to harden within one of the eighty drying cabinets to a solid entity. This process takes several hours up to three to four days, which depends on the structure and hardness of the product. The product portfolio of RSD-S is, therefore, categorized in short dryers (approximately 20%), mid-long dryers (approximately 60%), and long dryers (approximately 20%) for each production line. This ratio is important as an increased ratio of long dryers results in a shortage of drying cabinets. On the other hand, an increased ratio of short dryers results in a situation in which the drying cabinets are not fully occupied, causing that cost per semi-finished item increase.

Both molding lines are not completely identical to each other. NID2 produces from Monday to Friday. During the beginning of the week, short dryers and mid-long dryers are produced, and during the end of the week long dryers. Hence, short dryers and mid-long dryers can be used in the same week, whereas long dryers are finished at the beginning of the next week. On the other hand, NID3 produces 24 hours a day and seven days a week. To do so, short dryers, mid-long dryers, and long dryers are scheduled alternately to prevent a shortage in drying cabinets. By comparing the speed of both lines, it can be concluded that NID3 is about 15% faster compared to NID2.

After finishing the drying process, the corn starch, trays, and confectioneries are separated from each other at the beginning of one of the two molding machines. Here, the corn starch and trays are immediately re-used for a new production batch, causing that the molding line has to mold new confectioneries to guarantee that dried confectioneries can be separated from the corn starch and vice versa (in-line process). The confectioneries are, after that, either transported to the buffer or the storage-place before the Graining Department. Confectioneries that are transported to the buffer are first glazed in one of the two glazing drums before arriving at the buffer. During this process, the confectioneries are provided with gloss oil, which results in a good appearance of the product. The surface of confectioneries that are used at the Graining Department, on the other hand, is first made rough before arriving at the storage facility. This step is performed in order to be able to sugar-coat the product when graining them.

Compressing and Graining

When compressing confectioneries, a small dose of powder is pressed into a solid entity. This powder is a mix of dry ingredients and water, which are mixed before the compression process starts. When the products are compressed, they are either stored to be packed, transported to the Graining Department, or transported to one of the other Cloetta factories.

While graining a confectionery, a layer of sugar is added to the surface of the semi-finished item, which results in the hard layer and colorful appearance. To get this result, the semi-finished items are soft coated first, which means that in a short time a large amount of sugar is added. After that, the semi-finished items are hard coated, which results in the smooth appearance and crispy bite of the product. Lastly, the semi-finished items are glazed and then transported to either another Cloetta factory or the Packaging Department.

Packaging

During the packaging process, semi-finished items are either single packed (single-item) or packed in combination with other semi-finished items (mixed-item). The packaging machines are not placed in line with either the graining or glazing lines, causing that semi-finished items have to be stored at the buffer before packaging. When mixed-items, confectioneries have to wait until all semi-finished items have arrived at the buffer to continue the production process. The issue regarding the buffer is, however, the limited storage capacity. Hence, the time between production and packaging cannot be too long in order to prevent a lack of space. Having all semi-finished items available for mixed-items is, therefore, important to reduce needed storage capacity at the buffer.

The packaging lines located at RSD-S can pack rolls, tubs, bag in box, and different kinds of plastic bags. To pack these different kinds of products, each packaging line (of which there are ten) has its capabilities. The specifications per packaging line are presented in Table A.1. One can conclude from this table that some products are interchangeable between lines 902 and 903, and lines 905 and 909. However, only a small number of products is interchangeable between these packaging lines due to the size of the products packed. After finishing the packaging process, the products are located on a pallet, from where they are transported to a designated distribution center (DC).

Table A.1: Specifications of packing lines located at RSD-S

Packaging lines	**Product type**	**Interchangeable**
Line 902	Standing pouch	Some products are interchangeable with line 903
Line 903	Standing pouch	Some products are interchangeable with line 902
Line 905	Pillow bags	Some products are interchangeable with line 909
Line 906	Pillow bags	None, because of specified case packer
Line 907	Tubs	None
Line 909	Pillow bags	Some products are interchangeable with line 905
Line 918	Rolls	None, used for compressed products
Line 920	Rolls	None, used for molded products
Line 952	Carton boxes	None
Line 955	Cone bags	None

Appendix B

Interviews

B.1 Interview Questions

In total eight interview questions are prepared regarding the planning process within Cloetta. Open questions are prepared in order to obtain different opinions out of the planning process. The questions are prepared such that it starts with high-level questions and ends with more in-depth questions. The questions are:

1. What is your function within Cloetta and for how long are you working within this job? What are your main responsibilities and tasks within this job?
2. What are the facets of your job that gives (e.g. motivation) and costs (e.g. stress) you energy?
3. From what you know, how does the planning process looks like (from customer demand, via a production order to sending the product to the customer)? Which departments are responsible for which steps? How does the time horizon, including milestones, looks like regarding these steps?
4. What is your opinion regarding the information streams between these steps? Do you think that the information needed is available? Do you receive this information on time? Is the communication between stakeholders of each step clear and transparent?
5. What is your opinion regarding the current planning procedure (e.g. based on forecast and frozen plan eight weeks before production)? Do you think that this method is applicable for each product within Cloetta (e.g. seasonality, demand changes, promotions)? Do you see patterns in the current production planning (e.g. times that a particular (semi-finished) product is produced)?
6. Regarding the process you just mentioned and the schedule adherence shown in Table 1.2, which specific factors do you think that make the schedule adherence not 100%? What underlying problems causes these factors?

7. What could be a possible solution for these factors? Which persons/departments should be involved when implementing this solution?

8. Are there points of interest that are not discussed so far, but should be mentioned related to this interview?

B.2 Interview Outcomes

This appendix shows some important examples of citations that are mentioned during the interviews. From these citations it is indicated how some problems mentioned in Figure 3.1 are abstracted.

- "I see quite often that the forecast changes within eight weeks prior to a production week. That is largely a result of promotions. For example, I see that customer Z communicates their promotions within x-4 weeks." (Demand Planner). From this citation can be concluded that the demand plan actually changes within the eight weeks prior to a production week. Moreover, it can be concluded that the confirmation of promotions within these weeks is a root cause.

- "It has several causes, such as failures and quality issues. Therefore, you are not able to pack what is planned." (Team-leader Logistics). The Logistics Department delivers packaging materials to the Packaging Department. Therefore, other packaging materials have to be collected as a result of rescheduling the production plan. According to this citation, it can be concluded that rescheduling the packaging plan is a result of products that contain quality issues and production lines that are unreliable.

- "Especially failures and the disposal of products ensures that the planning is not achieved."(Team-leader Molding). From this citation it can be concluded as well that rescheduling the production plan is a result of products that contain quality issues and unreliable production lines.

- "The cleaning standards do not match the actual times". (Team-leader Molding). From this citation it can be concluded that the production norms used to schedule the production do not match the actual production times, causing that the production plan is not executed as obtained.

- "There is a big difference in how the schedule actually looks like before the production week and how this schedule is followed during the week. This may be a result of products that have not been delivered at the buffer or the Technical Department has not solved packaging line problems." (Team-leader Packaging). From this citation it can be concluded that not following the production plan at the Packaging Department faces two sides. Firstly, it could be a result of unreliable production lines within this department. Secondly, it could be a result of semi-finished items that are not present at the buffer.

- "We will look for alternative packaging orders when a product cannot be packed. Because the entire schedule then shifts, your schedule adherence decreases. The main reasons why we cannot pack according to the packaging plan is because products are not produced, are not produced according to the volume scheduled, or are not delivered on time at the buffer. Another very important one is the rejection of semi-finished items." (Team-leader Packaging). From this citation it can be concluded that, in addition to the previous citation, it could be possible that semi-finished items do not arrive at all at the buffer, only a part of the volume expected is received, or semi-finished items are received later than expected.

- "I do notice that it fluctuates so much that you adjust all schedules every week because there has been a malfunction or a product does not meet the quality. Therefore, you can immediately change the planning again." Scheduler/Call-Off. From this citation it can be concluded as well that rescheduling the production plan is a result of products that contain quality issues and unreliable production lines.

- "It could be possible that I do not receive products from the Molding Department or third parties. Moreover, it is possible that a machine has faced a failure or extra volume is added within the eight weeks prior to a production week." Scheduler/Call-Off. From this citation it can be concluded that the Graining Department is not able to produce when no semi-finished items are received from either the Molding Department or Compressing Department. Moreover, it can be concluded that production is not completed as a result of unreliable production lines. Lastly, it can be concluded that the volume plan (eight weeks rolling) has to be rescheduled as a result of extra demand that is added to the demand plan.

Comparing the above citations to Figure 3.1, it can be concluded that all problems are included within this figure.