TÉCNICO LISBOA

Optimization of Stock Cover in Nestlé Portugal

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List of Acronyms

3PL – Third Party Logistics

CAPDo – Check Act Plan Do

CFR – Case Fill Rate

CPW – Cereal Partners Worldwide

DPA – Demand Plan Accuracy

DSP – Demand and Supply Planning

KPI - Key Performance Indicator

NiM – Nestlé In Market

OOH – Out Of Home

PUM – Planning Unit Measure

SKU – Stock Keeping Unit

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Summary

In the fast-moving consumer goods industries, stocks of finished goods are very important for the business to run smoothly. On the one hand, they make it possible to ensure a good service level to the customers, but on the other hand, they can be a major cause of financial and freshness problems. Excess of inventories are considered a liability as they tie up capital, use storage space, can deteriorate or become useless. In line with this, a new challenge arose in Nestlé Portugal where the average stock cover had to be progressively reduced until 2020 and that is what this study/analysis is about – how to reduce the average stock cover?

In order to accomplish that, a characterization of Nestlé was made, and its history presented, along with the demand and supply chain activities in Portugal. This was followed by a literature review with the objective of characterizing stock and inventory in order to identify opportunities for improvement in the supply chain and stock of Nestlé Portugal.

The next step was the selection of the critical sub-categories of Nestlé. For this analysis all the subcategories were analyzed in terms of target stock cover and real stock cover in order to see which of the sub-categories were most off target.

After the selection of the critical sub-categories all the SKUs are analyzed and whenever possible improvement proposals are made to reduce the stock cover. This analysis resulted in a set of improvement proposals and general conclusions that would significantly improve the stock cover performance of Nestlé.

Key words: Inventory, Stock Cover; Stock, Supply Chain.

1. Introduction

1.1. Context of the Problem

Nestlé is one of the largest food companies in the world. Currently the company is facing an important challenge related to its inventory management. The goal is to reduce the average level of stock held by the company which can translate into stock cover reduction. Nestlé uses a Key Performance Indicator (KPI) designated Stock Cover used to quantify the levels of stock which must be reduced gradually until 2020. Currently the stock cover 27,8 days and it must reach 24,6 days by the end of 2017 and 23,1 by the end of 2018, always with an average service level of 99.1%. The ultimate objective is to reach the end of 2020 with 20 days of stock cover, this directive was given by Nestlé Swiss for all Nestlé worldwide, hoping that this decrease will reduce stock holding costs.

Nestlé currently has four major KPI's that are essential for evaluating the overall performance of the Demand and Supply Planning (DSP) department: Demand Plan Accuracy (DPA), Bias, Case Fill Rate (CFR) and Stock Cover.

In the context of this work, Stock Cover is one of the most important KPI, which is mainly used as a metric for analyzing the effectiveness of stock cover policies. Such Policies are defined by a minimum stock cover and a maximum stock cover per individual Stock keeping Unit (SKU). To avoid stock outs and over stock situations, the desired quantity of stock is somewhere between the minimum and maximum stock cover. The stock cover is commonly defined as the number of days (but it could be also months or weeks) for which finished goods at any given moment will last.

Currently the Supply Planners use a tool designated "Unbundlor" to define the stock cover policies. This tool is proprietary and was developed within the company. It is presently used worldwide by Nestlé, but because of confidentiality reasons, there is no detailed information about its characteristics. From past results, it is safe to say that the tool is very handy, since it combines historical data with demand projections and set several parameters automatically. However, the "Unbundlor" tends to overestimate what is needed, leading to cases of overstock. These are particularly bad for Nestlé Portugal since the warehouse has limited space and excess stock may implicate the need to rent an external warehouse (3PL), adding extra costs.

In addition, it's important to understand that it is only possible to reduce the inventory costs until a certain point without compromising the service level.

1.2. Main Objective and Methodology

The main goal of this thesis is to decrease the stock cover without jeopardizing the service level by optimizing the inputs of the tool Unbundlor. This tool uses a set of inputs to define the stock cover policies for each product. By analyzing the inputs and how these influence the output, it is possible to propose an improvement. Another important factor for Nestlé is that the service level cannot be compromised, this stock cover reduction cannot be at the cost of the service level because it is too important for Nestlé to keep customers satisfied with a service level of at least 99,1%.

In the fast-moving consumer goods industries in general, and in the food industry in particular, stocks of finished goods are tremendously important for the business to run efficiently. On the one hand, they make it possible to ensure a good service level to the customers, but on the other hand, they can be a major cause of financial and freshness issues. Excess of inventories are considered a liability as they tie up capital, use storage space, can deteriorate or become useless. In short, it is a waste that hides poor practices and does not add value.

As stated before, the Unbundlor is a complex and confidential tool that given a set of parameters will return the minimum stock level and that when combined with the human judgment of the Demand Planner the stock policies are set (minimum and maximum stock cover). Since the goal of this study is to reduce the average stock held by the company, the optimal scenario that DSP wishes is that by challenging the input data that is given to the Unbundlor the minimum stock cover level is reduced, without compromising the service level.

Being so, the methodology of the work to answer the research question and deliver what is required by DSP can be separated into 3 phases.

Phase 1: This phase is divided in three main points: definition of the objective of the study in question, characterization of the company and company structure, and State of the Art.

Phase 2: Data analysis and selection of critical categories to work on.

Phase 3: In this phase every SKU from the critical categories is analyzed and if possible, an improvement proposal is made.

In the first phase the problem is contextualized, along with a brief introduction to Nestlé Portugal and its history in Portugal and worldwide. Also, the structure of the company and its various businesses activities are explained. Then, the logistics and operations of Nestlé along with the most important KPI's for the DSP department are presented. And finally, the state of the art is done where subjects such as logistics, stock cover, supply chain management, inventory and so on are mentioned. In the second phase of the project all the categories are analyzed and only the more critical ones are selected for further study of improvement of the stock cover. In the third phase of the problem the SKUs from the critical sub-categories selected in the previous phase are analyzed and whenever possible, improvement proposals are made that reduce the stock cover. And finally, the conclusions are presented.

2. Nestlé S.A.

2.1. History Nestlé Globally

Nestlé's history began in 1866 when the Anglo-Swiss Condensed Milk opened the first factory in Switzerland, at the time it was the first factory in Europe. Henry Nestlé, founder of Nestlé, developed in 1867 an infant food called Farine Lactée and made milk-based nutrition the pillar of his business. From this year forward, a harsh competition began between the two companies which finally ended in 1905 when the Anglo-Swiss and Nestlé merged.

Some years later, World War I began, creating demand for milk-based products which Nestlé took advantage of and made huge government contracts. By the end of World War I, Nestlé's production had more than doubled with 40 factories worldwide. Later, World War II, was not as beneficial for Nestlé's business plans, since profits dropped from 20 million US dollars in 1938 to 6 million US dollars in 1939. Ironically, the decreasing profit lead to the rise of another product, Nescafé, which became a staple drink of the US military.

In the post-war period, prosperity rose and people were spending more money, so Nestlé took advantage of this situation and launched other products such as Nesquik. Moreover, this period was key for Nestlé's diversification. In those years, Nestlé acquired companies such as Maggi that enabled it to enter in the ready-made meals business. But the real diversification occurred when they became the major shareholders of L'Oréal and acquired Alcon Laboratories Incorporated stepping out of the food industry.

From the mid 70's to the mid 80's, Nestlé suffered the consequences of its aggressive marketing practices pushing for breast milk substitutes. Many consumers did not see this kindly and started to boycott the company's products. From this point forward, consumer attitude is part of any company's strategy. The boycott ended in 1974 when the company agreed to follow the International Code for the Marketing of Breast-milk Substitutes. Despite the boycott, Nestlé was able to keep growing and launched the Nespresso brand in 1986, and acquired Rowntree Mackintosh which brought brands like Kit-Kat and Smarties.

Since 1996, there have been various acquisitions such as San Pellegrino in the mineral water business; Spillers Petfoods and Ralston Purina that enabled the pet food industry. Furthermore, there were many more acquisitions that were very important like Novartis Medical Nutrition in 2007 and Kraft Foods frozen pizza business in 2010.

Consequently, Nestlé is the biggest food company in the world, with a market capitalization of roughly 247 Billion US dollars. The company has 447 factories in 86 countries worldwide, employs around 335 000 people, with a portfolio of more than 2000 brands that are currently sold in 189 countries.

(Nestlé, 2016a)
Moreover, Nestlé is recognized all over the world as a trusting company that assures quality and safety. They are the leading nutrition, health and wellness company.

2.2. History Nestlé Portugal

Nestlé Portugal SA has been in Portugal since 1933. Its establishment in our country was through Professor Egas Moniz who in 1923 created the first milk powder factory in Avanca, Portugal. That same factory was later awarded the exclusive right to produce and sell Nestlé products. Later, in the 50s Maggi products and Nescafé were introduced into the Portuguese market. In addition, Nestlé acquired facilities such as chocolate factory, coffee roasters and a yogurt producer. This allowed Nestlé to move production into the country and the creation of several business areas.

Since then, Nestlé has introduced products such as Nestea in 1994, Aquarel in 2001 and Nespresso in 2003.According to the corporate brochure in 2015, the turnover was 462.6 Million € and the share of turnover associated with exportation is 78 Million €, approximately 16% (Nestlé, 2016b).

In order to produce and distribute the products efficiently, Nestlé Portugal owns 3 factories, 1 Distribution Center and 5 Delegations to aid the various businesses. The main facility is the Distribution Center of Avanca (CDA), dedicated to Human and Animal Food Products.

All the businesses, factories and distribution centers are supported by a workforce of 1732 employees, and also managed by the headquarters of Nestlé Portugal,located in Linda-a-Velha, Oeiras (Nestlé, 2016b).

Currently Nestlé has several business areas: Infant Nutrition, Health science, Food Products, Out of Home, Beverages, Cereals, Pet Care, Nespresso, Waters, Davigel (Nestlé, 2014a).

Nespresso, despite belonging to Nestlé Portugal is an independent business and operates differently within the company.

2.3. Organizational Structure of Nestlé Portugal

Nestlé Portugal is fully owned by Nestlé Spain and managed from Barcelona, which is also fully owned by Nestlé Swiss in Vevey.

Management in Portugal is followed by the Steering Committee NiM (Nestlé In Market). The businesses are divided into global businesses and local businesses, and both participate in the committee.

As seen in Figure 1, departments such as Legal Services and Human Resources provide support across all businesses. (Nestlé, 2014a)

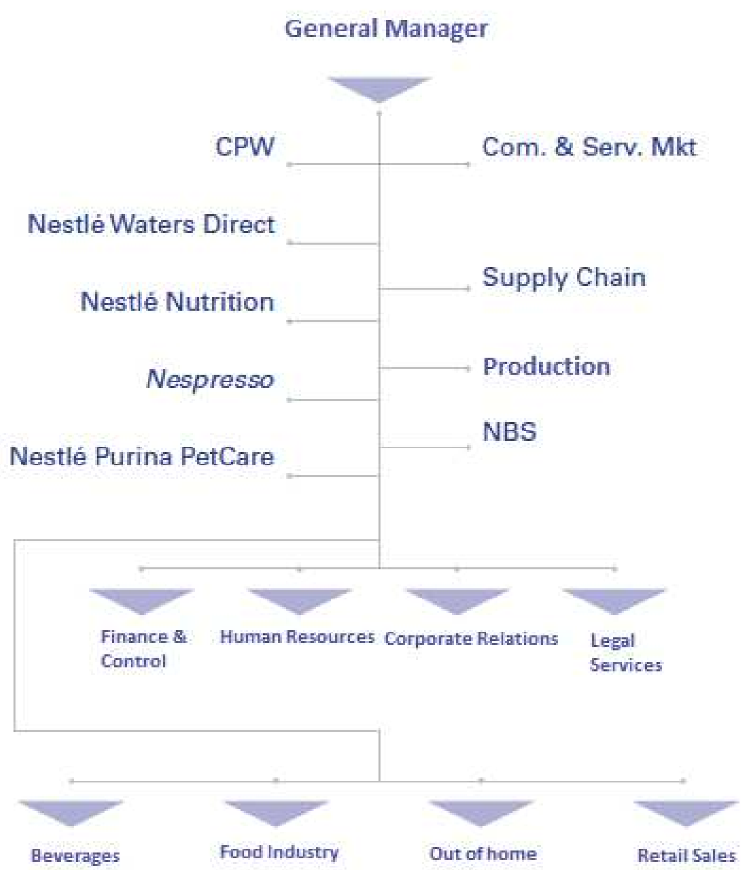

Figure 1 – Company Structure (Nestlé, 2014b)

This thesis will be done in the Demand and Supply Planning department of Nestlé Portugal which is currently coordinated by Miguel Calapez.

2.4. Businesses of Nestlé Portugal:

As previously mentioned, Nestlé Portugal is divided into several businesses areas: Infant Nutrition, Health science, Food Products, Out of Home, Beverages, Cereals, Pet Care, Nespresso, Waters, Davigel (Nestlé, 2014a). These businesses are connected to more than 2000 products in our market, and those numbers keep rising since Nestlé is always innovating, creating new products and finding new ways to satisfy their clients' needs.

The sales of Nestlé Portugal per business can be identified in Figure 2:

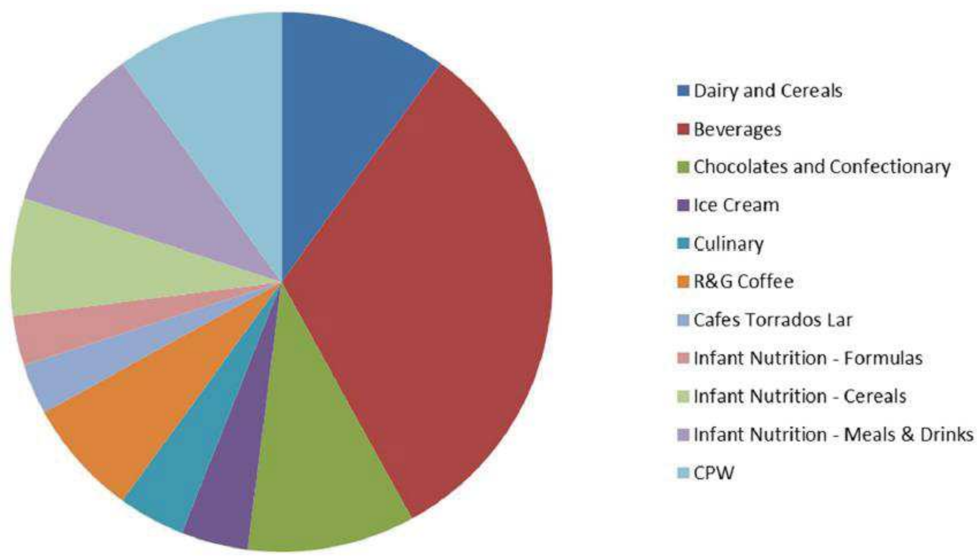

Figure 2 – Sales in 2014 (Nestlé 2015)

From Figure 2, a large portion of the sales in the Portuguese market are driven from the beverage business. This business includes products like: Pure coffee, Specialties coffee, Chocolate Based Products, Cereal Beverage with Coffee, and Coffee Capsules.

2.5. Logistics in Nestlé

As the number and variety of businesses has grown over time, the logistics operations have become more complex. The stress that currently exists in the supply chain is disadvantageous for long term solutions.
In order to maintain a satisfying service level, Nestlé logistics department turns to their own infrastructures and also to third-party logistics services (3PL) that are experts in storing and distribution.

Currently the logistics operations of Nestlé Portugal is divided into: Physical Logistics and Demand and Supply Operations.

2.6. Physical Logistics

The main goal of physical logistics is to manage operations in the distribution center and interactions between factories and delegations.

Nowadays Nestlé Portugal operates 3 factories in the following places:

- Porto- Dedicated to roasted coffee.
- Avanca- Dedicated to cereal beverages, breakfast cereal, infant cereal, cereal for the family, powdered milk, refrigerated cream, clinical nutrition, products related to restaurants.
- Lagoa- Dedicated to powdered milk and butter.

There are also 6 Distribution Centers and Delegations situated in Avanca, Porto, Coimbra, Carnaxide, Loulé and Funchal. The distribution operations of Nestlé Portugal are mainly centralized in Avanca, this being one of the most important facilities in Nestlé Portugal supply chain.

In figure 3 it is possible to see the location of all key facilities in our territory.

Figure 3 – Nestlé's facilities in Portugal (Nestlé, 2016b)

2.7. Demand and Supply Operations

As previously mentioned, the current work will be developed within the Demand and Supply Planning Department. This is the main department within the organization. This department is responsible for operations related with orders, stock management and shipping orders to customers. The objectives and functions of Demand and Supply Planning department are shown below. The figure shows a two-dimensional structure that is essential for comprehending the complexity of planning and managing the Demand and Supply Operations:

- Horizontally it is clear how the DSP interacts, from Customer to Supplier.
- Vertically the figure shows a time-frame, from execution (a few weeks), passing through Short-term and Tactical (months) to Strategic (years).

In addition, DSP has the responsibility to follow up planned implementation and deal with unforeseen situations as they unfold, in order to maintain the desired service level.

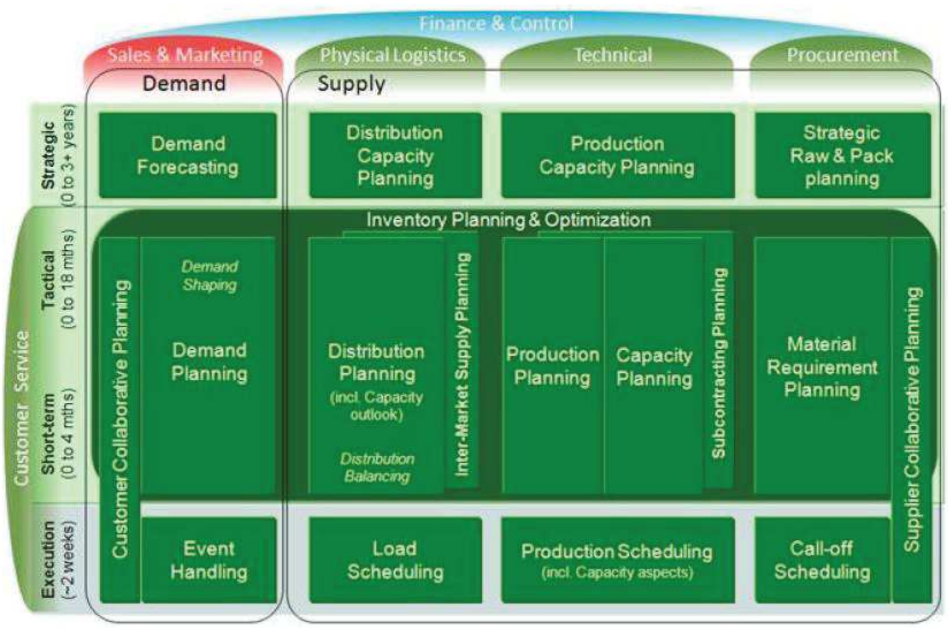

Figure 4 - Demand and Supply Structure (Nestlé, 2014b)

From figure 4, it is possible to identify two major areas – Demand Planning and Supply Planning.

1. Demand Planning- this area is treated by the Demand Planners of Nestlé, firstly an aggregated forecast is made for a period of 18 months being valid for a group of products, note that this forecast is updated every week. Secondly, a forecast for a shorter period of time is made, from 4 to 6 months, with better detail for each product allocated to one or more distribution center. This area also works with the marketing department in order to include possible promotions or external factors that might affect sales in the referred period.

2. Supply Planning- starting with production planning, which is an activity that is one level higher than distribution planning, the production must be planned considering the needs communicated by the Demand Planner. Production orders in the factory are conditioned by several factors such as the production cycle, minimum batches and raw material requirements. Regarding distribution planning, this activity is performed by the distribution departments at a national and international level, to guarantee that the products are available when and where needed. They have to consider the suppliers (factories) and the clients (stores or DC's at a lower level) of each Distribution Center, this way they aim at effectively distributing the products to maintain a certain service level.

There is a dedicated Supply Planner and Demand Planner for each business area. The Demand Planner sets up the projections of demand for each SKU and the Supply Planner defines the stock cover levels for each SKU fulfilling the needs established by the Demand Planner. In addition, the Supply Planner is responsible for developing efficient and effective responses to deviations of the planning scenarios.

It is important to note that the time scope of DSP planning is 18 months, but on a weekly basis, the forecasts are updated, and the existing plan adjusted to meet the stock cover levels defined.

In addition to this, Nestlé's DSP department utilizes the CAPDo approach to optimize the finished goods inventory. This technique is a well-known continuous improvement methodology that was adjusted to fit the inventory optimization needs of the company.

CAPDo methodology is divided into four steps:

1. **Check-** This step is about reviewing and identifying improvement areas in the stock cover, inventory freshness and stock service.
2. **Act-** Analyse the behavior of inventory components and drivers, and if possible identify opportunities to improve. The Unbundlor is very important in this step because it enables the creation of new stock policies when using the Unbundlor.
3. **Plan-** In this step a cross-functional action plan is designed with responsibilities, timelines and expected results defined.
4. **Do-** This is when the action plan is carried out, with improved control and evaluation of the performance considering stock cover, stock service and inventory freshness.

This approach covers all that is needed to improve the process of inventory management. The DSP managers have daily, weekly and monthly meetings in order to coordinate and solve problems that might emerge. The daily meetings, also known as DORs, cover problems with a maximum spectrum of 2 days. The weekly meetings, are also known as WORs, cover problems up to 7 days. The monthly meetings cover aspects with at least a month.

In figure 5, it is possible to see how does the CAPDo approach works.

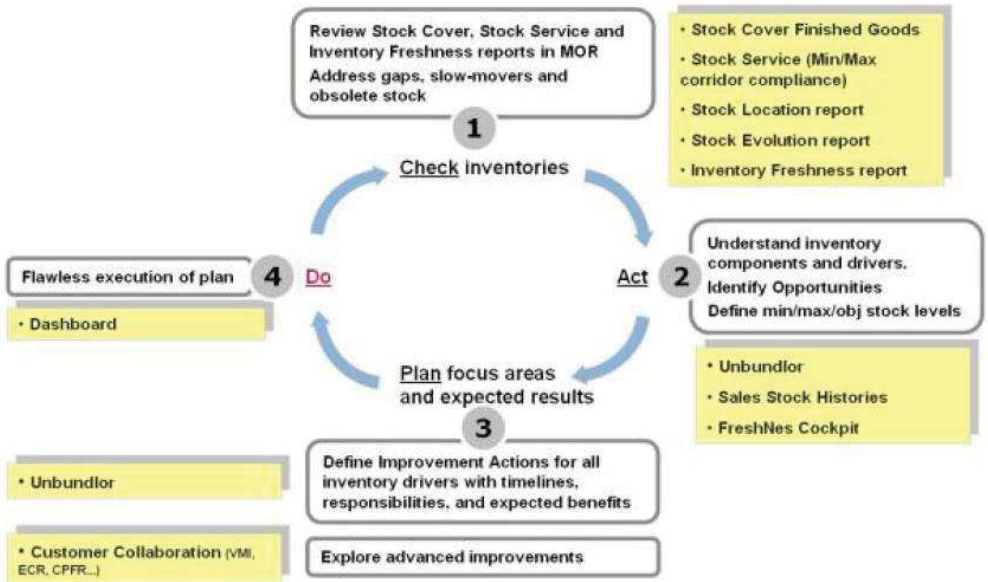

Figure 5 – CAPDo Approach (Macca, 2012)

2.8. Key Performance Indicators – KPIs

After understanding the demand and supply operations, it is important to have an idea of how Nestlé evaluates their own performance. This is done by using Key Performance Indicators which are used by Nestlé to evaluate and compare the performance of inventory management decisions which can help assess improvement areas. The major KPI's used by DSP department for managing inventory are presented next.

2.8.1 Stock Cover

This indicator is one of the most important because it helps to compare the actual level of stock in one period with the forecast of future sales. This indicator provides a simple way of identifying whether the existing stock is enough to cover the estimated demand in the near future.
There are two ways of calculating the stock cover:

$$Forecasted\ Stock\ Cover = \frac{Stock\ in\ Period\ n}{Forecasted\ Sales\ for\ Period\ n} \quad \textbf{(1)}$$

And,

$$Real\ Stock\ Cover = \frac{Stock\ in\ Period\ n}{Actual\ Sales\ in\ Period\ n} \quad \textbf{(2)}$$

Equation 1 is used to estimate the stock cover for when the sales are forecasted. Equation 2 is used to calculate the real stock cover for periods that have passed. This value is used for historical records. The stock cover is usually measured in number of days (but it could be also months or weeks) for which finished goods at any given moment will last.

2.8.2. Case Fill Rate (CFR)

This indicator represents the quantity of orders that were delivered to the client in due time, also called service level. The value of CFR indicator is expressed in percentage, varying between 0% and 100%. The higher the CFR, the higher the customer satisfaction. The formula for calculating this KPI is shown below:

$$CFR\ (\%) = \frac{Orders\ delivered\ to\ the\ clients}{Total\ number\ os\ orders\ received} \times 100 \quad \textbf{(3)}$$

2.8.3. Demand Plan Accuracy (DPA)

Demand Plan Accuracy is an indicator that represents and evaluates the quality of the demand plan, relating the actual sales with the forecast in the following manner:

$$DPA = \left(1 - \frac{\sum|Demand\ Plan - Actual\ Demand\ |}{\sum Demand\ Plan}\right) \quad \textbf{(4)}$$

This indicator is a perceptual measure of the reliability of the forecast, but it doesn't distinguish when the forecast is above or below the actual sales.

2.8.4. Bias

Bias represents the relative difference between forecast and sales, and as the DPA, it evaluates the quality of the demand plan. This indicator eliminates the limitation of the DPA as it indicates whether the forecast was over or under estimated. The formula for the Bias is as follows:

$$Bias = \left(\frac{\sum(Demand\ Plan - Actual\ Demand)}{\sum Demand\ Plan}\right) \quad \textbf{(5)}$$

2.9 Problem definition and Conclusions

Nestlé's ongoing search for improvements and efficiency provides directives to all Nestlé worldwide offices for better stock management. As previously stated, it is within the scope of this study to make a detailed analysis of the process of stock management by analyzing the main KPIs that have already been explained and by analyzing the software "Unbundlor" which clearly holds a very important role in achieving the desired improvement in terms of inventory management. The ultimate goal of this study is to contribute to the decrease the stock cover without jeopardizing the service level by optimizing the inputs of the tool Unbundlor. The desired scenario is that this decrease will help to reduce stock holding costs.

In this chapter a summarized description of the company was outlined, including its history and the logistics organization and operations. In addition, the problem and main objectives of the project were identified.

In order to obtain theoretical basis to complement and structure the analysis developed in this dissertation, in chapter 3 a literature review will be presented relating concepts that are important to stock management and the optimization of stock.

3. State of art

3.1. Introduction

This study is to be performed within the Demand and Supply Chain Department of Nestlé whose main activities are forecasting planning and managing stock. A literature review on these subjects will be included. Firstly, some general definitions on Supply Chain Management and stock management are presented, followed by a deeper analysis on stock related subjects such as stock policies, safety stock, lead time, forecasting and others.

3.2. Supply Chain Management

Before entering into inventory specific related issues, it is relevant to understand what the main functions of Supply Chain Management are, and how these relate to inventory optimization.

The concept of Supply Chain Management is defined by the Council of Supply Chain Management Professionals as "All activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers." (CSCMP, 2016)

The main purpose of Supply Chain Management is to enhance the operational efficiency, profitability and competitive position of a firm and its supply chain partners.

This definition is referred to a traditional Supply Chain Management, which could also be defined according to a set of inter-related business processes that work as an integrated system in order to:

1. Acquire raw materials;
2. Transform raw materials and parts into finished products;
3. Add value to these products;
4. Distribute and promote these products to either retailers or customers;
5. Facilitate information exchange among various business entities (e.g. suppliers, manufacturers, distributors, third-party logistics providers, and retailers);

(Min & Zhou, 2002)

Another concise definition of Supply Chain Management was given by Cooper et al. (1997) as "the integration of key business processes from end-users through original suppliers that provide products, services, and information and add value for customers and other stakeholders".

In addition to this, it is also important to understand what makes Supply Chain Management a difficult challenge today. Simchi-Levi et al. (2000) identified some key issues in Supply Chain Management:

- Distribution Network Configuration – "How should management select a set of warehouse locations and capacities, determine production levels for each product at each plant, and set transportation flows between facilities, either from plant to warehouse or warehouse to retailer, in such a way as to minimize total production, inventory, and transportation costs and satisfy service level requirements?"

- Supply Contracts – "What is the impact of volume discount and revenue-sharing contracts on supply chain performance?"
- Inventory Control – "The objective is to decide at what point to reorder a new batch of product, and the amount to order so as to minimize inventory ordering and holding costs."

3.3. Stock/Inventory Management

Companies keep inventory within the supply chain in order to cope with uncertain events that could occur (Waters, 2004). Before explaining inventory management, it is important to understand the difference between stock and inventory which are often used to refer to the same thing (Wild, 2002).

Thus, Inventory is a list of items that is held in stock, while stock is defined as the amount of goods that are being kept in a specific place (the warehouse, for example). Inventory management is mainly about specifying locations, size and placement of stocked goods so as to assure that supply chain activities don't run out of goods or supply (Van Den Berg et al. 2011).

Chu et al. (2008) emphasized that "the objective of inventory management is to make decisions regarding the appropriate level of inventory. In practice, all inventories cannot be controlled with equal attention."

Waters, (2004) defined inventory management as "function responsible for all decisions about stock in an organization. It makes decisions for policies, activities and procedures to make sure the right amount of each item is held in stock at any time."

Nowadays, all organization compete in global markets, so it is very important that companies offer a high service level, maintaining themselves competitive and profitable. According to (Zhaohui Zeng & Hayya, 1999) the two major functions of inventory are:

1. To provide support and physical inputs for manufacturing

2. To provide protection against uncertainties, such as discrepancies between demand and production, machine malfunctions, and human errors.

Also, it is agreed that holding stock is extremely expensive and for that reason the inventory should be managed as efficiently as possible (Zhaohui Zeng & Hayya, 1999).

Additionally, Simchi-Levi et al. (2000) identified four main reasons for holding stock across the supply chain:

1. Unexpected changes in customer demand.
2. The presence in many situations of significant uncertainty.
3. Lead times.
4. Economies of scale offered by transportation companies.

In supply chains of large companies, the number of SKUs (Stock Keeping Unit) that a company holds in inventory can easily reach thousands. For this reason, it is obvious that it is not possible to design an inventory management policy for each individual SKU. Furthermore, each SKU have different degree of importance for the company's business leading to different levels of management attention per SKU or group of SKUs (Chen et al. 2008).

Furthermore, a large number of items kept in stock complicate the process of controlling inventory (Mohammaditabar et al. 2012).

Finally, it can be said that an efficient and effective inventory management will ultimately help any company to develop and maintain a competitive advantage, especially in these times of accelerated globalization (Silver et al 1998).

Organizations would like to maintain a sufficient level of inventory for various reasons such as the need to manage sudden variation in supply and demand, exploit the economies of scale, and manage variation in price change, among many others. The study by Pong & Mitchell (2012) indicated a positive association of financial performance with improvement in inventory.

3.3.1. Optimization of Inventory/Stock

As stated above, the main objective of any company is to maintain a certain service level with minimum stockholding costs.

Wild (2002) identified three main components, order quantity, safety stock and lead time that if reduced, would lead to a drop in the average stock. The lowest inventory will result from receiving the same order size into stock as requested by the customers, hence it will be at minimum if the order size is small.

In addition, Chen et al. (2008) stated that efficient and effective inventory management helps a firm maintain competitive advantage, especially in a time of accelerating globalization. In large firms, the number of SKUs can easily reach thousands and for that reason it is important to create and sort the SKUs into groups according to the importance each SKU has for the firm. This process is called classification of inventory.

3.3.2. Classification of Inventory – ABC analysis

An important notion about inventory management is that not every product has the same degree of importance for the company, either in terms of money invested, profit potential, sales or even turnover ratio (Chen et al., 2008). Therefore, it is very important to classify the products amongst the supply chain.

The most used method for classification of SKU is the ABC method. According to Chen et al. (2008), this method is based on annual dollar usage, reflecting the principle that a small proportion of SKUs accounts for a majority of the dollar usage. Since the ABC classical analysis is based on Pareto's famous observations on the uneven distribution of income, it is also known as Pareto analysis. He also stated that "because of its easy-to-implement nature and remarkable effectiveness in many inventory systems, this approach is still widely used in practice."

In this method the SKU's are divided in classes (A, B and C). Ramanathan (2006) explained the ABC analysis as follows:

- Class A items- relatively few in number but representing a relatively large amount of annual use value; these types of items need to be tightly controlled and closely monitored in order to avoid stock outs.
- Class C items are relatively large in number but represent a relatively small amount of annual use value, these items are less crucial for the performance of the supply chain.
- Class B items are between the above two classes.

Wild (2002) studied the relation between ABC analysis and the stock cover indicator and he concluded that "using ABC and stock cover together saves time and money".

3.3.3. Inventory Management policy

Some researchers have studied the relation between inventory policy and each class of SKU and found that it's appropriate to set different policies for different classes.

The inventory policy selected differ on how often the inventory is checked (Cardos et al. 2009). These policies trigger the replenishment process and must be adjusted to the products and business considered. According to Estellés-Miguel et al. (2012), inventory management policies with random demand are divided into two main categories: continuous and periodic review.

According to the continuous review (also called reorder point policy or fixed order quantity policy), the inventory level is monitored in an almost continuous way. The replenishment order is made when the inventory level reaches a specific level. In addition, the quantity of order (order-up-to-level) is calculated from the difference between the initial quantities of stock minus the level of stock that triggered the replenishment order.

According to the periodic review (also called reorder cycle policy), the stock level is kept under observation periodically, which means that from time to time the level of stock is checked and one of two scenarios may occur:

Scenario 1: The stock is above the re-order level, so no new orders are made.

Scenario 2: The stock is under the re-order level; a new order is made in such a way that the stock level is back to maximum.

It's important to note that the safety stock for the periodic review policy is higher, however this policy does not require continuous monitoring of inventory. (Ghiani & Laporte, 2004)

On the one hand, Eynan & Kropp (1998) defended that periodic review policies allow cost savings through the coordination of the replenishment of several items. On the other hand, Yeh & Chang (1997) assume that continuous review policy is necessary in order to maintain an adequate service level. Furthermore, Rao (2003) stated that if the lead time is small, the continuous review policy is more efficient and can be managed without much stock. In addition, most inventory management models are based on assumptions rather than on a restrictive view (Silver et al., 1998).

In the case of Nestlé, the main focus is to achieve almost 100% service level. A stock-out scenario is not really an option because it will imply a loss and can damage the image of the company. In addition, an excess stock is not ideal, so a compromise must be reached in order to achieve maximum efficiency.

3.4. Demand Forecasting

As stated before, one of the main reasons for holding stock is due to changes in demand. Almost every company uses forecasting techniques to increase customer satisfaction.

Demand forecasting is essential for all organizations these days, since it helps to anticipate what is likely to happen in the future in terms of sales, plus it is an important tool in managing stock and planning production. Ultimately demand forecasting gives the company a competitive advantage. The activity of forecasting involves knowing historical data and market trends, and knowing the lifecycle of the product. Forecast is generally a monthly or weekly estimative of the demand per SKU. (Bowersox et al. 2002)

Stevenson (1999) identified six basic steps of the forecasting process:

1. Determine the purpose of the forecast- it will provide an indicator of the level of detail required in the forecast.
2. Establish a time horizon.
3. Select a firecasting technique.
4. Gather and analyze the appropriate data.
5. Prepare the forecast.
6. Monitor the forecast- monitoring is important to determine whether it is performing in satisfactory manner.

In addition, demand planners should always consider the forecast rules gave by Simchi-Levi et al. (2000):

- Forecasting is always wrong
- The longer the forecast horizon, the worse the forecast
- End item forecasts are even more wrong

These three rules are an inherent part of the forecasting process, since nothing is guaranteed when predicting future sales.

“It should be noted that when a forecasting process is based on appropriate techniques and extensively used for decision-making within the company, it is usually recognized by all functions as a crucial process for achieving a competitive advantage and, consequently, functions are more motivated to align their decisions and plans with forecasts provided by their company, rather than elaborating their own forecasts. The consequent effect is that of reducing costs.” (Danese & Kalchschmidt, 2011).

3.4.1. Forecasting Uncertainties

Holding stock is a way of coping with uncertainties related with sales, but holding finished products can be very expensive in the long run. Slack et al. (2009) explained two techniques that if used properly can help to cope with uncertainties related with forecasts:

1. Level Capacity Plan- This method ignores fluctuations on the demand and maintains a certain level of production constant. If the products are not sold after the production, they are kept as stock and used to anticipate future fluctuations. This technique has the advantage of maintaining a stable workforce, utilizing almost all the resources, maintaining the production costs low. The disadvantages are related with huge amounts of stock to avoid ruptures. It is very difficult to satisfy the demand when it is higher than the production capacity.
2. Choose demand Plan- This method tries to adapt as much as possible to the variations of the demand, by changing the workforce, increasing and decreasing work hours and the amount of equipment used. On the one hand, the stock level is reduced and the flexibility increases, on the other hand, this technique may not be capable of handling sudden rises in demand due to lead times. This method is suitable with a production strategy that aims at minimizing or even eliminating the stock of finished products (Slack et al., 2009).

Most of the organizations do not adopt a single method but a mix of the two. No one can really prove that one method is better than the other, or even ideal for one type of company which makes aggregate planning an extremely challenging and difficult task (Jay Heizer & Barry Render, 2016).

3.5. Safety stock

Most of the organizations hold safety stock, also known as buffer stock, to minimize the possibility of a stockout. "Stockouts occur because of the uncertainties in both demand and lead time." (Coyle et al., 2009).

Wild (2002) also emphasized the importance of ensuring that the safety stock is sufficient to provide the service required and not more. "Achieving a higher availability level than necessary is very expensive." Furthermore, the safety stock can be reduced by negotiating shorter lead times, although this requires collaboration and accurate forecasting in order to make items available by the demand date with shorter lead time.

As this component is an important aspect within our work, different methods to calculate the safety stock were studied. These account for uncertainties in the demand and lead time. The main approaches are characterized below.

3.5.1. Determination of safety stock by Schönsleben (2004):

This author suggests that there are three techniques for calculating safety stock, depending on the nature of the item.

Table 1 (Schönsleben, 2004)

Technique	Safety stock	Typical use
Fixed	Set (manually) quantity	New and old items, discontinuous or lumpy demand patterns, inexpensive items
Time period	Determine by forecasts for future periods	Critical components, new and old items, discontinuous or lumpy demand patterns
Statistical	Calculate via statistical method based on history	Mature items, continuous or regular demand patterns, deviations in predictable range

In Table 1, the Fixed and Time period are mainly intuitive and for that reason will not be explained. The statistical derivation uses formal techniques to compute the safety stock, either Normal distribution or Poisson distribution. In both cases the safety stock can be computed as indicated below:

$$Safety\ stock = Safety\ Factor\ \times Standard\ deviation\ of\ the\ demand\ during\ lead\ time \quad \textbf{(6)}$$

Where,

$$Safety\ Factor = g \times (Service\ Level) \quad \textbf{(7)}$$

$$g = inverse\ function\ of\ the\ integral\ distribution\ function\ chosen$$

And,

$$Standard\ deviation\ of\ the\ demand\ during\ lead\ time = \sqrt{\frac{lead\ time}{length\ of\ the\ statistic\ period}} \times standardard\ deviation\ of\ the\ demand\ during\ the\ statistic\ period \quad \textbf{(8)}$$

In addition, it is important to consider the coefficient of variation (the quotient of standard deviation and mean value), because if it is under 0.4 the demand can be defined by a Normal distribution, and if it is over 0.4 the demand is often defined by a Poisson distribution.

3.5.2. Determination of safety stock by Thomopoulos (2013):

According to this author there are two main methodologies for calculating the safety stock: the Service Level method and the Percent Fill (PF) method. In both methods the safety stock is calculated by:

$$Safety\ Stock = k\sigma\sqrt{L} \quad \textbf{(9)}$$

Where σ is standard deviation of the one month forecast error, k is the safety factor (obtained from the Normal Distribution Tables), and L is the lead time in months. The only component that is affected by the forecast accuracy is the standard deviation.

With the Service Level method, by defining the service level required, the value for k can be easily obtained in the Normal Distribution Tables.

The Percent Fill method determines the safety stock with the normal distribution of demand as follows:

$$PF = (Demand\ Filled)/(total\ demand) \quad \textbf{(10)}$$

The Percent Fill method is very similar to the CFR used by Nestlé which is one of the most important KPIs for the company because it translates in customer satisfaction.

The PF is set by the manager as an objective and the safety stock is calculated taking that objective into account. After setting the PF, it is necessary to establish for each SKU: monthly forecasts of demand, F, the lead time in months, L, the standard deviation of the one month forecast error, σ, the order quantity, Q, the months-in-buy (or period of months between orders), M, and the forecast of demand during the lead-time, F_L.

When the Percent Fill method is used, the formula to find the safety stock is not as straight forward as in the service level method. The key is to calculate the $E(z > k)\ \sigma_L$ which is the expected demand exceeding the order point (OP) during the order cycle (OC). This parameter can be calculated by the following equation:

$$E(z > k)\sigma_L = (1 - PF) \times Q \quad \textbf{(11)}$$

The safety factor that can be obtained from the Normal Distribution Tables using the results of the expected demand, E(z > k), derived from the formula above.

Another way of estimating the E(z > k) is by considering the accuracy of the forecast which directly impacts the safety stock. Also called coefficient of variation, the accuracy of the forecast is defined by the following:

$$Coefficient\ of\ Variation = \frac{\sigma}{F} \quad \textbf{(12)}$$

Where σ is the standard deviation of the one-month ahead forecast errors and *F* is the average one-month forecast. A high coefficient of variation translates into inaccurate forecasts, so more safety stock is required. The other way around is also valid. So the E(z > k) can be calculated as follows:

$$E(z > k) = \frac{(1-PF)\times M}{\sqrt{L}\times Coefficient\ of\ Variation} \quad \textbf{(13)}$$

Having said this, the expected demand varies with PF, *M* Coefficient of variation and *L* which leads to a safety factor, *k*, and therefore the safety stock can be calculated.

It important to note that the Normal Distribution Tables gives negative values for *k*, and for that reason whenever E(*z* > *k*) > 0.4, *k* should be set to zero which translates to no safety stock needed. (Thomopoulos, 2013)

3.5.3. Determination of safety stock by QuickMBA (2010):

There are lots of ways of calculating the safety stock. There is no right or wrong way, only formulas and more or less appropriate equations, depending on the type of business and items under consideration. For example, QuickMBA uses a different approach to calculate the safety stock. First calculate the standard loss function, designated as L(z). This function is dependent on values of the desired fill rate *f*, the demand μ and its standard deviation σ, the time between orders p, and the replenishment lead time *l* :

$$L(z) = (1 - f)\ \mu \frac{p}{\sigma}\sqrt{p + l} \quad \textbf{(14)}$$

Once the L(z) is known, *z* can be found in Standard Normal distribution and the safety stock can be calculated by (QuickMBA, 2010):

$$Safety\ Stock = z\ \sigma\sqrt{p + l} \quad \textbf{(15)}$$

Despite the different ways of calculating the safety stock, there is one component that is present in all with significant weight, the lead time.

3.6. Lead time

Lead time is an important component in every business and has a significant impact on the safety stock. It can be described as the necessary time to deliver an order or render a service (Stevenson, 1999). Lead time is not only associated with the process of orders but also with production and distribution (Amini & Li, 2011).

Ben-Daya & Raouf (1994) stated that in many situations lead time can be reduced at an added cost and this reduction also allows for an improvement in the responsiveness of production and a reduction of the safety stock.

Many researchers have studied a problem that is related with the lead time called bullwhip effect. This is the name given to the variability in the ordering patterns which increases as we move upwards in the chain, from the customer to the factory and the suppliers (Garcia et al., 2012). This phenomenon is aggravated by longer lead times which cause inefficiencies in the supply chain as the stock increases in the buffers. This increase in stock is seen as a kind of a protection against the variability in demand (Sucky, 2009).

On the one hand, Lee et al. (1997) presented four main sources that cause the bullwhip effect:

- Demand forecast updating
- Order batching
- Price fluctuation
- Rationing and shortage gaming

On the other hand, Sterman (1989) said that the bullwhip effect is mainly caused by participants' tendency to under weigh inventory in the supply line. That is, participants place orders in one period, but do not account for them in their inventory calculations when placing orders for the next period. Thus, inventory that has been ordered but not yet received (i.e., is in the supply line) is under-weighted in the decision of further orders.

Despite there being several methods studied and proven as capable of reducing the bullwhip effect, Dejonckheere et al. (2003). Who have concluded that an order-up-to system will always give origin to this unwanted effect, and therefore, it is only possible to mitigate, not avoid.

Furthermore, Lee & Schwarz (2009) have stated that "the cost impact of lead time reduction can be very large. In our computational study the total costs were reduced 24.7% on average, compared with no-effort case."

3.7. Stock Cover

As this study's main purpose some improvements in order to reduce the stock cover of Nestlé's, it is important to understand what stock cover is and why it is an important tool. Stock cover measures the length of time that inventory will last if current usage continues. (Materials Management, 2016)

Wild (2002) defined stock cover as "the time in which the stock will run out at average usage rate."

$$Stock\ Cover = \frac{Current\ Stock}{Forecast\ Annual\ Usage} \times 365 \quad \textbf{(16)}$$

The stock cover could be measured in days (365), weeks (52) or months (12), depending on the type of product and company.

Atanasov et al., (2014)defined stock cover as a key performance indicator that calculates the number of days of forecasted consumption which the current stock level can face. This indicator's main purpose is to determine priorities for the replenishment of certain products/goods, indicating when to produce or purchase orders.

It is however important to note that stock cover should be used for analysis, but not for control. Besides being a crude analysis tool for each stock item, stock cover is also an important metric for measuring the total inventory. (Wild, 2002)

The controlling inventory's main purpose is to instigate stocks to reach appropriate levels. According to Wild (2002) the main factors that influence the stock cover levels are: lead time, average demand rate, variability of demand, supply frequency, customer delivery time allowed, reliability of the supplier, criticality of the item, and item availability from other sources.

Atanasov et al. (2014) has identified three different ways of measuring the stock coverage expressed through three different (Stock Cover) StC indicators:

(1) Based on historical sales:

$$\mathrm{StC}(1) = \frac{\text{Inventory on Hand}}{\text{Average Monthly Historical Sales}} \quad \textbf{(17)}$$

(2) Based on sales plan:

$$\mathrm{StC}(2) = \frac{\text{Inventory on Hand}}{\text{Average Monthly Sales Plan}} \quad \textbf{(18)}$$

(3) Based on revised sales plan (Last Estimation):

$$StC(3) = \frac{\text{Inventory on Hand}}{\text{Average Monthly Last Estimation Sales}} \quad \textbf{(19)}$$

StC(1) is the projected stock cover when considering past sales of the considered product. StC(2) is the projected stock cover when considering what the company expect to sell of the considered product. StC(3) is the stock cover according to last estimations of sales, this indicator is the closest to the real stock cover. All of which are subjected to large deviations in planning frequency and launching orders for procurement or production, which directly affects costs and the competitiveness of enterprises. (Atanasov et al., 2014)

3.8. Conclusions of the State of Art

During my research, the State of the Art faced several issues related with the proprietary nature of the Unbundlor and for that reason was not mentioned in the literature review. Extra care was required in the selection of what to investigate so as to avoid including inapplicable data. The review was then made to understand the current challenge that Nestlé is facing.

Taking into account the problem that Nestlé is facing, in the present chapter the main subjects that directly affect the stock cover were analyzed. These were presented along with the primary concepts, as well as a literature review based on the work performed by the scientific community.

Before entering into specific inventory related issues, it is relevant to understand what the main functions of the Supply Chain Management are and how it relates to inventory optimization. The literature review on this subjects helped in identifying the important aspects that are related to the problem at hand, moreover it helped to understand the factors that might be enhanced so as to achieve a better performance of the stock management.

Following this, the ABC method was then presented. This is an important subject related with inventory classification which, if done correctly performed, helps to save time and money, and ultimately to control the stock in a more efficient way. This method groups the items into classes according to the degree of importance they have for the company. Still related to this subject, are the inventory policies which are mainly divided in periodic and continuous review, basically these policies help decide when to order or what quantity of product to order. The optimization of this process could enhance the operational performance and consequently a reduction of operational costs.

What follows next in the analysis are the demand forecasting process and common uncertainties associated. Forecasting is essential for organization. It helps to anticipate in order to manage stock and plan production in a proper way.

Moreover, three different approaches for calculating the safety stock were analyzed. Determination of safety stock is a very important topic for stock policies that motivated the work of several researchers.

The safety stock minimizes the possibility of going out of stock which could occur due to uncertainties in demand or lead time. The latter plays an important role in the performance of the supply chain. A reduction of the lead time will not only increase customer satisfaction, which is very important for Nestlé, but also reduce the safety stock.

In the last section of the literature review, the stock cover indicator and the main factors that influence it were presented. The reduction of the stock cover is the main purpose of this work, so this section is essential for an understanding of the relevance of this indicator. Summarizing, the indicator calculates the number of days of forecasted consumption which the current stock level can face.

The research contributions of the following steps of this study support a methodology of a proprietary system – Unbundlor – to investigate its possibilities for improvement.

4. Selecting Critical Categories for analysis

As previously stated, the objective of this project is to reduce the average stock cover of Nestle Portugal. To do that, it is important to select the most relevant SKUs within a specific business. To accomplish this objective, data analysis on all the products produced last year will be performed. The analysis will include average stock cover and quantity of stock held in PUMs (Planning Unit Measure). A PUM is a package of products (SKU) which, for logistic purposes has the same identification number. A PUM of a particular SKU always has the same number of items.

4.1. Data Gathering and Analysis

The data analyzed were produced in the year 2016. The excel document was developed through the Sales and Stock History, a tool used at Nestlé for data analysis, and contained information such as: Stock Level, Sales, Calculated Stock Cover, Projected Stock Cover, Minimum Cover, Maximum Cover, Average Stock Cover, Average Projected Stock Cover.

The analysis was only done for 2016, since in the previous years there were products and sub-categories that were allocated to different categories, and for that reason it is not possible to compare.

4.2. Analyzing Stock

The data involved 2619 products. Due to the high number of products, a selection of some was made in order to identify the products' critical business and category. In table 2 it is possible to see an example of a list of products under analysis.

Table 2 – List of Products (example)

Product Code	Business/Category	Avg Stock (PUMs)
12307066-3551	Beverages	44393,80392
12281713-3551	Beverages	34017,21569
12287660-3551	Food	33918,13725
12250049-3551	Beverages	22215,86275
12275897-3551	Food	22015,2661
12269798-3551	Beverages	20618,5098
12256662-3551	Nutrition	20081,27451
12089916-3551	Beverages	18613,93463
12257258-3551	Nutrition	18415,90196
427584-3551	Food	14854,60784

The first column of Table 2,"Product Code" identifies which product is being referring to. The second column, "Business/Category" indicates in what category the products are allocated. Finally, the last column shows the average stock per week in PUMs of each Product. Six major Categories: Beverages, Food, Nutrition, Out Of Home (OOH), Nutrition and Petcare.

The graphic showed in figure 6 is obtained by grouping the Average Stock in PUMs in 2016 into six major categories and indicates how the stock within Nestlé Supply Chain is distributed per category. Each category has its own objectives every year in terms of stock cover, and all the categories combined are supposed to reach a specific target that is previously set up.

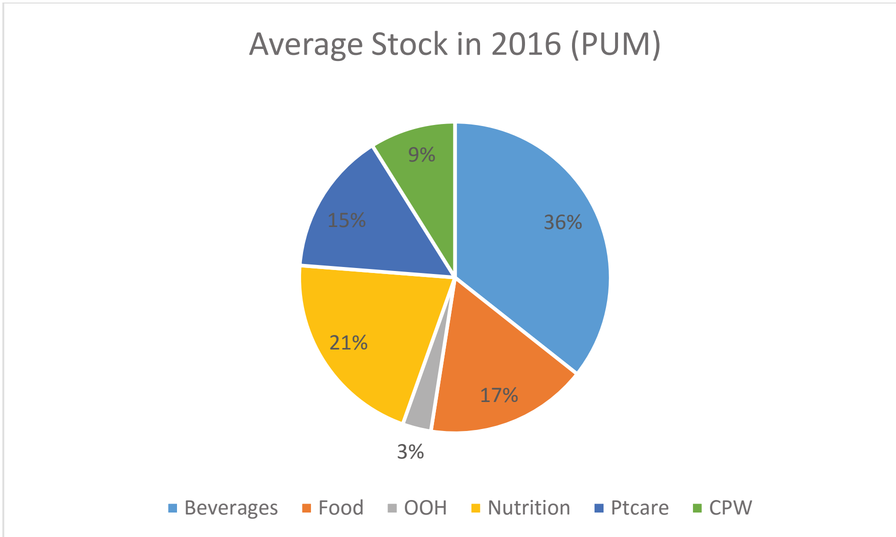

Figure 6 – Average Stock in 2016 in PUM

In Table 3 it is possible to identify what the objectives for 2016 were, what was the real stock cover, the average number of pallets for each category and new targets for 2017 - **NIM stands for Nestlé In Market,** which is basically **all the categories combined**.

Table 3 – Target Stock Cover VS Real Stock Cover

	Target Stock Cover 2016	Real Stock Cover	Target Stock Cover 2017	Average Pallets
Beverages	24	24,7	22,4	10 073
Food	31,7	32,6	29,3	5 997
Out Of Home (OOH)	27	25,5	23	2 526
Nutrition	33	31,5	30	5 133
Petcare	38	39,5	33,5	9 536
Cereal Partner WorldWide (CPW)	24	25,8	23	9 058
NIM	**28,5**	**27 ,8**	**24,6**	**42 323**

From Table 3 it is possible to note that Beverages is the category that uses more pallets and which didn't reach its objective for 2016. It is also important to note that the number of pallets does not represent the average stock; i.e., one pallet of Petcare products has only a few PUMs while one pallet of Beverages has hundreds of PUMs. The Real Stock Cover is calculated by **Equation 2.**

There are both individual targets and an overall target that combines every category. As previously explained, an average Stock Cover target for 2017 was set for Nestlé Portugal. This target represents the NIM Stock Cover target. This NIM Stock Cover Target was then desegregated in the different categories and sub-categories and given to different Demand Planners and Supply Planners, each one having their own different objectives but working for the same goal. After crossing the values from Figure 6 and values from Table 3, the following graph is obtained:

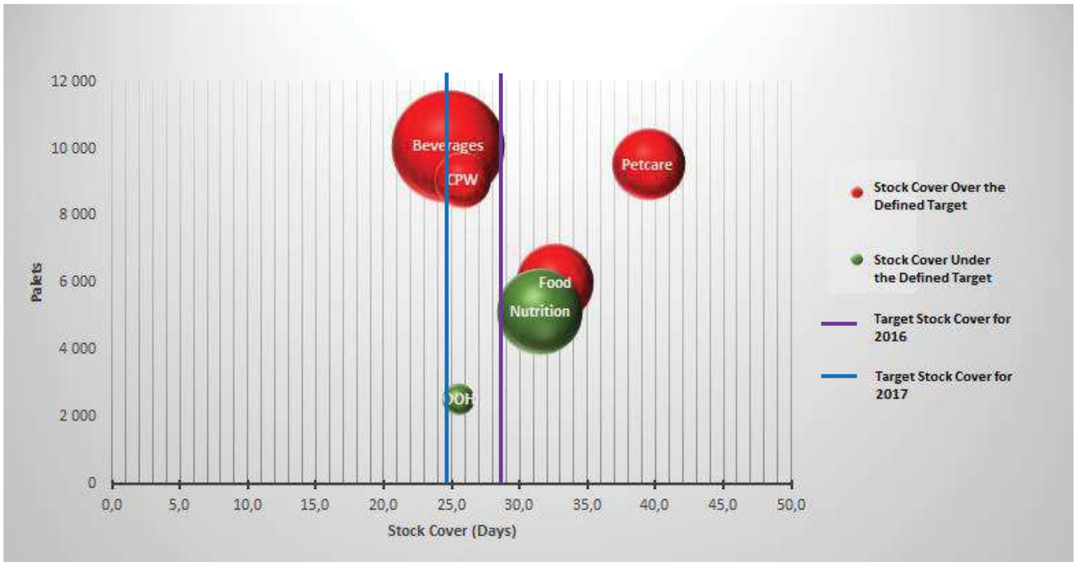

Figure 7 – Positioning of Each Category in 2016

Figure 7 shows how each business is positioned in terms of stock cover relating it with the NIM Target Stock Cover (purple line). Each ball is as big as the percentage of average stock that each category has. If real stock cover is below the target the ball is green, and if it is over the target, the ball is red.

From the data analyzed and by suggestion of Nestlé, the criteria for selecting categories and sub-categories to work in more detail is if the category and/or sub-category is over the Stock Cover Target in the year 2016.

For this case is possible to conclude that:

Conclusion 1: OOH is the smallest business with fewer pallets and the stock cover is within the target. For these reasons, the products of this category will not be further analyzed.

Conclusion 2: Nutrition represents 17% of the average stock and it is within the stock cover target. For these reasons it will not be further analyzed.

Conclusion 3: Beverages, CPW, Petcare and Food are the categories that had more stock related problems, and potentially classify for analysis. Below it is justified if they are going or not to be considered.

However, for the Petcare category the reason for having such a high stock cover is because all products from this category are imported from the United States and the United Kingdom. The lead times of this type of products are then very high, so the stock on hand must be higher in order to fulfill changes in demand. Consequently, as suggested by Nestlé, Petcare should not be the focus of this studies since: Petcare is managed by a totally different department independent from the DSP department; there is very low flexibility because the factories are not national, Portugal represents a very small business compared to other countries; and there is very low flexibility in transit time between factories and Portugal. In addition, CPW will not be considered for the analysis due to the fact that Nestlé does not establish targets for its different sub-categories.

In consequence, the categories that are going to be analyzed are **Beverages and Food**. To find out what products within each category are an issue for Nestlé, the next step in this analysis will consider the decomposition of each category into sub-categories. The only category that will not be decomposed is CPW because Nestlé Portugal doesn't establish targets for its different sub-categories.

4.2.1. Analyzing Beverages:

Grouping the Average Stock in PUMs in 2016 into the sub-categories of Beverages figure 8 is obtained:

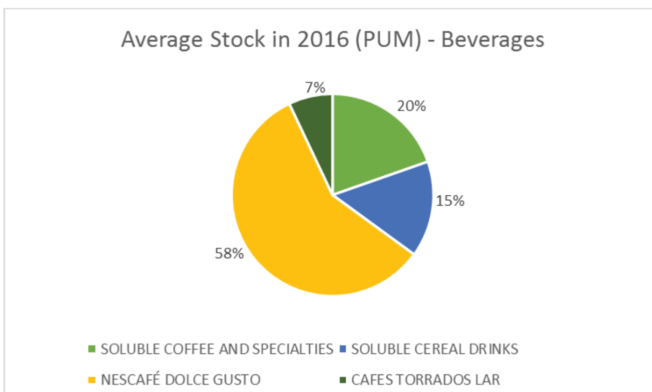

Figure 8 – Average Stock in 2016 (PUM) - Beverages

From table 4 it is possible to observe the target for the stock cover in 2016 for the category of beverages (and respective sub-categories) in 2016 (and 2017), compared with what really happened; besides, it is possible to see the average number of pallets of each sub-category.

Table 4 - Target Stock Cover VS Real Stock Cover (Beverages)

	Stock Cover Target 2016	Stock Cover Real 2016	Stock Cover Target 2017	Palletts
Beverages:	24	24,7	22,4	10111
Soluble Coffe and Specialties (SOL COF)	38	33,9	23,5	1556
Soluble Cereal Drinks (SOL CER)	25	28,5	23,5	2463
Nescafé Dolce Gusto	20,5	22,1	19,5	4811
Roasted Coffee Home (RC H)	23	22,2	21	1281

When crossing Figure 8 with Table 4, the following graph is obtained:

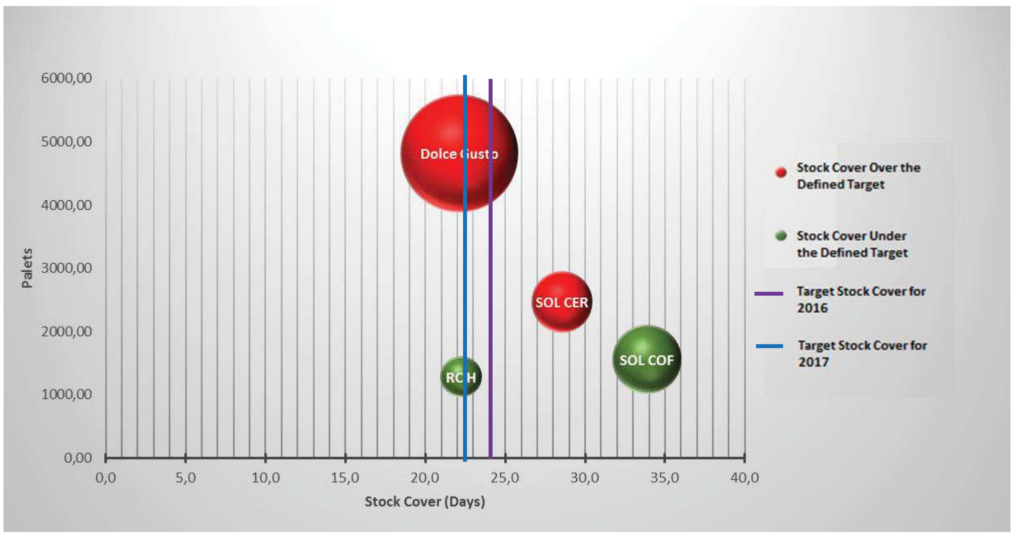

Figure 9 – Positioning of Each Subcategory (Beverages)

Figure 9 shows Dolce Gusto and Soluble Cereals as the sub-categories for Beverages that reached levels over the target for 2016 and so which are going to be selected for further analysis.

4.2.2. Analyzing Food:

Grouping the Average Stock in PUMs in 2016 into the sub-categories of Food, the following graph is obtained:

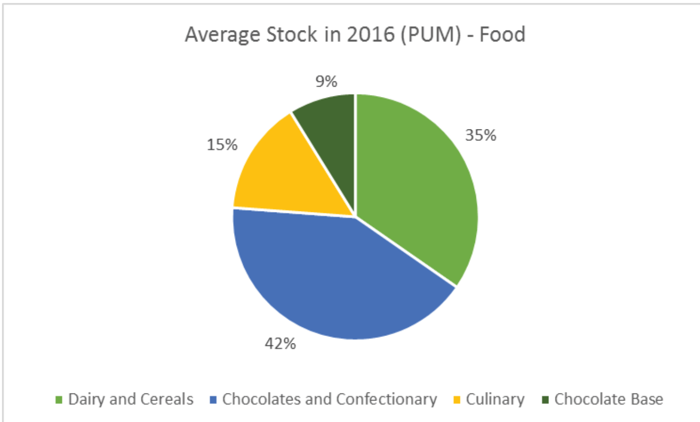

Figure 10 – Average Stock in 2016 (PUM) - Food

From the following list it is possible to observe the target for stock cover in 2016 vs what really happened; it is also possible to identify the average number of pallets.

Table 5 - Target Stock Cover VS Real Stock Cover (Food)

	Stock Cover Target 2016	Stock Cover Real	Stock Cover Target 2017	Palletts
Food:	31,7	32,6	29,3	7117
Dairy and Cereal (D & C)	31	33,3	29	4057
Chocolate and Confectionary (C & C)	32	31,8	29	1413
Culinary	38	35,9	32	710
Chocolate Base (CHC Base)	29	29,1	26,1	937

Which generates the following graph:

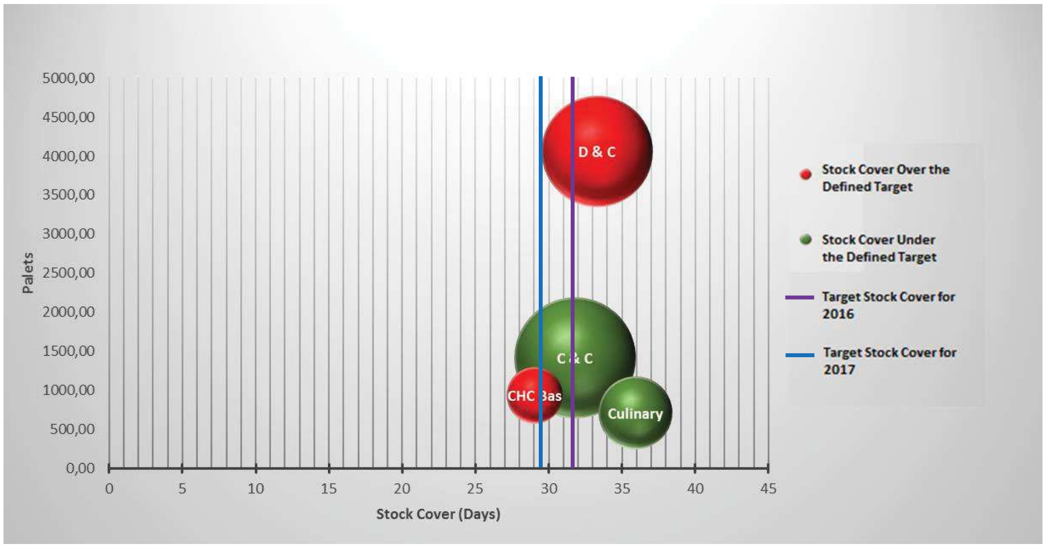

Figure 11 - Positioning of Each Subcategory (Food)

Figure 11 shows that Dairy and Cereal (D & C) and Chocolate Base (CHC Base) are the sub-categories from Food that were over the target in 2016 and which are going to be selected for further analysis.

4.3. Conclusions of Selected Categories for analysis

After analyzing all categories of Nestlé Portugal, it was easy to see that the ones that didn't meet expectations and had high volume of stock and pallets were Beverages, Petcare, Food and CPW. Petcare is not being focused on in this study for the following reasons: Petcare is managed by a totally different department independent from the DSP department; there is very low flexibility because the factories are not national and for them, Portugal represents a very small business compared to other countries; and also due to very low flexibility in transit time between factories and Portugal. Beverages and Food were then broken down into sub-categories in order to find out where the real problem was. CPW cannot be broken down because Nestlé Portugal doesn't establish targets for its different sub-categories. After breaking down Beverages and Food, the performance of each weighted sub-category was then compared to the defined target. From this analysis the following sub-categories were over the target and are selected for further analysis: **Dairy and Cereal, Chocolate Base, Nescafe Dolce Gusto and Soluble Cereal Drinks**.

5. Understanding Stocks and the tool Unbundlor

In the following section, the different components of stock are explained ant the purpose of each stock are defined. Following the next section, the calculation process, how the Unbundlor interacts with the user and what data is required by the system.

5.1 Understanding Finished goods stock

Before understanding the finished goods stock, it is important to acknowledge the different types of inventory within a supply chain. These are divided into: raw materials, products in process, purchased parts and supplies, components parts and finished goods. In the scope of this work only finished goods are taken into account. The finished goods stocks can be divided into several components: pipeline Stock, safety stock, cycle stock and build stock (Macca, 2012). From figure 12, it is possible to see how the different stock components may change over time.

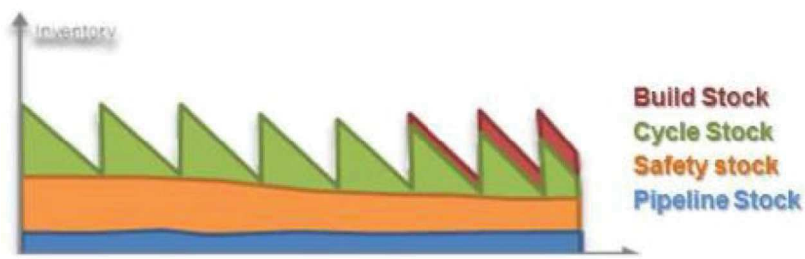

Figure 12- Finished goods components (Neguyen 2014)

Pipeline Stock (Blue color) – Stock that covers products that are still in production, transportation or incubations for quality tests. These products are still not available for sale. The main influences of this type of stock are: administrative lead time, distance between producing and receiving and the quality assurance release time.

Safety Stock (Orange color) – It ensures that the system is capable of handling uncertainty and achieving the targeted customer service level. This component of stock covers uncertainties in the supply, lead time and demand.

From the figure below it is possible to understand the relationship between the minimum stock cover, demand plan accuracy (DPA) and the service level. Low demand plan accuracy, when targeting a high customer service level, forces the company to have a high safety stock. (Macca, 2012)

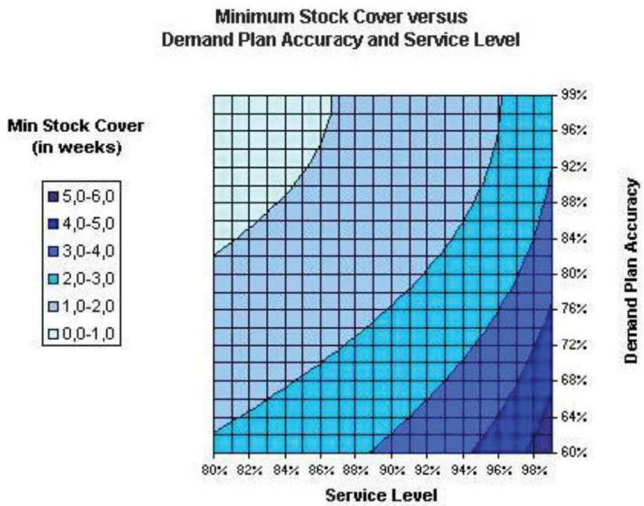

Figure 13 – Trade-off between Minimum Stock Cover, DPA and Service Level (Macca, 2012)

In addition to this, other factors also influence safety stock such as the variability of transit time and the number of warehouses.

Cycle Stock (Green color) – this type of stock relates to the production cycle, delivery frequencies, minimum production and transportation quantities. The production of Nestlé is not made continuously but in batches, which leads to a stock pattern as illustrated in figure 14.

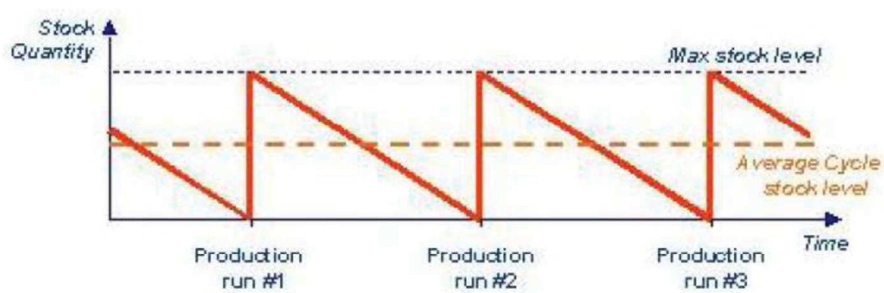

Figure 14 – Cycle Stock (Macca, 2012)

Build Stock (Red color) – covers all the situations where there is a likelihood of increase demand for the following reasons: promotions and/or product seasonal demand. It also covers situations where supply is expected to decrease, for example due to capacity constraints in production or factory shutdown. In those scenarios, production is made beforehand.

In the next section the specifications of the Unbundlor tool are outlined. Here, it becomes clearer how this tool operates through step-by-step guide.

5.2 The Unbundlor – How it operates

This section explains the calculation process, how the Unbundlor interacts with the user and what data is required by the Unbundlor.

The Unbundlor uses historical data from previous years and plans for the next year to support the decision making process in relation to stock policies: finished goods minimum and maximum stock cover levels (expressed in days) (Nguyen 2014). This process involves the following steps:

Step 1 – At this first stage, the supply planner that is using the Unbundlor chooses a category of SKU's (products), from which factory the SKU's are coming from and the distribution center where they will be delivered to. The Unbundlor returns a list of SKUs that fit the requirements defined by the supply planner. This list is returned in an excel where the inputs to calculate the stock cover are visible.

Step 2 – From the information given in the previous step, the Unbondlor gathers the most relevant information from the last 12 months in terms of demand, production, etc. pertaining to each SKU defined. Afterwards, the tool looks for the projections made available by the Demand Planner for the incoming 12 months. These projections are developed by a demand planning team on a previous stage.

Step 3 – The supply planner completes the inputs required by the system according to the following list:

A – Demand Details

A1 – CFR target: the default value for Nestlé is 99.1%;

A2 – Adjusted DPA: Adjustments can be made to the results of automatic information retrieval according to how well predictions have worked in the past for a particular SKU. The supply planner and demand planner should together decide on the cases where a more optimistic or pessimistic value might be adopted.

B – **Distribution Details**

B1 – Frozen Horizon Dispatches: number of days during which the load plan cannot be altered, for example the days required to get the necessary documents for custom clearance.

B2 – Constrained Delivery Frequency: represents the delivery frequency estimated between the source and the DC (for example once a week).

B3 – Minimum Transit Time: minimum number of days of transportation time.

B4 – Maximum Transit Time: maximum number of days of transportation time.

C – Technical and Production Details

C1 – Production Stability Period: represents the number of days during which the production plan cannot be changed.

C2 – Minimum Lot Size: minimum production of packages of a particular SKU.

C3 – Quality Assurance (QA) Release Time: number of days necessary to assure the quality of a particular SKU.

C4 – Early Shipment: maximum number of days for a particular set of SKUs to be shipped from the source to the DC when the QA results are not yet known.

C5 – Adjusted MSA: adjustments can be made to the results of automatic information retrieval according to how well production has met the agreed quantities in the past for a particular SKU. The supply planner and the Detailed Production Scheduling of the factory should coordinate and decide accordingly which cases are more optimistic or pessimistic.

D – FreshNes (Freshness Nestlé)

D1 – Total Shelf Life: number of days that a particular SKU lasts for consumption.

D2 – Minimum Required Customer: represents the minimum number of days of shelf life at which the customer is still willing to buy the product (usually this number is 66% of total shelf life).

Step 4 – At this point the Unbundlor proposes a minimum stock cover level for each SKU and one of two things can happen: 1) the stock cover level is approved by the user or 2) the user makes adjustments to the stock cover level (if this happens a new maximum stock cover will be calculated).

Step 5 – In this last step, the stock policies are defined in relation to each SKU for the next 3 to 4 months.

5.3 How inputs of the Unbundlor affect stock policies

In this section the relationship between the inputs that are given to Unbundlor and the output stock policies are discussed in order to perceive the impact that each one has on the minimum and maximum stock cover level:

1. Case Fill Rate (CFR): this indicator reveals how well customers' needs are being met and has a default value of 99.1%, also called service level. It is important to note that this default value is an average of all products, there are products with a service level higher than 99.1% and others with lower. A higher CFR has an increasing effect on stock cover levels.

2. Demand Plan Accuracy (DPA): it evaluates the accuracy of the demand plan, relating actual demand with what was forecasted. This information is automatically given by the system and an increase in the inaccuracy of forecast leads to a higher stock cover level, to achieve the pre-determined CFR.

3. Adjusted DPA: concedes the supply planner the opportunity to override the DPA given by the system, introducing a new value.

4. Master Schedule Attainment (MSA): is the efficiency of the work done by the factory, meaning the percentage of production that was actually done with the production that was scheduled. This information is automatically given by the system on a weekly basis. The higher the MSA, the lower is the stock cover levels.

5. Adjusted MSA: concedes the supply planner the opportunity to override the MSA given by the system by introducing a new value.

6. Production Stability Period: is the number of days during which an order cannot be changed. A higher Production Stability Period translates into lower flexibility and increased stock cover levels.

7. QA Release Time: this is the Quality Assurance tests, these tests are legally mandatory and serve to assure that the products doesn't have any problems. A lower QA Release Time translates into a decreasing effect on the stock cover levels.

8. Minimum Lot Size: another measure of flexibility whereby the increase on Minimum Lot Size has an increasing effect on stock cover levels.

9. Minimum and Maximum Transit Time: this parameter will have a greater impact on stock cover, as the Transit Time increases, so do the stock cover levels.

10. Early Shipment: This parameter allows the absorption of the QA Release Time by the Transit Time, significantly reducing the time between a particular set of SKUs leaving the source and arriving at the DC. This decrease has a significant decreasing effect on the stock cover, however there is a risk that the batch of SKUs fails the Quality Assurance Tests and if that happens the particular batch has to go back to the source and another batch has to be produced.

From these 10 inputs that can be adjusted to reduce the stock cover, the most relevant are Case Fill Rate and DPA combined with Bias indicator. Unfortunately, according to Nestlé, these two inputs are already optimized and cannot be changed, but are important to analyze and in doing so, understand how they impact the stock cover. The reason why these 3 indicators are the only ones that are studied in this thesis is because the other ones are very complex and does not have the flexibility to improve.

5.4 Conclusions of the Unbundlor

From the above description of the tool Unbundlor it is possible to understand that this process is very complex and does not give much freedom to the demand planner. In the following chapter it is possible to see an analysis on the Case Fill Rate, DPA, Bias and also optimization on the minimum lot size for each SKU selected.

6. Data Analysis

In the following sections there will be a brief analysis on the Case Fill Rate, one of the most important input of the Unbundlor because represents the service level, which is very important for Nestlé. After that, there is an analysis to the Bias, DPA and Minimum Lot Size to all the subcategories selected: **Dairy and Cereal, Chocolate Base, Nescafe Dolce Gusto and Soluble Cereal Drinks.**

6.1 Analysing Case Fill Rate

Case Fill Rate is probably one of the inputs that has major influence on the stock cover of the products. As explained before, CFR indicates the service level provided and it is important to understand how it works.

As indicated in the section 2.7.2 the CFR is given by:

$$CFR\ (\%) = \frac{Orders\ delivered\ to\ the\ clients}{Total\ number\ os\ orders\ received} \times 100 \quad \textbf{(3)}$$

As was explained before, the CFR is one of the inputs of the Unbundlor tool which is normally set as 99,1%, keeping every other input constant an increase was made to the CFR until it reached 100% and registered all the average proposed stock cover (output) for every defined CFR. This can be summarized in figure 15.

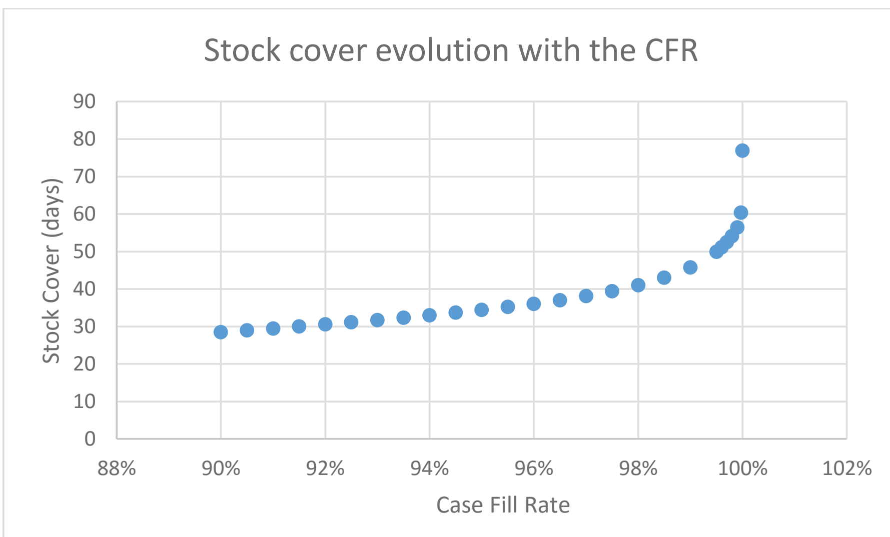

Figure 15 – Stock Cover evolution with Case Fill Rate

It is possible to conclude that CFR and Stock cover follow an exponential distribution. This means that for Nestlé the costs of having a higher service level of over 99,1% would be much more expensive in terms of money spent in inventory than the gains that would come from a higher service level.

6.2 DPA, Bias and Minimum Lot Size

In section 4.2 the products sub-categories Dairy and Cereal, Chocolate Base, Nescafe Dolce Gusto and Soluble Cereal Drinks have been selected for further study. If improved, these products would lead to a significant reduction in the stock cover. In the next section, a detailed analysis is done in order to find ways of improving the stock cover. To maintain the previously agreed confidentiality with Nestlé, the names of the products have been masked.

Before analyzing the data from each sub-category, it is important to remember how the DPA (see equation (4) – section 2.7.3) and Bias (see equation (5) – section 2.7.4) are calculated. The Bias KPI represents the relative difference between what was forecasted and actual sales and combined with the DPA, it evaluates the quality of the demand plan. This combination indicates clearly whether the forecast was under estimated or over estimated.

Another analysis that will be made is related to the minimum lot size which could be an area for most of the improvements. The Unbundlor proposes a determined average stock cover according to the number set as the minimum lot size. Also, each SKU is grouped in category **A** if produced every week, **B** if produced every two weeks or **C** if produced every three weeks. Given an SKU of category A with an average weekly demand, what would be the improvement in stock cover if the minimum lot size was optimized accordingly? The answer to this question is what this analysis is dealing with. By identifying the savings in days that this reduction could give, it is possible to challenge the factory to reduce the lot size based on this work. Keep in mind that by reducing the minimum lot size the days between production or production frequency also decrease. From indication of the DSP department the days between production cannot (Production Frequency) be reduced drastically because of factory constraints, the desired outcome is to reduce the stock cover without compromising the days between production.

6.2.1 Soluble Cereal Drinks Analysis

The soluble cereal drinks sub-category is part of the beverage business, which is the one that represents the largest turnover of Nestlé. Initially 9 SKUs in this sub-category were to be analyzed, but there were some problems with 3 of the SKUs and for that reason it was not possible to make this analysis. These problems arose from technical issues exporting the data from SAP, or because the product was discontinued or even because it is a new product with a new product code. Then 6 SKUs were analyzed. Something important to have in mind is that the factory in Avanca is not very flexible due to technology constraints and for that reason only works on a minimum of 1000 PUMs or multiples of it.

6.2.1.1 – SKU 1

Figure 16 shows the behavior of SKU1 DPA and Bias that had a distinct behavior during the year 2016-2017.

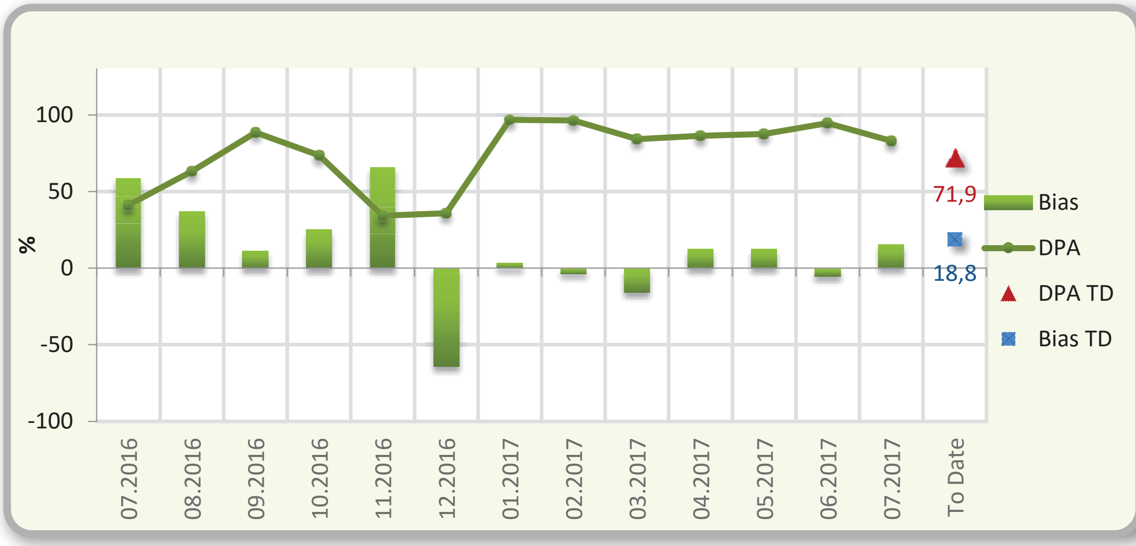

Figure 16 – SKU 1 DPA and Bias analysis (retrieved from Unbundlor)

From the graph above, it is important to note that in 2016, the average value for the DPA was 64% with a positive bias (with the exception of December). This means that for 5 months the sales predictions were overestimated and therefore stock was being accumulated. Furthermore, in December, because of accumulated stock from the previous months, the prediction of sales was below the actual demand which led to a negative bias of 64,2%. In addition to this, during the year 2017 the average DPA was 89,8% which is a better result compared to 2016. The behavior of the bias indicator was as desired, varying between positive and negative.

From Table 6, the average weekly future demand gives an indication that a minimum of 638 PUMs of products are needed, since this is a product of category B (production every two weeks) which indicates that the minimum production should be 2 x 638 = 1276 PUMs. By suggestion of the DSP of Nestlé an extra 20% should always be added as a safety stock to prevent ruptures, 1276 x 1,2 = 1532. In conclusion, the minimum lot size that is possible to suggest is 2000 PUMs which brings the days between productions further to the desired (suggestion 1). The next possible suggestion is more efficient in terms of days between productions and could result in a reduction of 14,6 of days, but the production frequency is still 12 days what could be more difficult to convince the factory to accept this number (suggestion 2). In conclusion, Suggestion 3 might be more attractive to the factory and could result in a reduction of 7,3 days of stock in this SKU.

Table 6 - Minimum Lot Size Analysis for SKU 1

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	638	5000	48,90	17
Suggestion 1	638	2000	27,00	9
Suggestion 2	638	3000	34,30	12
Suggestion 3	638	4000	41,60	14

6.2.1.2 – SKU 2

For SKU 2, it can be seen from the Figure 17, that the behavior of the bias indicator was not as desired. Along 5 months the values were negative which means that the demand was greater than what was predicted. In January and February of the following year the bias continued to be negative, which means that it could lead to stock rupture. In the following months the bias was always positive and with a significant value what led to accumulated stock. In relation to the DPA, it was stable during 2016 having an average of 77% and was rather fluctuant during the year 2017, especially in the first two months where the values of DPA were low.

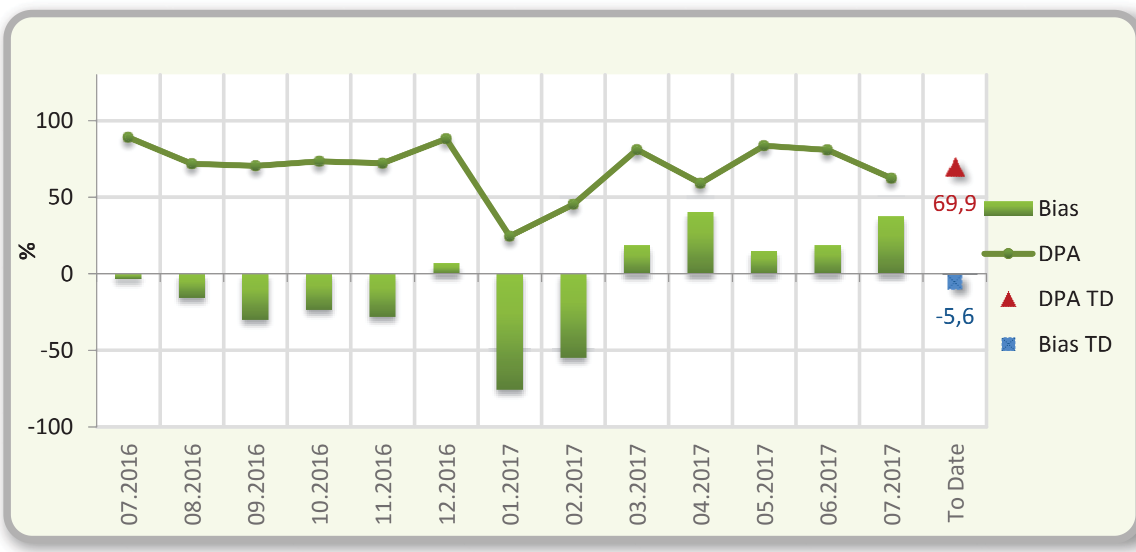

Figure 17 – SKU 2 DPA and Bias analysis (retrieved from Unbundlor)

Following the same logic from the previous analysis, in Table 7 it can be seen that the average weekly future demand gives an indication that a minimum of 1199 PUMs of products are needed, since this is a product of category B (production every two weeks) it indicates that the minimum production should be 2 x 1199 = 2398 PUMs. By suggestion of the DSP of Nestlé, an extra 20% should be added to work as safety stock and prevent ruptures, 2398 x 1,2 = 2878. This calculation represents the only possible suggestion that could be made in a minimum lot size of 3000 that gives a production frequency of 8 and a reduction of stock cover of 4,7 days.

Table 7 - Minimum Lot Size Analysis for SKU 2

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	1199	4000	31,60	10
Suggestion 1	1199	3000	26,90	9

6.2.1.3 – SKU 3

From Figure 18 it is possible to note that during 2016 the bias indicator fluctuated between positive and negative as desired; and that the average DPA during this period was 75,2%. In the beginning of 2017, the bias indicator was negative for 5 months, which is not recommended because it could lead to a shortage of stock. For this time period, the DPA values were better than the previous period with an average of 83,5%.

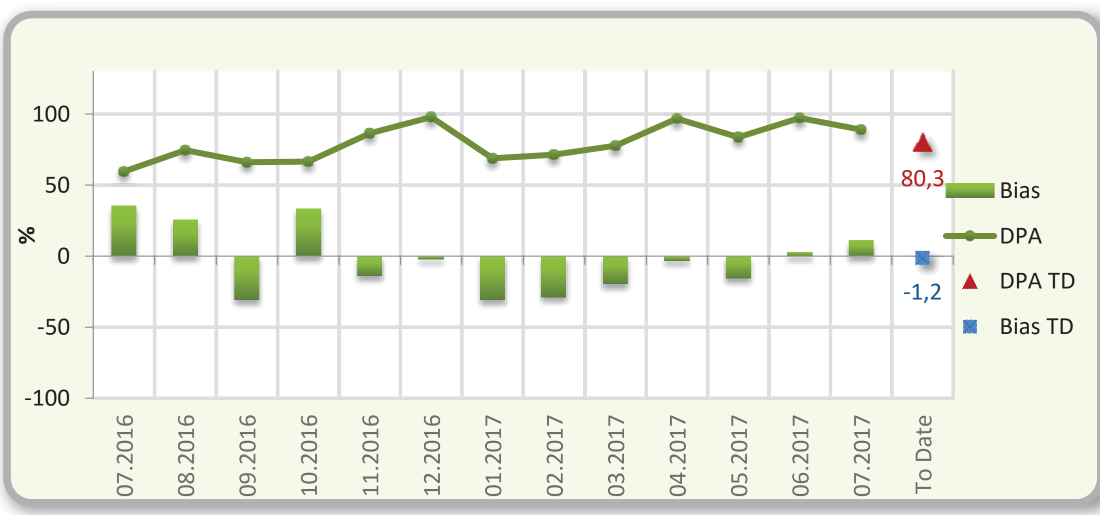

Figure 18 – SKU 3 DPA and Bias analysis (retrieved from Unbundlor)

From Table 8, the average weekly future demand gives an indication that a minimum of 2154 PUMs of products are needed per week, since this is a product of category B (production once every two weeks) which indicates that the minimum production should be 2 x 2154 = 4308 PUMs. By suggestion of the DSP department of Nestlé an extra 20% should always be added as safety stock and to prevent ruptures, 4308 x 1,2 = 5169. From these calculations it is not possible to make any suggestion for the improvement of this particular stock cover. The minimum lot size is optimized at 6000 PUMs with a proposed stock cover of 29,4 days.

Table 8 - Minimum Lot Size Analysis for SKU 3

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	2154	6000	29,40	14

6.2.1.4 – SKU 4

From Figure 19 it is possible to see that the behavior of the bias indicator was not what is desired, in general the behavior of the bias indicator varied between positive and negative which is what is expected, but in the months of October and November 2016 and March 2017, the bias value was negative with high value which could mean stock rupture. Nestlé sold more than what was expected. The DPA indicator was rather good with an average of 80,8% except in the months when the bias spiked.

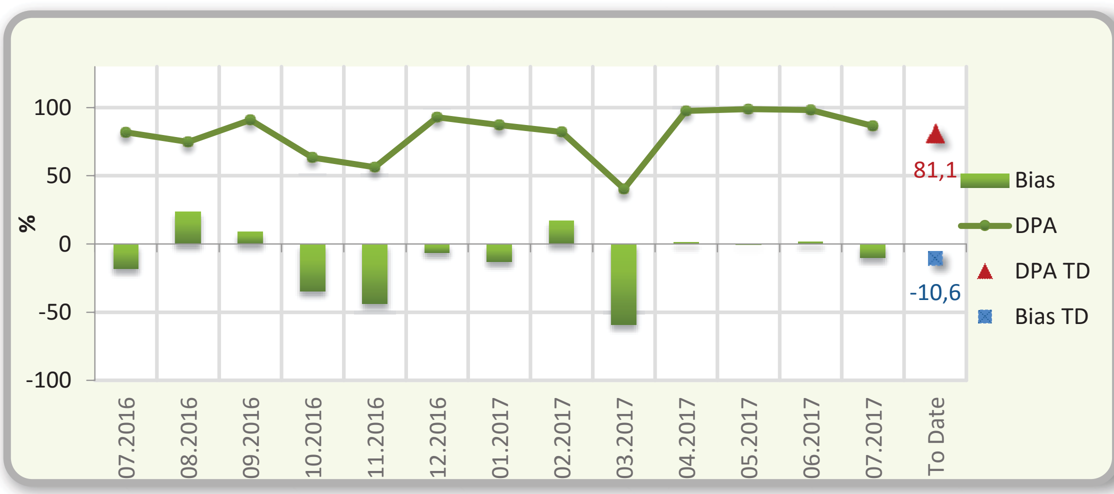

Figure 19 – SKU 4 DPA and Bias analysis (retrieved from Unbundlor)

Following Table 9, the average weekly future demand gives an indication that a minimum of 3007 PUMs of products are needed per week, since this is a product of category A (production once per week) it indicates that the minimum production should be a minimum of 3007 PUMs. By suggestion of the DSP department of Nestlé it an extra 20% should always be added as safety stock and to prevent ruptures, 3007 x 1,2 = 3608. From these calculations it is possible to make two suggestions of improvement. Both give the same improvement in stock cover with the same days between production, so it is possible to conclude that a minimum lot size of 5000 is more attractive for the factory and improves stock cover by 1,5 days.

Table 9 - Minimum Lot Size Analysis for SKU 4

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	3007	6000	24,70	3
Suggestion 1	3007	4000	23,20	3
Suggestion 2	3007	5000	23,20	3

6.2.1.5 – SKU 5

Figure 20 shows the behavior of SKU5 DPA and Bias that had a distinct behavior during the year 2016-2017.

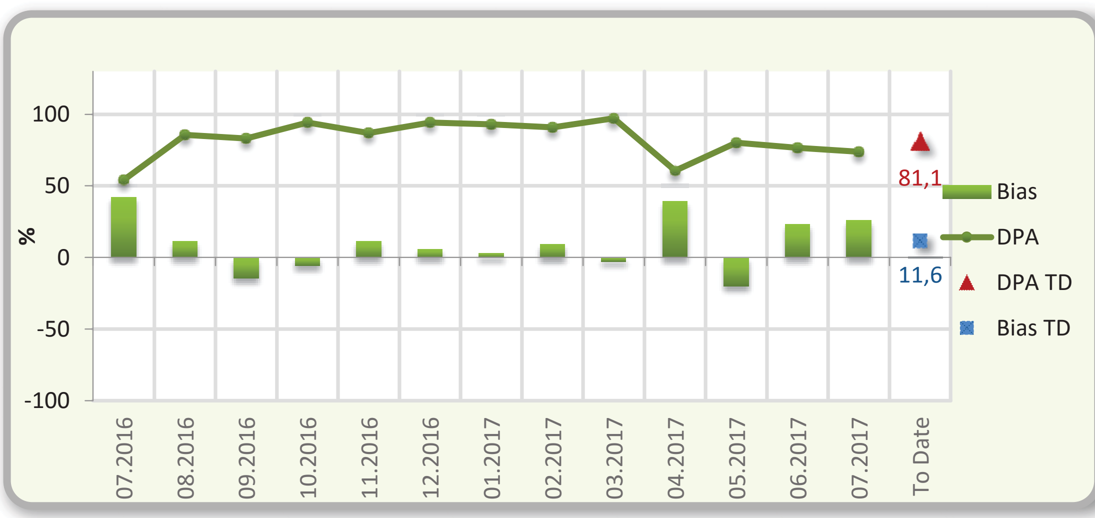

Figure 20 – SKU 5 DPA and Bias analysis (retrieved from Unbundlor)

For SKU 5 the values of DPA were mainly stable and with an average of 83% during the period of 2016 and 2017. Note that in July of 2016 the bias was very high and the DPA was very low compared to the average, which is an indicator of overestimating the demand plan, leading to overstock situations. In April of 2017 a similar situation occurred but with a higher value of DPA.

Table 10 - Minimum Lot Size Analysis for SKU 5

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	5658	10000	23,30	4
Suggestion 1	5658	7000	18,70	3
Suggestion 2	5658	8000	19,50	3
Suggestion 3	5658	9000	20,40	4

Following Table 10, The average weekly future demand gives an indication that a minimum of 5658 PUMs of products are needed per week, since this is a product of category A (production once per week) it indicates that the minimum production should be a of 5658 PUMs. By suggestion of the DSP department of Nestlé an extra 20% should always be added as safety stock and to prevent ruptures, 5658 x 1,2 = 6789. From these calculations it is possible to make three suggestions of improvement. Suggestion 1 and 2 are the ones that gives the most improvement in stock cover but have the inconvenience of reducing the days between production by 1 day. Suggestion 3 reduces the stock cover in 2,9 days and does not change the production frequency and for that reason it is a more attractive option for the factory than the other two.

6.2.1.6 – SKU 6

In Figure 21 it's possible to see the behavior of the bias for SKU 5 is reasonably good with low value deviations from the center with the exception of July of 2016 where the sales were much higher than what was projected which could lead to shortage of stock. Another problematic month was July of 2017 where the bias was 30,1% which means that the sales were much lower than was projected, this leads to higher costs of holding stock. The DPA was relatively good with an average of 82% during all the periods except on the previously mentioned months.

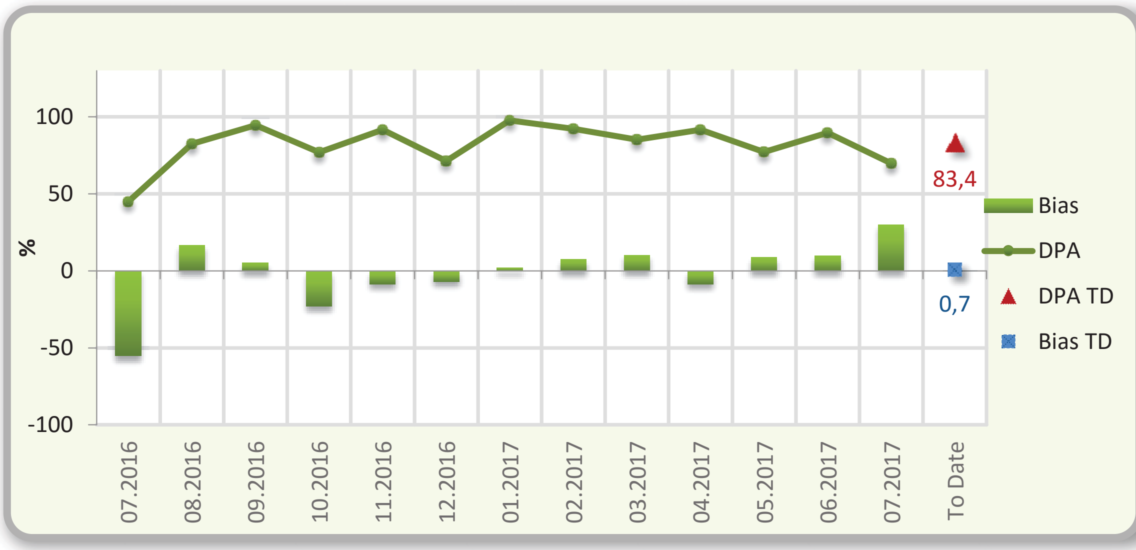

Figure 21 – SKU 6 DPA and Bias analysis (retrieved from Unbundlor)

Following Table 11, the average weekly future demand gives an indication that a minimum of 3918 PUMs of products are needed per week, since this is a product of category B (production once every two weeks) it indicates that the minimum production should be 2 x 3918 = 7836 PUMs. By suggestion of the DSP department of Nestlé an extra 20% should always be added as safety stock and to prevent ruptures, 7836 x 1,2 = 9403. From these calculations it is not possible to make any suggestion for the improvement of this particular SKU. The minimum lot size is optimized at 6000 PUMs with a proposed stock cover of 27 days.

Table 11 - Minimum Lot Size Analysis for SKU 6

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	3918	10000	27,00	13

6.2.1.7. Recommendations for Soluble Cereal Drinks

For the sub-category Soluble Cereal Drinks a total of 6 SKUs were analyzed in terms of DPA and Bias during 2016-2017 and in terms of possible improvement in the minimum lot size. This sub-category is produced in the Avanca factory which is a very old facility with very low flexibility, for that reason the minimum lot size can only be multiples of 1000 PUMS.

From the previous analysis, it is possible to see that SKU 1 can be improved reducing the Minimum Lot Size from 5000 to 4000 PUMS giving a reduction of 48,9 – 41,6 = 7,3 days of average stock cover. However this SKU has improvement proposals that could give a higher reduction of stock cover, but the days between productions would decrease even more. In this case the days between production is now at 17, the suggestion closer to this production frequency is suggestion 3 which has a production frequency of 14. The possibility of decreasing even more should be study more in detail by the DSP department and Avanca's factory.

In the case of SKU 2 there is only one improvement proposal possible reducing the Minimum Lot Size from 4000 to 3000 PUMs giving a reduction of 31,60-26,9 = 4,7 days of average stock cover. For SKU 3 there is no recommendations possible, this product is already optimized.

For the case of SKU 4 there are two possible suggestions, it's possible to reduce the Minimum Lot Size for 4000 and 5000 PUMs, however the average proposed inventory cover stays the same being 23,20 days. As the objective is to reduce the stock cover there is no need to recommend a minimum lot size of 4000 if the stock cover is the same and for that reason the recommendation for SKU 4 is 5000 PUMs.

SKU 5 can be improved by reducing the Minimum Lot Size from 10000 to 9000 PUMs giving a reduction of 23,3-20,4= 2,9 days of average stock cover. However this SKU has two other improvement proposals that could give a higher reduction of stock cover, but that would imply a reduction of days between productions from 4 to 3 days. Despite being only one day of reduction this could be very significant to the factory and should be studied in more detail by the DSP department and Avanca's factory. For SKU 6 there is no recommendations possible, this product is already optimized.

As seen in section 4.2.1 table 4 the 2017 target stock cover for the sub-category Soluble Cereal Drinks is 23,5 days. On October 2017 the real stock cover was 24,4 days. When implementing the suggestions on SKU 1, 2, 4 and 5 to the Unbundlor, the estimated stock cover for the whole sub-category improves for 23,9 days.

6.2.2 Nescafe Dolce Gusto Analysis

The Nescafe Dolce Gusto sub-category is part of the beverage business, which is the one that represents the largest turnover of Nestlé. . In this sub-category 6 SKUs were to be analyzed, but there were some problems with 2 of the SKUs and for that reason it was not possible to make this analysis. These problems arose from technical issues exporting the data from SAP, or because the product was discontinued or even because it is a new product with a new product code. Then the 4 SKUs are analyzed. Other important information is that this factory in Girona, Spain is much more flexible and for that reason it works on a minimum of 100 PUMs or multiples of it.

6.2.2.1 SKU 7

From figure 22 it is possible to see that the Bias indicator is mostly positive (sometimes with high values), this is a serious problem because for almost a year the demand planners of Nestlé were over forecasting the sales of this product, leading to accumulated stock which means money tied up as inventory. Following the same behavior of the Bias indicator is the DPA with an average of 71,3% which is still lower than what is desired.

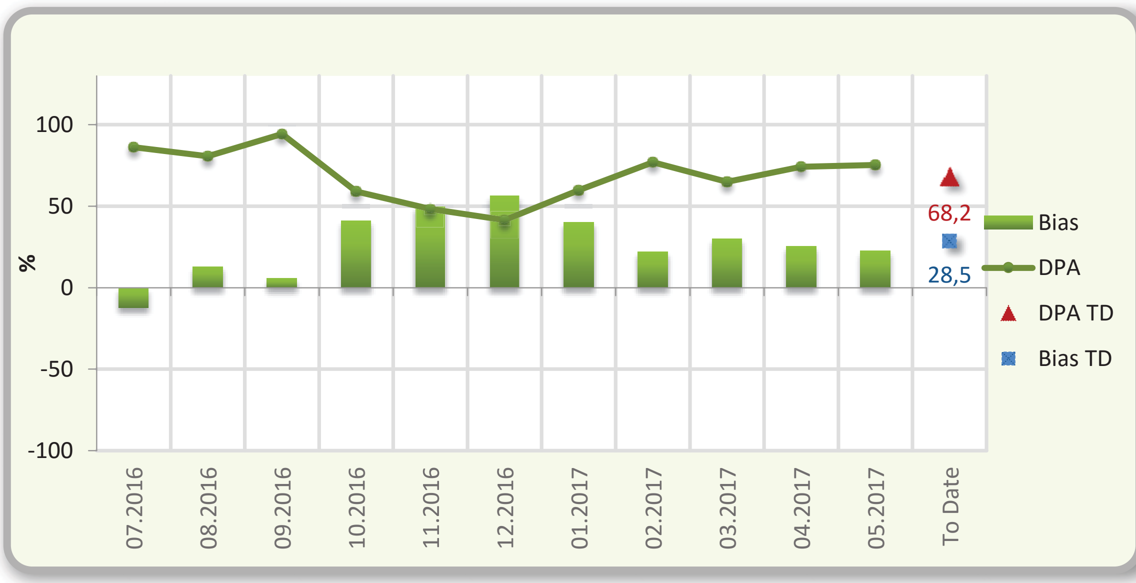

Figure 22 – SKU 7 DPA and Bias analysis (retrieved from Unbundlor)

From Table 12, the average weekly future demand gives an indication that a minimum of 2663 PUMs of products are needed per week, since this is a product of category A (production once every week) it indicates that the minimum production should be 2663 PUMs. By suggestion of the DSP department of Nestlé an extra 20% should always be added as safety stock and to prevent ruptures, 2663 x 1,2 = 3195. From these calculations it is possible to make a suggestion of improvement of minimum lot size from 3300 to 3200 which gives a reduction of 2,23 days of proposed stock cover.

Table 12 - Minimum Lot Size Analysis for SKU 7

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	2663	3300	24,86	7
Suggestion 1	2663	3200	22,63	6

6.2.2.2 SKU 8

From Figure 23 it is possible to identify irregular behavior in terms of Bias. The months of October and November must be referred because of their significant negative value which means that the sales exceeded the expected sales. In addition to this, another problem with this SKU happened on December where the expected sales were far smaller than what was actually sold. The DPA indicator followed the erratic behavior of the bias and obtained an average of 67,5%.

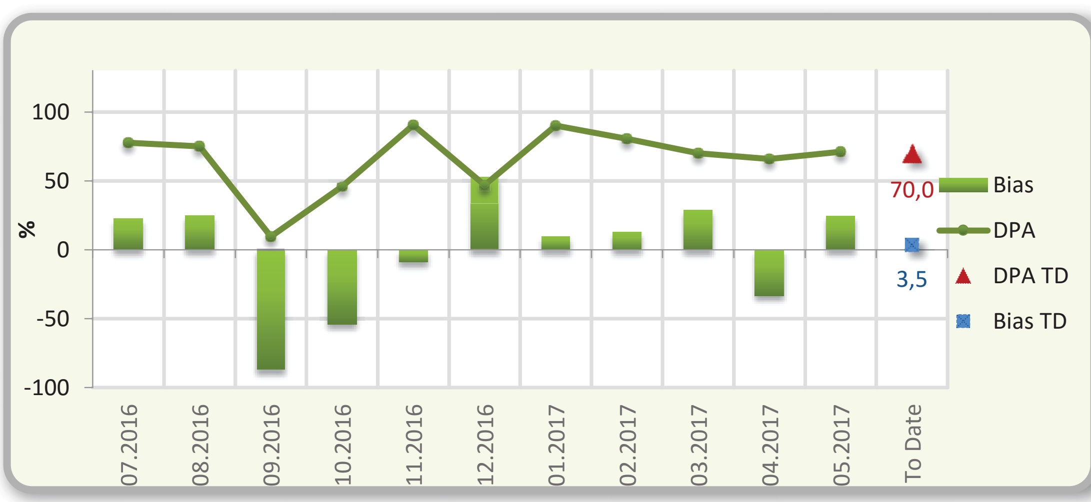

Figure 23 – SKU 8 DPA and Bias analysis (retrieved from Unbundlor)

From table 13, the average weekly future demand gives an indication that a minimum of 1495 PUMs of products are needed per week, since this is a product of category B (production once every three weeks) it indicates that the minimum production should be 1495 x 2 = 2990 PUMs. By suggestion of the DSP department of Nestlé an extra 20% should always be added as safety stock and to prevent ruptures, 2900 x 1,2 = 3588. From these calculations it is possible to make two suggestions of improvement, the first has a minimum lot size of 3600 and an average stock cover of 34 but the production frequency changes from 14 to 8 days which could be a problem for the factory. The second suggestion has a minimum lot size of 3700 which is more attractive for the factory because it is only a two day reduction in the production frequency and results in a 1,5 days reduction of the average stock cover.

Table 13 - Minimum Lot Size Analysis for SKU 8

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	1495	3800	26,70	14
Suggestion 1	1495	3600	24,00	8
Suggestion 2	1495	3700	25,20	13

6.2.2.3 SKU 9

From Figure 24, it is possible to see that the behavior of the bias indicator was not what is desired. In the months of September and October of 2016 the sales were over what was planned which resulted in -30,6% and -47,9% of Bias. Also, in March of the following year the bias was 43,9% which means that the sales of this product was under expected, resulting in accumulated stock. In the other months of the year the behavior of the bias was rather normal varying between positive and negative. The DPA indicator was quite good with an average of 79,7% except in the months when the bias spiked.

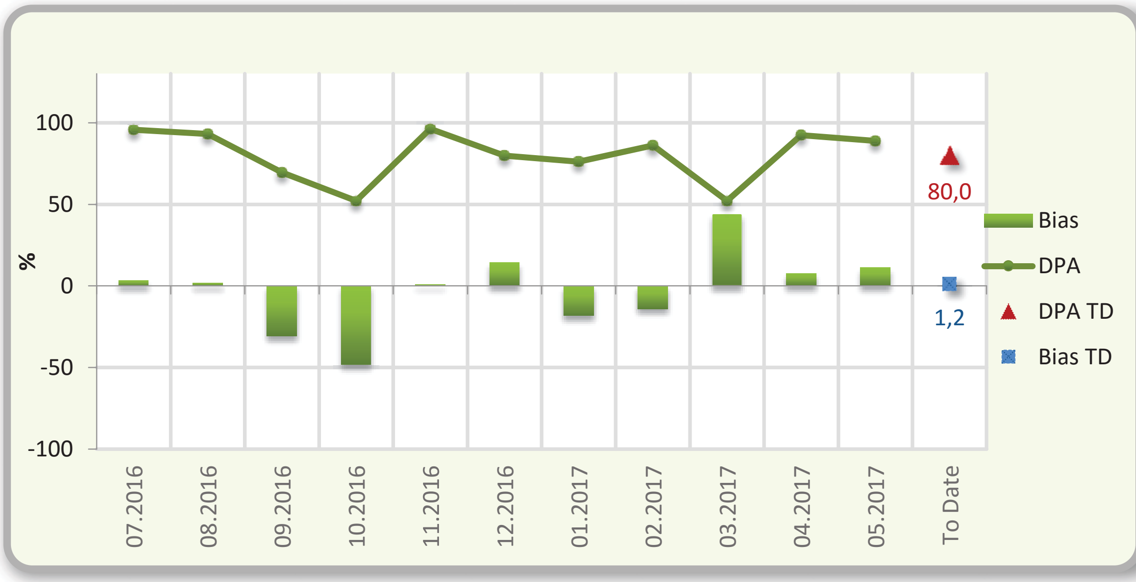

Figure 24 – SKU 9 DPA and Bias analysis (retrieved from Unbundlor)

From table 14, the average weekly future demand gives an indication that a minimum of 581 PUMs of products are needed per week, since this is a product of category A (production once every week) it indicates that the minimum production should be 591 PUMs (Table 14). By suggestion of the DSP department of Nestlé an extra 20% should always be added as safety stock and to prevent ruptures, 591 x 1,2 = 697,2. From these calculations it is not possible to make any suggestion for the improvement of this particular stock cover. The minimum lot size is optimized at 700 PUMs with a proposed stock cover of 36,7 days.

Table 14 - Minimum Lot Size Analysis for SKU 9

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	581	700	26,7	6

6.2.2.4 SKU 10

From Figure 26 it is possible to see that the Bias indicator is mainly always positive (sometimes with high values). This is a serious problem because for almost one year the demand planners of Nestlé were over forecasting the sales of this product, leading to accumulated stock which means money tied up as inventory. Following the same behavior of the Bias indicator is the DPA with an average of 76,4% which is still lower than what is desired.

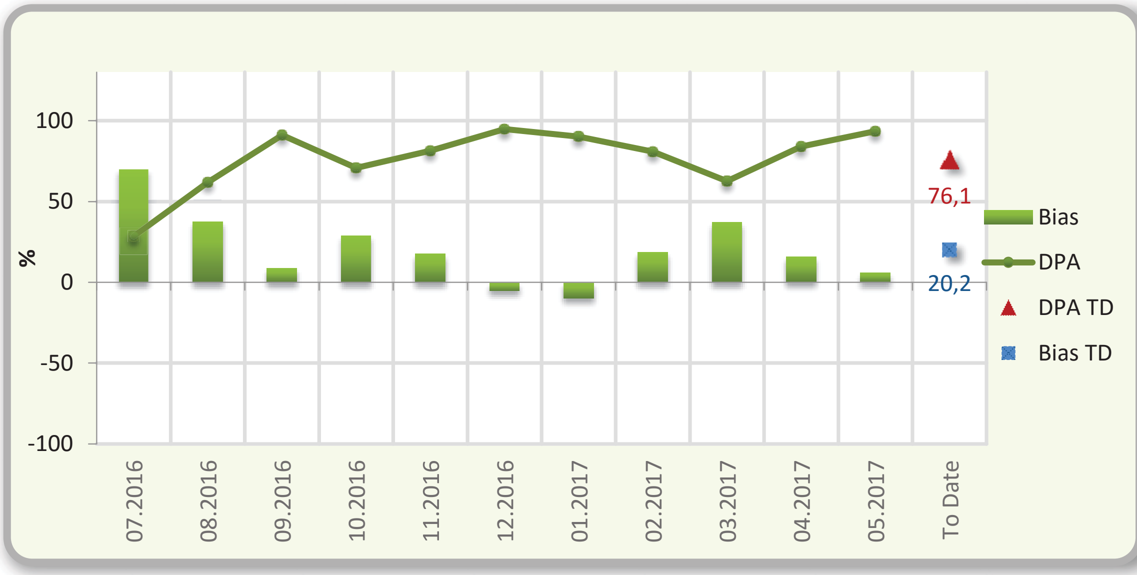

Figure 25 – SKU 10 DPA and Bias analysis (retrieved from Unbundlor)

From Table 15, the average weekly future demand gives an indication that a minimum of 1561 PUMs of products are needed per week, since this is a product of category A (production once every week) it indicates that the minimum production should be 1561 PUMs. By suggestion of the DSP department of Nestlé an extra 20% should always be added as safety stock and to prevent ruptures, 1561 x 1,2 = 1873. From these calculations it is possible to make a suggestion of improvement reducing the minimum lot size for 1900 reduces the proposed stock cover in about 2,05 days.

Table 15 - Minimum Lot Size Analysis for SKU 10

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	1561	2000	22,68	7
Suggestion 1	1561	1900	20,63	6

6.2.2.5. Recommendations for Nescafe Dolce Gusto

For the sub-category Nescafe Dolce Gusto a total of 4 SKUs were analyzed in terms of DPA and Bias during 2016-2017 and in terms of possible improvement in the minimum lot size. This sub-category is produced in the factory of Spain which is newer and more flexible than the Avanca's factory, for that reason the minimum lot size can be multiples of 100 PUMS.

From the previous analysis, it's possible to see that SKU 7 can be improved reducing the Minimum Lot Size from 3300 to 3200 PUMS giving a reduction of 24,86– 22,63 = 2,2 days. SKU 8 can be improved by reducing the Minimum Lot Size from 3800 to 3700 PUMs giving a reduction of 26,7-25,2= 1,5 days. However this SKU has one other improvement proposal that could give a higher reduction of stock cover, but would imply a reduction of days between productions from 13 to 8 days. These 5 days of reduction of days between production could have major significance to the factory and this possibility should be further studied by the DSP department and the factory.

For SKU 9 there is no recommendations possible, this product is already optimized. In the case of SKU 10 there is only one suggestion of improvement that reduce the minimum lot size from 2000 to 1900, reducing the average stock cover in 22,68-20,63= 2,05 days.

As seen in section 4.2.1 table 4 the 2017 target stock cover for the sub-category Nescafe Dolce Gusto is 19,5 days. On October 2017 the real stock cover for this sub-category was 21,3 days. When implementing the improvements suggested on SKU 7, 8 and 10 to the Unbundlor, the real stock cover for the whole sub-category improves to 20,8 days.

6.2.3 Chocolate Base Analysis

The Chocolate Base sub-category is part of the food business, which is the one sub-category where improvement is needed. Initially 3 SKUs in this sub-category were to be analyzed, but there were some problems with 3 of the SKUs and for that reason it was not possible to make this analysis. These problems arose from technical issues exporting the data from SAP, or because the product was discontinued or even because it is a new product with a new product code. Then 6 SKUs are analyzed. One information on this aspect is that is important to have in mind is that this factory in Avanca is not very flexible due to technology constraints and for that reason only works on a minimum of 1000 PUMs or multiples of it.

6.2.3.1 – SKU 11

Figure 26 shows the behavior of SKU1 DPA and Bias that had a distinct behavior during the year 2016-2017.

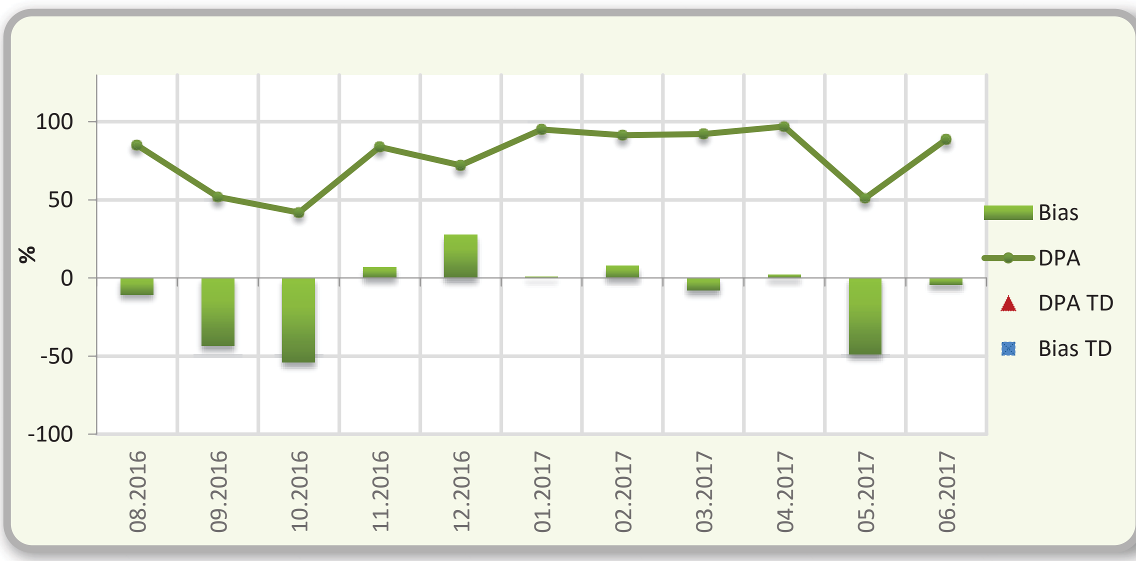

Figure 26 – SKU 11 DPA and Bias analysis (retrieved from Unbundlor)

For this SKU, in first three months of 2016 the bias was getting worse with a decreasing value every month. This means that every month the stock diminishes which could lead to stock ruptures. The average DPA for this year was around 62,6% which is rather low and shows the inaccuracy of the demand plan. The values of DPA were mainly stable in 2017 and with an average of 85,9% which was a great improvement, with exception of May where the DPA was rather low due to sales being over the demand plan as indicated in the bias.

Following the same logic of the previous analysis and looking at table 16, the average weekly future demand gives an indication that a minimum of 1242 PUMs of products are needed, since this is a product of category B (production once every two weeks) it indicates that the minimum production should be 2 x 1242 = 2484 PUMs. By suggestion of the DSP of Nestlé an extra 20% should always add as safety stock and to prevent ruptures, 2484 x 1,2 = 2981. From this calculation the only possible suggestion that could be made in a minimum lot size of 3000 that gives a production frequency of 14 and a reduction of stock cover of 1,8 days.

Table 16 - Minimum Lot Size Analysis for SKU 11

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	1242	4000	27,90	15
Suggestion 1	1242	3000	26,10	14

6.2.3.2 – SKU 12

In Table 27, for this SKU the values of DPA were mainly stable and with an average of 81,9% during the period of 2016 and 2017. Note that in February of 2017 the bias was very high and the DPA was very low compared to the average, an indicator of underestimating the demand plan, leading to stock rupture situations. In May and June of 2017, a similar situation occurred.

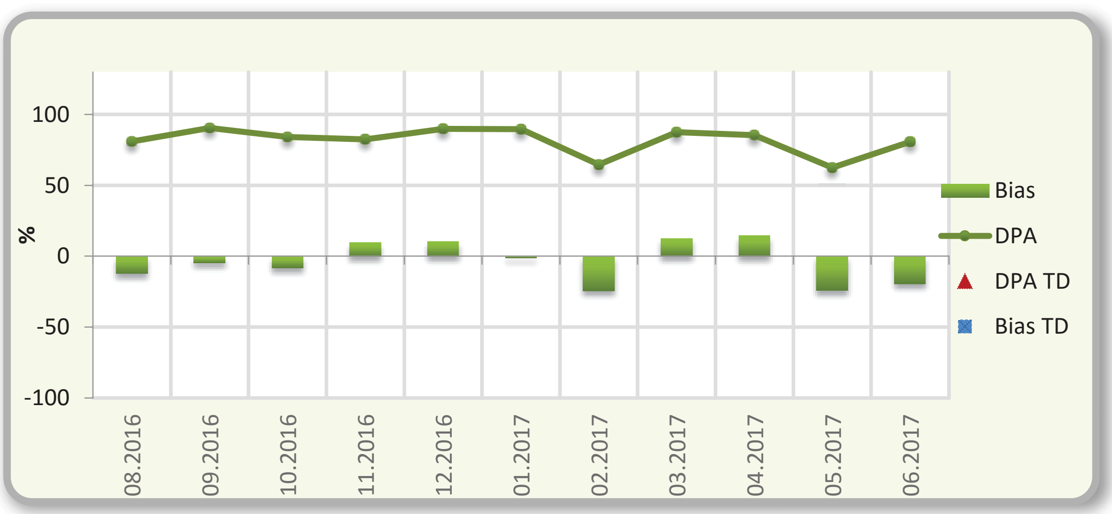

Figure 27 – SKU 12 DPA and Bias analysis (retrieved from Unbundlor)

Following the same logic of the previous analysis and looking at table 17, the average weekly future demand gives an indication that a minimum of 4116 PUMs of products are needed per week, since this is a product of category A (production once a week) it indicates that the minimum production should 4116 PUMs. By suggestion of the DSP department of Nestlé an extra 20% should always be added as safety stock and to prevent ruptures, 4116 x 1,2 = 4939. From these calculations it is not possible to make any suggestion for the improvement of this particular stock cover. The minimum lot size is optimized at 5000 PUMs with a proposed stock cover of 19,5 days.

Table 17 - Minimum Lot Size Analysis for SKU 12

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	4116	5000	19,50	6

6.2.3.3 – SKU 13

From Figure 28 it is possible to see very irregular behavior in terms of Bias. The months of October and December of 2016 must be referenced because of their significant negative value which means that the sales exceeded by far the expected demand. In addition, in 2017 the bias and DPA was very irregular varying between positive and negative. The DPA indicator followed the erratic behavior of the bias with an average of 60,9%.

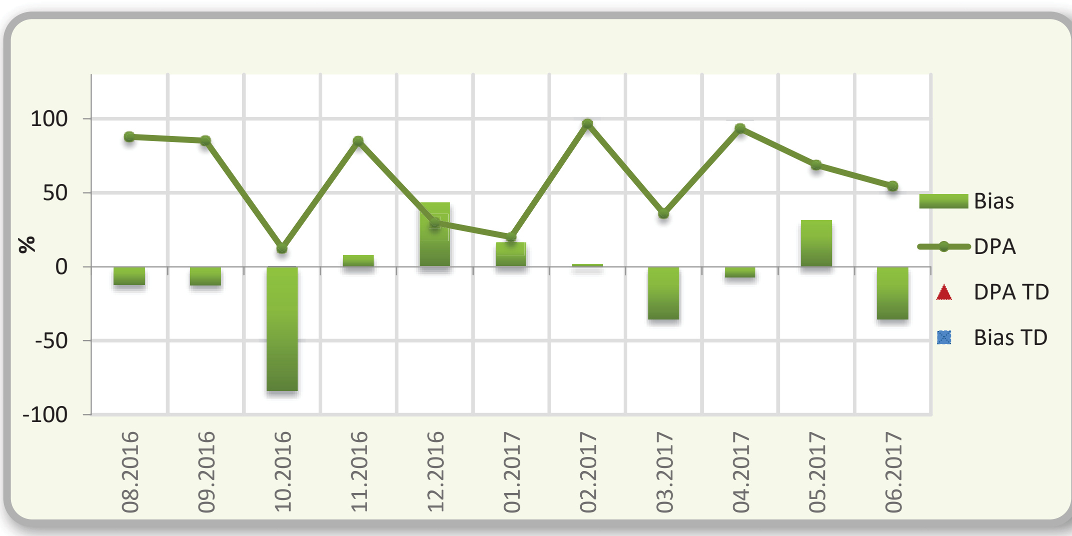

Figure 28 – SKU 13 DPA and Bias analysis (retrieved from Unbundlor)

Looking at table 18, the average weekly future demand gives an indication that a minimum of 592 PUMs of products are needed per week, since this is a product of category C (production once every three weeks) it indicates that the minimum production should be of 3 x 592 = 1776 PUMs. By suggestion of the DSP department of Nestlé an extra 20% should always be added as safety stock and to prevent ruptures, 1776 x 1,2 = 2131. From these calculations it is not possible to make any suggestion for the improvement of this particular stock cover. The minimum lot size is optimized at 2000 PUMs with a proposed stock cover of 30,9 days.

Table 18 - Minimum Lot Size Analysis for SKU 13

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	592	2000	30,90	20

6.2.3.5. Recommendations for Chocolate Base

For the sub-category Chocolate Base a total of 3 SKUs were analyzed in terms of DPA and Bias during 2016-2017 and in terms of possible improvement in the minimum lot size. This sub-category is produced in the Avanca factory which is a very old facility with very low flexibility, for that reason the minimum lot size can only be multiples of 1000 PUMS.

From the previous analysis, it's possible to see that SKU 11 can be improved reducing the Minimum Lot Size from 4000 to 3000 PUMS giving a reduction of 27,90 – 26,10 = 1,8 days. For SKU 12 and 13 there is no possible suggestion of improvement, the product is already optimized.

As seen in section 4.2.2 table 5 the 2017 target stock cover for the sub-category Chocolate Base is 26,1 days. On October 2017 the real stock cover was 27,4 days. When implementing the suggestions on SKU 11 to the Unbundlor, the estimated stock cover for the whole sub-category improves for 27,2 days.

6.2.4. Dairy and Cereals Analysis

The Chocolate Base sub-category is part of the food business, which is the one sub-category where improvement is needed. Initially 9 SKUs in this sub-category were to be analyzed, but there were some problems with 2 of the SKUs and for that reason it was not possible to make this analysis. These problems arose from technical issues exporting the data from SAP, or because the product was discontinued or even because it is a new product with a new product code. Then 7 SKUs are analyzed. One information on this aspect is that is important to have in mind is that this factory in Avanca is not very flexible due to technology constraints and for that reason only works on a minimum of 1000 PUMs or multiples of it.

6.2.4.1- SKU 14

From Figure 29 it is possible to see that the behavior of the bias indicator in the year 2016 was not very problematic, the values were relatively close to zero and varying between negative and positive which is what I desired. In the year 2017 the actual sales exceeded always the expected demand which lead to negative bias during all the 6 months, this could be a problem because it can lead to stock rupture. Relative to the DPA indicator it is rather constant in the year 2016 with an average of 87,1% which is very good. In the year 2017 the DPA was significantly lower with an average of 75,3%.

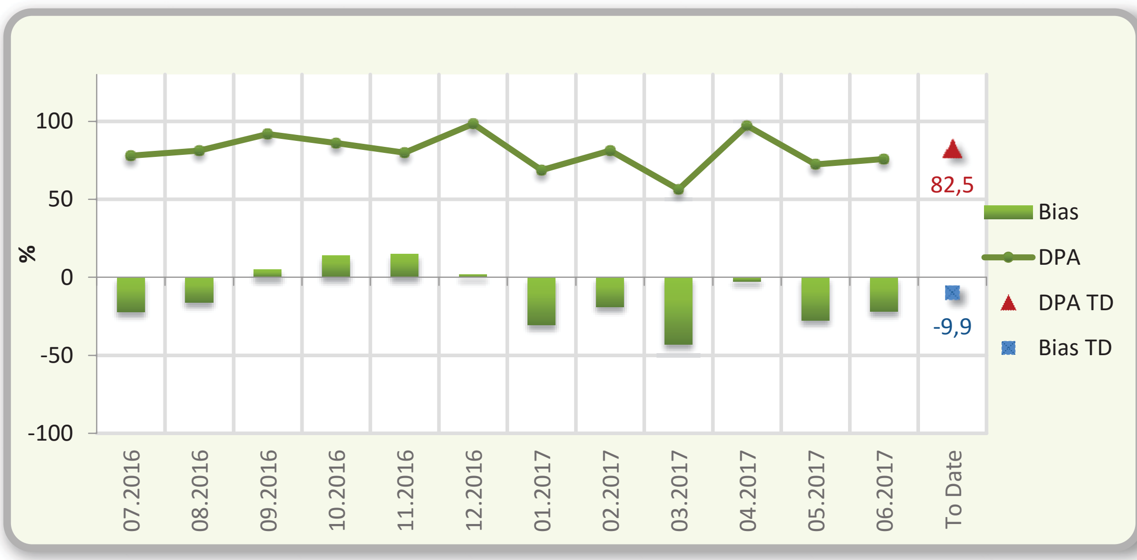

Figure 29 – SKU 14 DPA and Bias analysis (retrieved from Unbundlor)

From table 19, the average weekly future demand gives an indication that a minimum of 759 PUMs of products are needed per week, since this is a product of category B (production once every two weeks) it indicates that the minimum production should be 759 x 2 = 1518 PUMs. By suggestion of the DSP department of Nestlé an extra 20% should always be added as safety stock and to prevent ruptures, 1518 x 1,2 = 1822. As seen in table 19, from these calculations it is possible to make a suggestion of improvement of minimum lot size from 3000 to 2000 which gives a reduction of 4,8 days of proposed stock cover,.

Table 19 - Minimum Lot Size Analysis for SKU 14

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	759	3000	39,40	16
Suggestion 1	759	2000	34,60	14

6.2.4.2- SKU 15

Figure 30 shows very problematic behavior of DPA and Bias of this SKU, during 9 months the Bias indicator was positive (sometimes with large value) which means that during all this time the stock was accumulating maintaining the stock cover high. In the few last months of the analysis the bias was negative with high values also, indicating sales over the expected demand. In addition, the DPA was very low with an average of 50% which indicates the lack of accuracy of the demand plan.

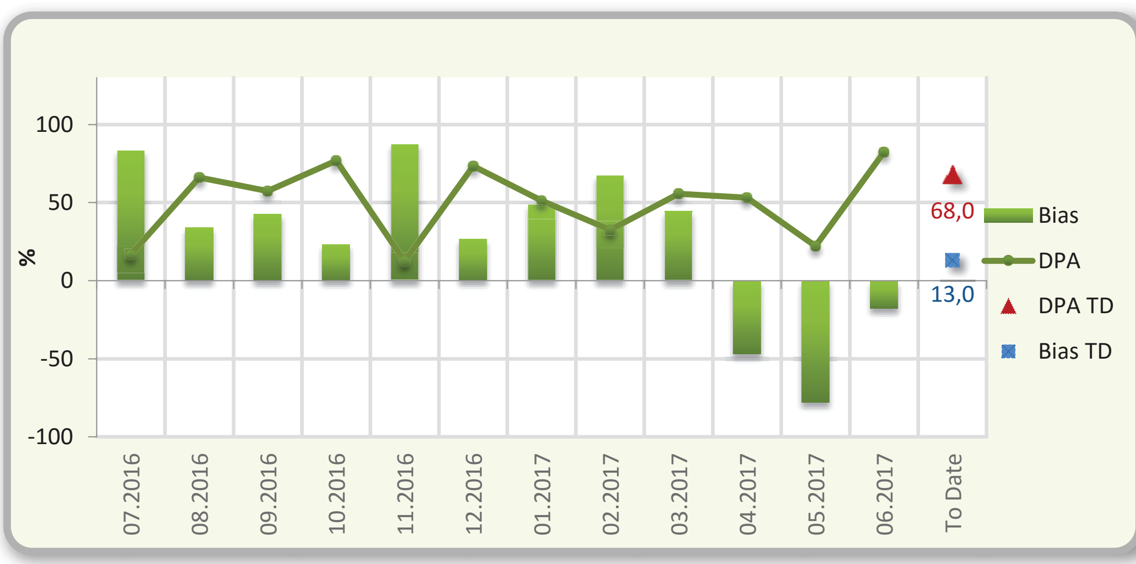

Figure 30 – SKU 15 DPA and Bias analysis (retrieved from Unbundlor)

Following the same logic of the previous analysis, the average weekly future demand gives an indication that a minimum of 2437 PUMs of products are needed per week, since this is a product of category C (production once every three weeks) it indicates that the minimum production should 3 x 2437 = 7311 PUMs. By suggestion of the DSP department of Nestlé an extra 20% should always be added as safety stock and to prevent ruptures, 7311 x 1,2 = 8773. From these calculations it is possible to make a suggestion of improvement reducing the minimum lot size for 9000 reduces the proposed stock cover in about 1,8 days. In table 20 the improvement proposal and the impact in the stock cover is summarized.

Table 20 - Minimum Lot Size Analysis for SKU 15

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	2437	10000	28,10	22
Suggestion 1	2437	9000	26,30	19

6.2.4.3- SKU 16

Figure 31 shows the behavior of SKU1 DPA and Bias that had a distinct behavior during the year 2016-2017.

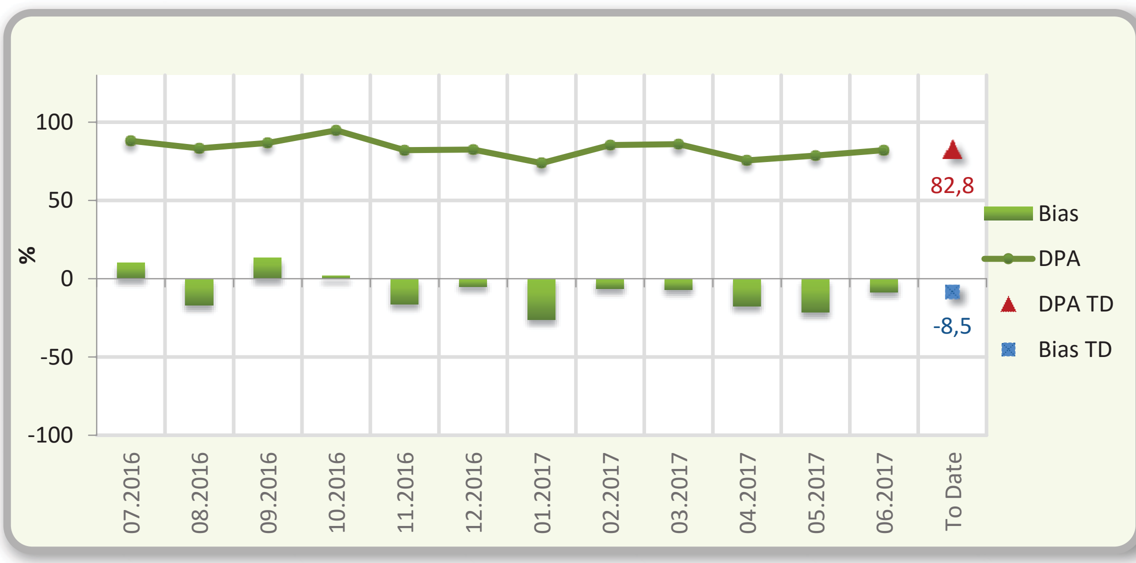

Figure 31 – SKU 16 DPA and Bias analysis (retrieved from Unbundlor)

For this SKU the values of DPA were mainly stable and with an average of 83,3% during the period of 2016 and 2017. Note that in January 2017 the bias was very high and the DPA was a little bit low compared to the average, which is an indicator of overestimating the demand plan, leading to overstock situations. From November to June the Bias was continually negative which means that every month in this period the sales overcome what was expected which could eventually lead to stock rupture.

Following the same logic of the previous analysis, the average weekly future demand gives an indication that a minimum of 1506 PUMs of products are needed per week, since this is a product of category A (production once per week) it indicates that the minimum production should 1506 PUMs. By suggestion of the DSP department of Nestlé an extra 20% should always be added as safety stock and to prevent ruptures, 1506 x 1,2 = 1807. From these calculations it is not possible to make any suggestion for the improvement of this particular stock cover. As seen in table 21, the minimum lot size is optimized at 2000 PUMs with a proposed stock cover of 27,7 days.

Table 21 - Minimum Lot Size Analysis for SKU 16

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	1506	2000	27,70	5

6.2.4.4- SKU 17

Figure 32 shows the behavior of SKU1 DPA and Bias that had a distinct behavior during the year 2016-2017.

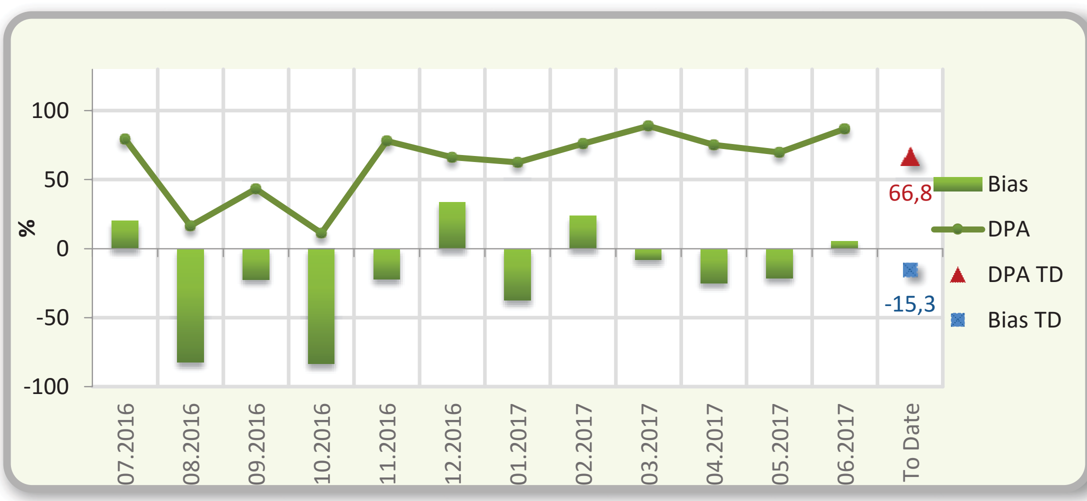

Figure 32 – SKU 17 DPA and Bias analysis (retrieved from Unbundlor)

From the graph above, it is possible to see an erratic behavior during 2016 with special notice to August and October where the bias was -82,4% and -83,3% which means that the sales over exceeded expectations which could eventually lead to stock rupture scenarios. In 2017 the bias and DPA stabilized with more desired values and with the bias oscillating between negative and positive. The average DPA was 68,3 % during all the periods considered.

For this SKU, the average weekly future demand gives an indication that a minimum of 8240 PUMs of products are needed per week, since this is a product of category A (production once per week) it indicates that the minimum production should 8240 PUMs. By suggestion of the DSP department of Nestlé an extra 20% should always be added as safety stock and to prevent ruptures, 8240 x 1,2 = 9888. From these calculations it is not possible to make any suggestion for the improvement of this particular stock cover. As seen in table 22, the minimum lot size is optimized at 10000 PUMs with a proposed stock cover of 29,6 days.

Table 22 - Minimum Lot Size Analysis for SKU 17

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	8240	10000	29,60	6

6.2.4.5- SKU 18

From Figure 33 below it is possible to see that the behavior of the bias indicator in the year 2016 varied between positive and negative but with high values in October and December. In 2017 the same happened in the month of January, also in March and April stock was accumulated because it sold less than it was expected. The average DPA of this SKU was around 69,6%.

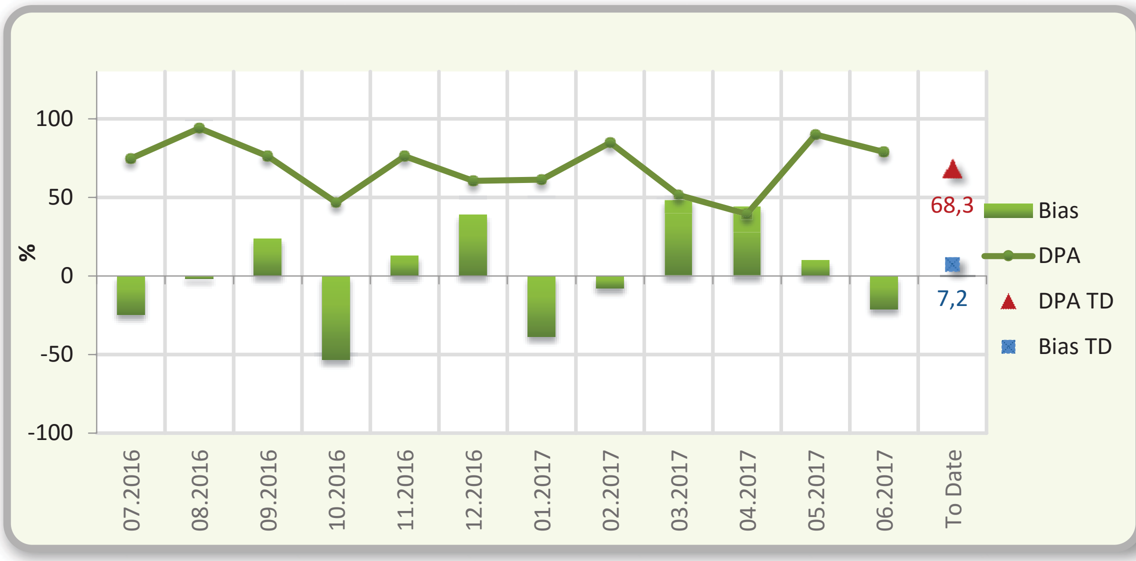

Figure 33 – SKU 18 DPA and Bias analysis (retrieved from Unbundlor)

For SKU 18, the average weekly future demand gives an indication that a minimum of 8240 PUMs of products are needed per week, since this is a product of category B (production once per week) it indicates that the minimum production should 1421 x 2= 2842 PUMs. By suggestion of the DSP department of Nestlé an extra 20% should always be added as safety stock and to prevent ruptures, 2842 x 1,2 = 3410. From these calculations it is not possible to make any suggestion for the improvement of this particular stock cover. As seen in table 23, the minimum lot size is optimized at 4000 PUMs with a proposed stock cover of 49,6 days.

Table 23 - Minimum Lot Size Analysis for SKU 18

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	1421	4000	49,60	15

6.2.4.6- SKU 19

From Figure 34 it is possible to see the behavior of the DPA and bias indicator. It is worth highlighting the month of October 2016 and May of 2017 where the significant negative bias indicates that the forecast was really wrong and that the amount of products sold was much bigger. In addition, the positive bias indicates that sales did not meet expectations and lead to stock accumulation. The Demand Plan Accuracy of these periods had an average of 71,1%.

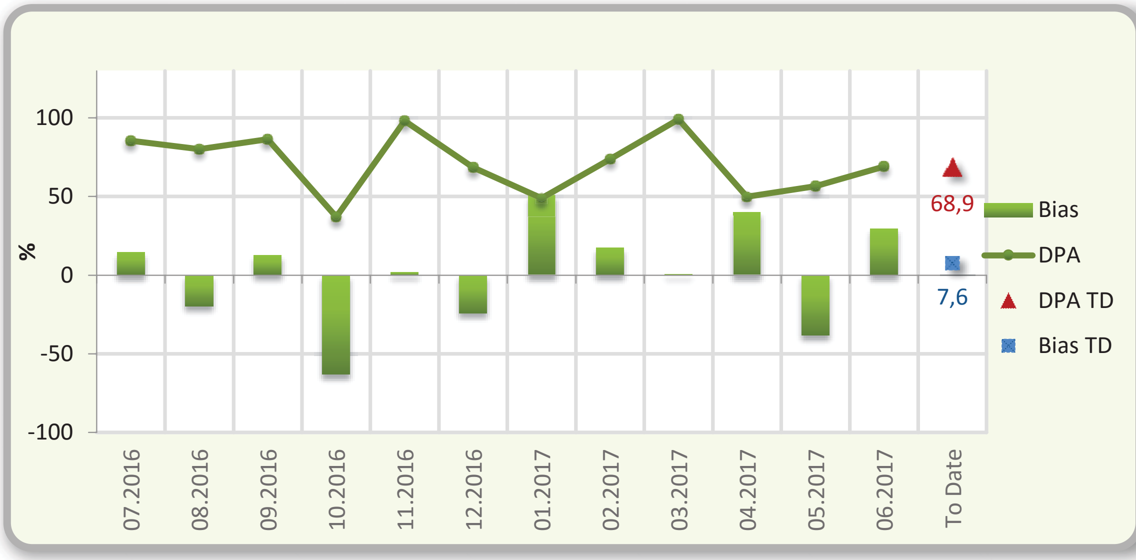

Figure 34 – SKU 19 DPA and Bias analysis (retrieved from Unbundlor)

Following the same logic from the previous analysis, the average weekly future demand gives an indication that a minimum of 1958 PUMs of products are needed per week, since this is a product of category A (production once every week) it indicates that the minimum production should be 1938 PUMs. By suggestion of the DSP department of Nestlé an extra 20% should always be added as safety stock and to prevent ruptures, 1938 x 1,2 = 2325. From these calculations it is possible to make a suggestion of improvement reducing the minimum lot size for 3000 which reduces the proposed stock cover in about 0,3 days. In table 24 the improvement proposal and the impact in the stock cover is summarized.

Table 24 - Minimum Lot Size Analysis for SKU 19

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	1938	4000	33,40	8
Suggestion 1	1938	3000	33,10	7

6.2.4.6- SKU 20

From Figure 35, it is possible to see that in 2016 the DPA and bias had a problematic behavior where in the first two months the bias was positive, which means that the sales were over the forecast and in the other months , the bias was negative which means that for four months the sales were over expectations, leading to stock rupture. In 2017 the behavior improved but the bias was still positive. The ideal is to have a bias oscillating between positive and negative. The average DPA of this period was around 59,6%, which is not optimum.

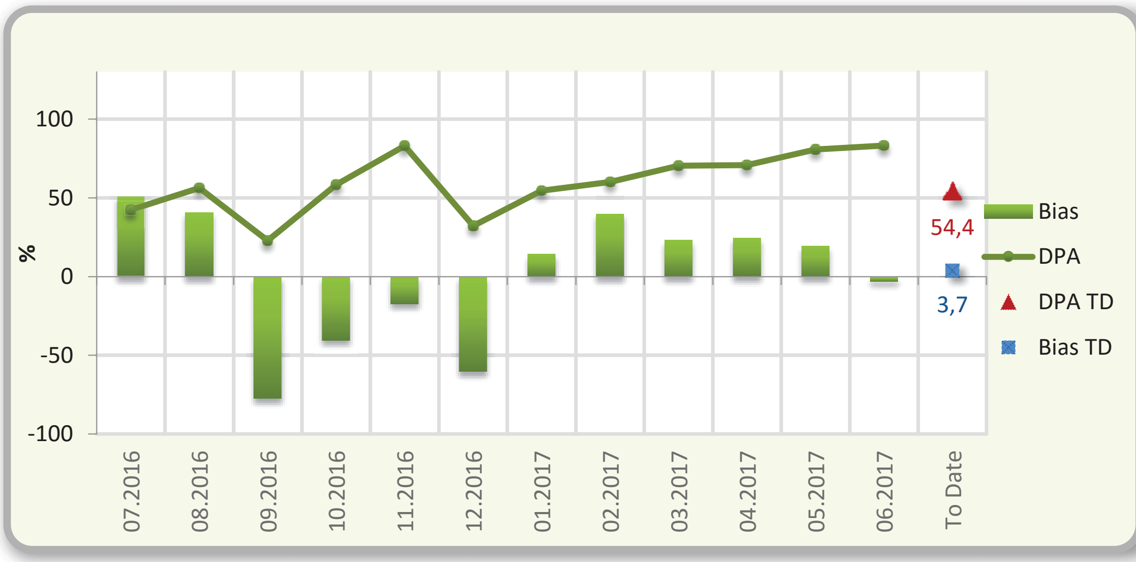

Figure 35 – SKU 20 DPA and Bias analysis (retrieved from Unbundlor)

For SKU 20, the average weekly future demand gives an indication that a minimum of 2321 PUMs of products are needed per week, since this is a product of category B (production once per week) it indicates that the minimum production should be 2321 PUMs. By suggestion of the DSP department of Nestlé an extra 20% should always be added as safety stock and to prevent ruptures, 2321 x 1,2 = 2785. From these calculations it is not possible to make any suggestion for the improvement of this particular stock cover. The minimum lot size is optimized at 4000 PUMs with a proposed stock cover of 34 days, as seen in table 25.

Table 25 - Minimum Lot Size Analysis for SKU 20

	Average weekly future demand	Minimum Lot Size	Avg. Future Proposed Inventory Cover	Production Frequency
	Report	Manual	Calculated	
	PUM	PUMs	Days	Days
Previous	2321	3000	34,00	7

6.2.4.7. Recommendations for Dairy and Cereals

For the sub-category Dairy and Cereals a total of 7 SKUs were analyzed in terms of DPA and Bias during 2016-2017 and in terms of possible improvement in the minimum lot size. This sub-category is produced in the Avanca factory which is a very old facility with very low flexibility, for that reason the minimum lot size can only be multiples of 1000 PUMS.

From the previous analysis, it's possible to see that SKU 14 can be improved reducing the Minimum Lot Size from 4000 to 3000 PUMS giving a reduction of stock cover of 39,40 – 34,60 = 4,8 days. Also, SKU 15 has a suggestion worth mentioning that decreases the stock cover by decreasing the Minimum Lot Size from 10000 to 9000 PUMs leading to an 1,8 days improvement of proposed stock cover.

The SKU 16, 17, 18 and 20 there is no possible suggestion of improvement, the product is already optimized. In addition, it's possible to see that SKU 19 can be improved reducing the Minimum Lot Size from 4000 to 3000 PUMS giving a reduction of 33,40 – 33,10 = 0,2 days.

As seen in section 4.2.2 table 5 the 2017 target stock cover for the sub-category Dairy and Cereals is 29 days. On October 2017 the real stock cover was 31,3 days. When implementing the suggestions on SKU 14, 15 and 19 to the Unbundlor, the estimated stock cover for the whole sub-category improves for 30,7 days.

7. Improvement proposals

In this section, the conclusions of the data analysis of the previous section are outlined. As it was demonstrated in Section 6.1, the CFR follows an exponential distribution – the money invested in stock (meaning stock cover) would increase exponentially if the CFR increases more than 99,1%, and in fact if the CFR is decreased, the stock cover would also decrease exponentially. However, Nestlé worldwide is not keen on scarifying the service level (which is translated in customer satisfaction) in order to save money on inventory. The other main influencer of the stock cover is the DPA that relates the accuracy of the forecasts made by the demand planners, this is a well know problem for Nestlé and they are continually trying to improve their forecasts. And for that reason, it is important to know the process that drives the demand forecast of Nestlé which will be presented in the following chapter.

7.1 Process and Problems related with sales forecast

The process of sales forecast made in Nestlé is based on a set of meetings that have the objective of validating the forecast in the short term, medium term and long term, but also to identify opportunities and risks of business. The meetings designated Monthly Business Plan or MBP are organized in the following sequence:

1st - Monthly Sales Review (MSR) - The main objective of this meeting is to assess and analyze the sales of the previous month in terms of quantity and KPI’s. The teams of Sales, Marketing, Finance and Supply Chain join together to align ideas and information, the ultimate objective of this meeting is to build an aggregated forecast of demand for the following three months.

2nd – Monthly Gap Review (MGR) – In this meeting the output of the previous meeting (demand forecast for the next three months) is analyzed by the finance and control people which present the profit and loss that are associated with this prediction. This information is important for the final decision.

3rd – Monthly Forecast Review (MFR) – in the third meeting the Demand Planners present the output of the previous meeting to the directors where they analyze the data and approve it or not.

4th – Monthly Operations Review (MOR) – In this meeting where the team of demand and supply planning presents the logistics KPI’s associated with the products. The output of this meeting is actions that can be taken to address the situation at hand.

After these meetings there is one more step: the value that comes out from the MBP is aggregated for sub-category of business and is responsibility of the Demand Planner to desegregate the prediction in each SKU of the sub-category.

As previously mentioned, the Demand Planners are aware that this system is not perfect and that there are several problems associated with sales forecast. The following are particularly common:

- Promotional prices in the market –when the price set by Nestlé's clients are lower than the average price of the general market, influencing the consumers to buy more and increasing sales leading to unplanned orders.
- Error in estimating the impact on client activity – it is very hard for the demand planners to accurately estimate the impact of islands, fairs, or additional spaces displays and eventually this leads to errors in predicting demand.
- Seasonality – the impact of seasonality of sales is already included when making the forecast but still this component is very hard to predict and the impact is not always correctly estimated. This component has great impact on planning production.
- Blocked article from clients – is when clients stop ordering some product without communicating in advance to Nestlé. This situation is often associated with periods where the price of the product is too low and profitability for the client is diminished to a point that becomes negative.
- Production Problems –situations that affect the normal function of the factory which negatively influence the forecast.
- Promotional activities – when the clients decide to make promotions without informing Nestlé. This situation if prior of the MGR always causes increased sales which were not planned by Nestlé.
- Additional sales after MGR – sometimes there are sales with some clients that happen after the meeting where the forecasts are made that eventually increase the volume of sales and decrease the DPA significantly.
- Displaced price –when the price of a product is below the average price market and there is an increase in sales which leads to an increase of unplanned orders of that product, increasing the DPA.

The above situations are the most common in terms of forecasting errors that affect DPA, although there are other causes that are punctual situations and cannot be described. In the next section the improvement proposal relative to the analysis performed of the minimum lot size is discussed, as well as suggestions on how to improve some of the forecasting errors outlined above.

7.2 Improvement Proposals

Here are the suggestions for improvement relating to the minimum lot size per SKU with the objective of reducing the stock cover of Nestlé and subsequently reducing costs. Four sub-categories were analyzed: Soluble Cereal Drinks; Nescafe Dolce Gusto; Chocolate Base; and Dairy and Cereal.

For the sub-category Soluble Cereal Drinks a total of 6 SKUs were analyzed. All produced in the Avanca factory which is a very old facility with very low flexibility, for that reason the minimum lot size can only be multiples of 1000 PUMS. In table 26 it is possible to see a summary of the analysis of the 6 SKUs. The last column shows the difference between the average proposed future stock cover from the selected suggestion and the existent average proposed future stock cover. For example, Δ Average Proposed Stock Cover for SKU 1 is the difference between 48,9 – 41,6 = 7,3 days. Where 48,9 was the real average proposed stock cover and 41,6 is the optimized average proposed stock cover.

Table 26 – Summary of Improvement Proposals for Soluble Cereal Drinks

	Previous Minimum Lot Size	Suggestion Minimum Lot Size	Δ Average Proposed Stock Cover
SKU 1	5000	4000	-7,3
SKU 2	4000	3000	-4,7
SKU 3	6000	6000	0
SKU 4	6000	5000	-1,5
SKU 5	10000	9000	-2,9
SKU 6	10000	10000	0

From Table 26 one can see that it is possible to improve the stock cover at least in 4 SKUs of this category. The remaining two are already optimized in terms of minimum lot size. SKU1 and SKU5 have improvement proposals that could give more reduction in the stock cover, but diminish the days between productions, which could or not be acceptable for the factory (section 6.2.1.7). This should be studied more by the Demand and Supply Planning Department in order to make the best improvement possible.

For the sub-category Nescafe Dolce Gusto there were 4 SKU's analysed, all of them come from Girona, Spain where Nestlé has another factory. This facility is much newer than Avanca's which allows for better and faster flexibility being the minimum lot size multiples of 100 PUMS. In the next table it is possible to see a summary of the analysis made of this sub-category. Same as before, the last column shows the difference between the average proposed future stock cover from the selected suggestion and the existent average proposed future stock cover.

Table 27 – Summary of Improvement Proposals for Nescafe Dolce Gusto

	Previous Minimum Lot Size	Suggestion Minimum Lot Size	Δ Average Proposed Stock Cover
SKU 7	3300	3200	-2,23
SKU 8	3800	3700	-1,5
SKU 9	700	700	0
SKU 10	2000	1900	-2,05

In table 27 it is possible to see that the possible stock cover reduction of this sub-category is very limited compared to soluble cereal drinks. By indication of the Demand and Supply Planning Department this is due to the fact that this factory in Girona is much more optimized. Despite that it was possible to make some suggestions that would improve the stock cover of the SKUs. It is important to note that for SKU 8 there were suggestions that could give more reduction in the stock cover but further diminish the days between productions which could or not be acceptable for the factory (section 6.2.2.5). This should be studied in more detail by the Demand and Supply Planning Department in order to make the best improvement possible.

For the next sub-category of Chocolate Base there were only 3 SKUs analyzed. All produced in the Avanca facility. These products also have many constraints in terms of flexibility and technology which also makes the minimum lot size multiples of 1000. In the next table it's possible to see the summary of the proposals for this sub-category. As before, the last column is the difference between the average proposed future stock cover from the selected suggestion and the existent average proposed future stock cover.

Table 28 – Summary of Improvement Proposals for Chocolate Base

	Previous Minimum Lot Size	Suggestion Minimum Lot Size	Δ Average Proposed Stock Cover
SKU 11	4000	3000	-1,8
SKU 12	5000	5000	0
SKU 13	2000	2000	0

From Table 28, it is possible to see that in this sub-category there was only one improvement proposal which is not very significant. This is probably because of the low significance of this category compared to overall sales of Nestlé despite being over the target stock cover in 2016 (section 4.4.2).

In the last sub-category, Dairy and Cereal, 7 SKUs were analyzed. This subcategory is also produced in the facility of Avanca and for that reason has the same constraints as the other products that are produced there, the minimum lot size has to be multiples of 1000. Same as before, the last column of the following table is the difference between the average proposed future stock cover from the suggestion selected, and the existent average proposed future stock cover.

Table 29 – Summary of Improvement Proposals for Dairy and Cereal

	Previous Minimum Lot Size	Suggestion Minimum Lot Size	Δ Average Proposed Stock Cover
SKU 14	3000	2000	-4,8
SKU 15	10000	9000	-1,8
SKU 16	2000	2000	0
SKU 17	10000	10000	0
SKU 18	4000	4000	0
SKU 19	4000	3000	-0,3
SKU 20	3000	3000	0

From table 29 it is possible to see that there are 4 SKUs for which it was not possible to make any suggestion for the sub-category of Dairy and Cereal meaning that this category is already at optimum minimum lot size. Although it was possible to make one suggestion for each of the remaining SKU, it is important to mention that SKU 14 with a 1000 minimum lot size reduction can give a 4,8 days of stock cover reduction.

In relation to the Unbundlor there is one suggestion that could improve the overall performance of the tool. The Unbundlor only incorporates the DPA which is a good indicator to evaluate the accuracy of the demand plan, but the DPA doesn't distinguish the overestimate from underestimate, which is a problem because the Unbundlor also becomes insensitive to this difference, possibly leading to proposals of higher stock. A solution to this problem would be the utilization of the Bias indicator combined with the DPA in the tool, this would lead to a more accurate stock cover proposal.

7.3 General Conclusions

The main goal of this thesis was to improve the stock cover of Nestlé Portugal. In order to achieve this goal, the supply and demand chain of Nestlé were studied to fully understand the process by which demand and supply planning and delivery work.

Nestlé is one of the largest nutrition, health and wellness companies in the world present in 86 countries and with a portfolio of more than 2000 brands manufactured in 447 factories worldwide (Attachment 1). Nestlé SA has been in Portugal since 1933 and currently has a workforce of 1732 employees.

The present study describes the operations of Nestlé Portugal, in terms of logistics, portfolio of products, and the organization of the Demand and Supply Department. The focus of the work was on the stock management activities, more specific in stock cover optimization by means of the tool Unbundlor and the KPIs that influence the output.

This was followed by a state of the art and a study that focused on subjects such as logistics and supply chain management, stock and stock management and the importance these areas have in today's market. This study was of extreme importance as basis for the following data analysis.

There were two types of analysis of the data provided by Nestlé; firstly the selection of the sub-categories that were more off-target in terms of stock cover for the year 2016, which are: Dairy and Cereal, Chocolate Base, Nescafe Dolce Gusto and Soluble Cereal Drinks. The second analysis was in each individual sub-category where the possibility of reducing the minimum lot size in order to reduce the suggested stock cover given by the Unbundlor.

This analysis was accompanied by a DPA and Bias study that was important to understand and see the behavior of the stock and sales of each individual product. Many of the products had DPA and Bias related problems, having DPA values of 80% average is not so bad if the Bias varies between positive and negative. On the one hand, if the bias is always positive it means that the sales did not meet expectations leading to accumulated stock which in the long term is very expensive. On the other hand, if the Bias is always negative it means that the sales exceeded expectations which could lead to stock rupture and consequently decreased service level. In conclusion, the Demand Planners should be very careful with situations where the over forecasting and under forecasting occur repeatedly.

The analysis revealed that there are possible improvement proposals, from the 20 SKUs analyzed there were improvements in 11 of them. Some of the improvements significantly impacted the stock cover, but there were others were the improvements were not so significant. In addition, from the 11 SKUs that were improved, there are four that could reduce the minimum lot size even more (greater reduction in the stock cover). This possibility is real but depends on the ability of the factory of reducing the production frequency even more. From the suggestions made in all the subcategories it was possible to improve the stock cover from all the sub-categories. For Soluble Cereal Drinks it was possible to reduce from 24,4 days to 23,9 days. For Nescafe Dolce Gusto it was possible to improve from 21,3 days to 20,8 days. For Chocolate Base it was possible to improve from 27,4 days to 27,1 days. Last but not least, Dairy and Cereals was possible to improve from 31,3 days to 30,7 days. All of the sub-categories reduced the stock cover but none of them reached the target stock cover set for 2017, this is probably because the estimation was done in October the real stock cover could be better in the end of the year.

It is also important to mention some difficulties encountered during the development of this project: the complexity and size of data to treat, the Unbundlor files used, extracted data and other complex information made it very difficult to work. In addition, the focus of the project was only defined near to its end due to the lack of other choices in terms of inputs that could be challenged in the Unbundlor tool. Another difficulty was the structuring and writing of the document in such a way that the methodology, analysis and conclusions were perceptive to the reader.

On the upper side, the benefits of this thesis are related to the reduction of costs associated with stock held by Nestlé without compromising the service level which was the main goal. For future work related with this subject, is advised to study the benefits of investing in better factory technology for Avanca's in order to increase the flexibility of the minimum lot size and subsequently reduce the stock cover.

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9. Attachment 1

9.1 Brands and businesses of Nestlé

NUTRIÇÃO INFANTIL Leites Infantis, Papas para Bebés, Frutas e Refeições para Bebés e Lácteos Infantis.
HEALTH SCIENCE Nutrição Clínica.
ALIMENTAÇÃO Flocos e Farinhas de Cereais para toda a Família. Leite Condensado e Evaporado. Leite em Pó Completo e Magro.
KIT KAT, LION, TOFFEE CRISP, NUTS, SMARTIES, NESTLÉ CLASSIC, CRUNCH, MILKYBAR, NESQUIK, BACI, AFTER EIGHT, CAJA ROJA, QUALITY STREET, DAIRY BOX, GRAND CHOCOLAT e NESTLÉ SOBREMESAS.
MAGGI (Puré de Batata, Caldos, Sopas, Noodles, Suculento no Forno e na Frigideira) e BUITONI (Pizzas, Refeições Italianas e Massas Finas para Doces e Salgados).
FORA DO LAR NESTLÉ PROFESSIONAL, NESCAFÉ®, LOTE HOTEL, COMFORT OFFICE, CLIC, MOKAMBO, PENSAL, NESQUIK, NESTEA, MAGGI, CAJA ROJA, DOCELLO, SICAL, TOFA, BUONDI e CRISTINA.
MAXIBON, NESTLÉ BOMBONS, EXTREME, SMARTIES, NESQUIK, KIT KAT, NESTLÉ GOLD, NESTLÉ GELATARIA e PIRULO.
BEBIDAS Cafés Puros, Especialidades de Café, Achocolatados, Bebidas de Cereais com Café, Bebidas de Cereais sem Café e Cápsulas.
CEREAIS CHOCAPIC, ESTRELITAS, NESQUIK, COOKIE CRISP, GOLDEN GRAHAMS, LION, CRUNCH, CHEERIOS, FITNESS, CLUSTERS e CORN FLAKES SEM GLÚTEN.
PET CARE PRO PLAN, PURINA ONE, GOURMET, FELIX, FRISKIES, DOG CHOW, CAT CHOW, PURINA VETERINARY DIETS, TIDY CATS e DELIBAKIE.
NESPRESSO NESPRESSO.
ÁGUAS NESTLÉ SELDA, NESTLÉ AQUAREL e PERRIER.
DAVIGEL DAVIGEL e CRIAÇÃO BRIGADA.