



TAMPERE UNIVERSITY
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IMPROVING INVENTORY MANAGEMENT IN A PAPER SUPPLY CHAIN

UPM Sales

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ABSTRACT

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UPM Sales

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UPM is one of the leading forest industry companies of the world. In the competitive business environment of today the agility of companies is emphasized all the time. Modern day supply chains are under continuous need for transformation in order to increase their agility to serve their markets better. Having the best product is not anymore enough, but companies need to be able to deliver it to customers faster, cheaper and more reliable. It is crucial that the companies are able to manage their operations efficiently and improve them continuously.

The target of this research was to find out how the amount of working capital tied to non-sound CMR paper inventories of UPM could be reduced. It concentrated on studying current processes and their efficiency, gathering ideas to improve the current status of the problem and making suggestions how the problem could be proactively prevented in the future. The qualitative information used to analyze the problem was collected in form of interviews from people working with inventory topics daily, both in supply chain and at mill sites.

During the study significant improvements in the non-sound inventory level of the company were achieved. Particularly raising awareness of the problem and improving communication seemed to be key points to lead to a reduction in the inventory levels. Common targets were set as well as reporting to follow the development of the inventories. An atmosphere of continuous improvement was established and the targets set to this study were doubled thanks to active participation of all parties. The outcomes of this research show that with engagement of relevant people substantial results could be achieved and because of that also the financial performance was improved.

Key words: agile supply chain, inventory management, supply chain management

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ABBREVIATIONS AND TERMS

CE mills	Paper mills located in Central Europe: Augsburg, Caledonia, Plattling
CMR	Coated Mechanical Reels
DDSC	Demand-Driven Supply Chain
Finnish mills	Paper mills located in Finland: Kaukas, Kaipola and Rauma
JIT	Just-In-Time production ideology
MTO, MTS	Make-To-Order, Make-To-Stock concepts
MDSC	Market-Driven Supply Chain
Overflow warehouse	All mill warehouses as well as external warehouses located inside Finland, like ports and Cargo East Terminal (CET)
SCM	Supply Chain Management
SKU	Stock-Keeping-Unit
UPM	UPM-Kymmene Corporation / UPM Sales GmbH

1 INTRODUCTION

1.1 Background of the thesis

In today's competitive world just having the best product is not enough anymore. The companies need to be able to deliver their product or services to market faster and cheaper. Modern day's Supply Chains are under continuous need for transformation in order to increase their agility to serve their markets better and quicker.

Power in the supply chain has shifted downstream towards the consumer (Lee & Katzorke 2010, 3). While the companies need to optimize their operations, simultaneously they need to make sure that it is not done with the cost of customer service or delivery reliability. Otherwise the company will risk its future in the industry, as often the customers have a vast supplier selection and the possibility to choose another supplier that fulfils the customers' needs better. Therefore in order to succeed in today's challenging market situation the companies will need to be highly customer oriented and differ from their competitors by extraordinary service level.

One very common key performance indicator in big manufacturing enterprises is Return on Capital Employed (ROCE). Inventories are considered as company's current asset on balance sheet and in paper industry due to very large-scale production the amount of capital tied to these assets can be very significant. Therefore there was a clear need to study how the inventory level and the capital tied to it could be reduced. Inventory management is a daily task of several people working in the supply chain but the presumption was that it could still be done more efficiently and cost-effectively and by these means even better results could be achieved.

The theoretical production capacity only for UPM's CMR paper machines is up to 2,3 million tons per year. Paper inventories are considered as company's current assets on the balance sheet but cannot be realized to cash immediately. The capital tied to these stocks can be several million euros and instead of having this amount of money lying in warehouses, ports or transportation equipment and waiting to be diminished, it could be used for example for investments, product development or business acquisitions.

In UPM Paper Business Disciplines it is stated that inventory management is a financial trade-off between inventory costs and stock-out costs, for example conversion costs. The more stock, the more working capital (WOC) is needed and the more stock depreciation is suffered. Therefore the company wanted to find out what would need to be done in order to release this capital from inventories to other purposes. These above mentioned factors were the main drivers for the assignment.

1.2 Limitations and structure

This study will have a look on evolution of supply chain management and inventory optimization from Supply Chain Value Network point of view. Chapter 3, which is the literature part of this study, will concentrate on supply chain development and key concepts of Demand-Driven and Market-Driven Supply Chains as well as their benefits. It will also introduce some production and management strategies that companies should concentrate on in order to improve their performance in inventory management.

Chapter 4 will provide a description of different inventory classifications, their typical features and characteristics as well as factors causing these inventories. Also responsibilities of managing these inventory classes is clarified. Together with the company representative it was decided that the study will be limited to consider only non-sound finished goods inventories, meaning inventories that are not delivered to the customers in their current status but are for example faulty or obsolete and under company's responsibility. Also raw material inventories were left out of the scope. This limitation was done simply because of the responsibility sharing between different functions of the company: the supply chain is in charge of non-sound inventories and customer service of sound inventories that will be delivered to the customers eventually. Therefore the amount of total stocks is not studied, which leaves i.e. lead time calculations of prime stocks out of scope.

The study was an applied research trying to find a solution for the already existing problem as well as ways to prevent it. The study was carried out with a qualitative research methodology. Majority of the information was collected via interviews of production planners working in the supply chain as well as the relevant mill

representatives. Supporting data was gathered from the data management systems of the company. Chapter 5 will explain the research process and methods more in detail.

The interview questions concentrated on three bigger themes for production planners and two for the mill representatives. The results of the interviews are opened up and analyzed in chapter 6.

Chapter 7 consist of suggested actions based on the results analyzed in chapter 6. This action list including a proposal of responsible people for each point was delivered to relevant people in April 2016.

2 THE CASE COMPANY DESCRIPTION

2.1 UPM-Kymmene Corporation

UPM-Kymmene Corporation is one of the world's leading forest industry companies that employs almost 20,000 people around the world. It had production in 12 countries, employees in 45 countries, sales network in 6 continents and sales of almost 10 billion € in 2016. It has a long history in forest industry, the first paper and sawmill production plants were established already in 1870 and pulp mills the following decade. UPM-Kymmene Corporation was formed in 1996 when Kymmene Corporation and Repola Ltd with its subsidiary United Paper Mills Ltd merged. Nowadays the company is commonly known as UPM. The company's shares are listed on the NASDAQ OMX Helsinki stock exchange and it had approximately 85 000 shareholders in the end of 2015. The vision of the company is to be a frontrunner of forest industry by combining bio- and forest industries and build new, sustainable and innovation driven future (UPM website 2016).

The company consists of six business groups:

- **UPM Biorefining:** Pulp, timber and biofuels businesses
- **UPM Energy:** Hydropower, nuclear power and condensing power
- **UPM Raflatac:** Self-adhesive label materials
- **UPM Speciality Papers:** fine papers, label materials and flexible packing materials for Asian market
- **UPM Paper ENA:** Magazine papers, newsprint and fine papers.
- **UPM Plywood:** Plywood and veneer products

In addition there are other supporting operations like Wood Sourcing and Forestry. Paper ENA is the largest of these groups with 45 % of sales, total 4 818 million euros in 2016. However, out of these six business groups UPM Paper ENA's share of comparable EBIT was only 25 % (280 m€) in 2016, UPM Biorefining holding the biggest share of 36 % whereas its share of sales was only 20 %. Paper business is still bringing most of the turnover of the company but during the last decades its profitability has been decreasing significantly. However, UPM managed to improve the profitability of PAPER ENA from 2015 significantly with several saving programs. In UPM Energy, share of sales of which

was only 3 % in 2016 gained 10 % share of EBIT, which makes it one of the company's most profitable functions together with Biorefining.

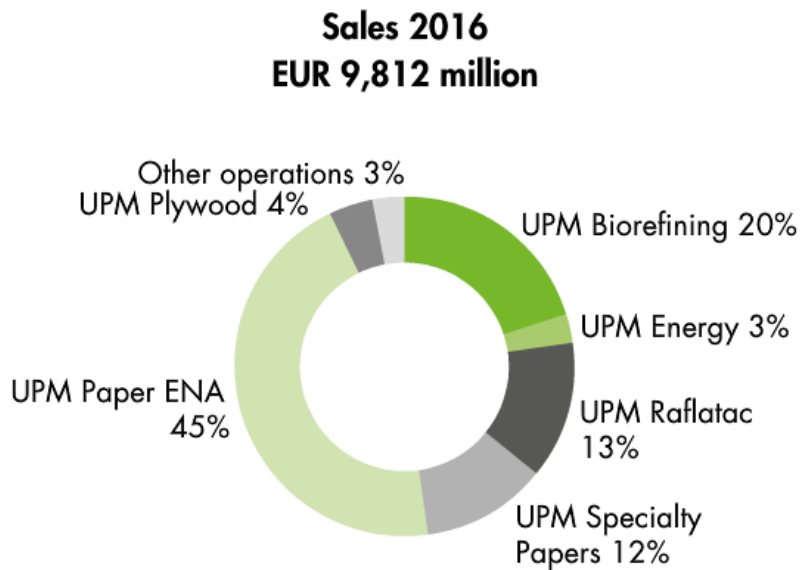


FIGURE 1. UPM's Sales in 2016 (UPM 2017)

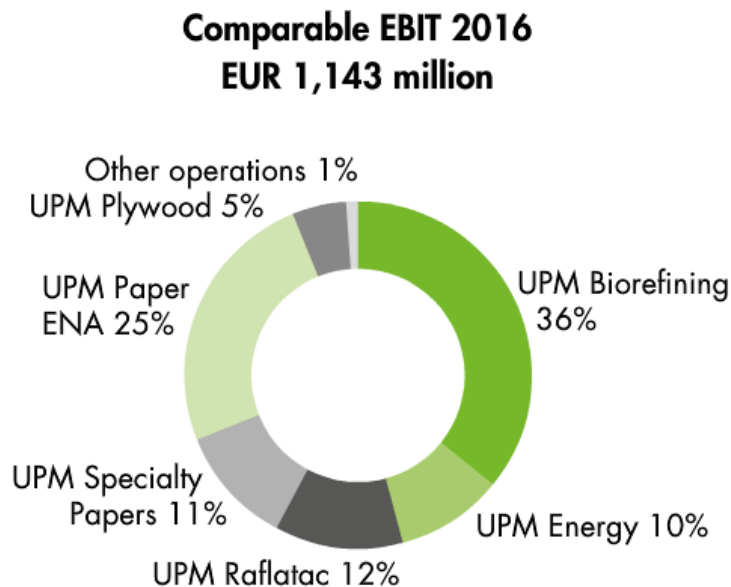


FIGURE 2. UPM's comparable EBIT in 2016 (UPM 2017)

UPM labels itself as the Biofore Company which means it targets to create value from renewable and recyclable materials. Resources are used as long as possible and in the end recycled and regenerated into new products, materials and energy. The target is to maximize value while minimizing waste with efficient processes. UPM Paper creates the basis of today's Biofore Company as it is made of renewable and recyclable raw materials and remains sustainable throughout its whole lifecycle.

2.2 UPM Paper ENA

UPM Paper ENA (Europe & North America) is the largest of UPM's six business groups with 45 % of UPM's sales, in total 4 818 million euros in 2016. It is the world's leading producer of graphic papers and employs approximately 8 600 people. The business group consists of two strategic business units (SBU's): Magazines, Merchants & Office (MM&O) and News and Retail (N&R), and it provides magazine papers, newsprint and fine papers for its main customers that are publishers, retailers, printers and merchants. UPM Paper ENA's 15 paper mills are located in Finland, Germany, the United Kingdom, France, Austria and the United States. They have annual capacity of more than 9 million tons and a wide product palette serving the needs of diverse customers.

MM&O business unit consists of Coated Mechanical Reels (CMR), Coated Mechanical Sheets (CMS) as well as woodfree products. UPM Sales GmbH, to which this study is conducted, is a subsidiary of UPM-Kymmene Corporation. It consists of Supply Chain, Sales, Customer Service and Inventory team as well as other supporting functions.

2.3 UPM Paper ENA Supply Chain

The supply chain of Paper ENA is divided in two centralized service centers, Supply Chain Augsburg and Supply Chain Dörpen. These supply chains are the contact points for UPM's sales and customer service organizations, production and warehousing units, inventory team as well as internal and external parties of logistics chain. The tasks of supply teams include determining product availability, order confirmation, production planning, delivery planning, inventory management and general order completion follow-up, as well as problem solving when normal processes cannot be followed. The objective of a supply chain is to ensure perfect order fulfillment by production and delivery reliability and guaranteeing cost and service efficient logistics planning.

2.4 CMR products

UPM is the leading manufacturer of magazine papers globally with theoretical annual capacity of 2,3 million tons in 2016. It has a wide selection of coated mechanical papers

to serve a vast range of diverse customers. The end use purposes of coated mechanical reels are normally magazines, catalogues and advertisement products and customers are usually publishers or printers. Europe was the most significant market area for CMR products in 2016.

The demand of graphic papers is driven by the amount of advertising in printed media and in targeted and unaddressed direct marketing as well as circulation and demand of magazine and newspaper products and consumption of home and office papers. Paper demand has been reducing continuously due to the increased use of digital media in the consumer market since 2007, but despite that UPM still sees growth opportunities in certain end-use and market segments.

The product offering of UPM's CMR paper consists of products with substance from 36 g/m² to 100 g/m² with different technical properties like shade, brightness and gloss. In Europe there are six paper mills and altogether 8 paper machines producing different CMR products for both Rotogravure (gravure) and Heat Set Web Offset (offset) printing methods. Kaipola PM6 and Plattling PM11 produce purely gravure products. Kaukas PM1, Rauma PM1 and Rauma PM4 have both gravure and offset grades in their product palette and Caledonia PM1 and Augsburg PM3 produce only offset grades. Plattling PM10 produces mostly offset reels but also some mother reels for the sheeting line within the same mill. In addition to the Central-European assets there is one CMR mill with two paper machines located in Blandin, USA and its customers are located in Northern America.

Majority of the raw-material wood UPM uses originates from certified forests that are sustainably managed. Therefore UPM is able to provide its customers paper with environmental FSC or PEFC certifications and EU Ecolabel, to name but a few. By providing paper with these internally known certifications UPM shows its engagement to sustainable development and values.



FIGURE 3. UPM Paper ENA's CMR mills in Europe (Anna Lammi 24.10.2016)

3 INVENTORY OPTIMIZATION IN A DEMAND-DRIVEN SUPPLY CHAIN

3.1 Supply Chain Management

Supply Chain is commonly understood as a company department, which manages the flow of materials, entities and the processes of bringing the company's products or services into market and customers. It manages the company's order handling, steers production, confirms product availability and manages the logistic chain of the goods. It coordinates all activities around these processes and aims to ensure customer satisfaction by timely and accurate delivery of the goods to the retailer or end customer. In other words, a supply chain is a link between the customer, production and logistics distribution, both inside the organization and with external parties. According to Skjøtt-Larsen et al. (2007, 17) the underlying concept of the supply chain is simple: it is a linear sequence of operations organized around the flow of materials from source of supply to their final distribution as finished products to ultimate users. Traditionally it includes sources of material resources, the organization of processors, distributors and users. It also involves supporting enterprises to provide transport, communications and other specialized functions. Together, they become a single coordinated entity that transcends organizational boundaries.

Council of Supply Chain Management Professionals (CSCMP) defines **Supply Chain Management** as follows:

Supply chain management encompasses the planning and management of 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. In essence, supply chain management integrates supply and demand management within and across companies.

In general, the complexity of a supply chain and its distribution network can vary greatly depending on the size of the company and the industry where it is operating. Blanchard (2010, 105-107) states that the ultimate goal of a distribution network plan is a supply

chain properly balanced between inventory, transportation and manufacturing, and an on-time delivery is a fundamental premise behind supply chain management.

3.2 Supply modes

3.2.1 Demand-Driven Supply Chain

According to Faraoni and Petretto (2009, 69-70) there are two types of Supply Chains: **Traditional** and **Demand-Driven**. Faraoni and Petretto see the Traditional Supply Chain as a Push-model that is based on anticipated demand due to long response time compared to market demand. In these models, the designing driver is the proper chain integration, the only element that can provide competitive advantage and value creation. The Demand-Driven Pull-model then again means that the waiting time of the market is longer than the time of production logistics so it is possible to work with pull logic and the process starts after the detection of market demand.

Versloot (2013) points out well the difference between traditional **Supply Chain Management** (SCM) and **Demand-Driven Supply Chain** (DDSC) management. According to him traditional SCM is driven by planning and communication and it is working continuously to ensure that all stakeholders get the information they need at the right time and can respond without incurring errors, cost overruns and delays. Although the customer is the factor who is driving demand, the producing and delivering company still decides what comes onto the market and when. In DDSC management however, there is a critical change in leadership: the customer dictates how the supply chain operates. A demand-driven network involves everything that customers want: quick turnaround, reduced costs and outstanding customer service. To sustain profitability, companies need to look at new ways of responding to demand and best practices for reducing operating costs while optimizing quality and service.

Versloot states that the biggest theoretical difference is that when traditional SCM aims to “optimize the flow”, DDSC management is more complex. It includes upstream and downstream relationships between suppliers and customers that need to be managed to deliver the lowest cost and the best value for the customer across the entire supply chain.

Customers, rather than companies, drive Demand Chain Management, which means that companies need complete, accurate and proactive visibility into customer trends. In short, the customer determines what he wants, how he wants it and when he gets it.

Shortly described, Cecere and Mayer (2013, 14) define DDSC as a business where the processes first sense and then shape demand based on revenue management practices. Cecere (2011) sees that demand-driven companies have five typical characteristics in common:

1. **Demand sensing:** The companies understand the fluctuations in demand and transform by moving from a push-based to a pull-based production system
2. **Active demand shaping:** Recognizing that just sensing demand is not enough but also shaping it needs to be done actively through demand orchestration. Demand can be shaped for example through new product launches, marketing programs, sales or channel incentives, after-market support and price management to speed up sales of product with slow demand. The key of being demand-driven is to actively shape demand to maximize profitability ensuring alignment of all functions to deliver against the opportunity
3. **Design of value networks for demand:** The companies need to recognize that they have multiple value networks which each have unique characteristics for response time, cycle times and flows. They understand that networks with high variability and high volumes need to be designed to be responsive, whereas networks with low demand variability can be push-based supply chains based on efficiency goals of lowest cost per unit. The goal of the supply chain shifts with demand variability.
4. **Agility through demand translation:** Enabling agility by flexible supply network, for instance by shifting manufacturing to another plant closer to the customer or shipping mode is changed to quicker one in order to ensure maximum value in the value network.
5. **Focus on outcomes:** The companies understand the difference in shifting the focus from the process to the outcome, which enhances the change management success of the organization implementing the strategy.

When demand-driven maturity is achieved, not only is there better balance, but greater agility. Quicker alignment enables better customer service with substantially less inventory, waste and working capital. (Cecere, 2011)

Budd et al. (2012, 3) claim that according to a recent research conducted by The Boston Consulting Group, companies with advanced DDSC can have substantial advantages: they can carry up to 33 percent less inventory, improve their delivery performance by 20 percent and as a result reduce supply chain costs dramatically. According to them, DDSC can be seen as a system of coordinated technologies and processes that sense and react to real-time demand signals from customers, suppliers and employees.

A report from the Economist Intelligence Unit (2009, 3-14) points out that it is not anymore enough that companies succeed to maintain an efficient supply chain that keeps inventory levels low and manufacturing lean. In addition the companies need to make their supply chains more responsive to customer demand and actively shape the demand towards more profitable business by applying new technologies and sophisticated analytics. They will need to be flexibly considering pricing, sales incentives, promotions and other marketing techniques to stimulate demand for their highest margin products and to maximize business with their most profitable customers.

The report by Economist Intelligence Unit (2009) advises that building DDSC operations requires:

1. Developed demand forecasting tools that allow adjusting forecasts and eliminate differences before including larger deviations and less predictable variables.
2. Real time visibility of supply and demand and accurate information throughout the network by integrated forecasting and demand management tools. In order to shape demand towards more profitable business companies need timely and accurate information on customer behavior. Close co-operation between sales, marketing and supply chain all the way to product development to build a cross-functional collaborative approach to sales and operations planning.
3. Profitability as a key indicator when measuring supply chain performance and customer differentiation to target the company's most profitable customers and promote their most profitable products and services.

Demand management is not only matching supply and demand anymore, but it must also include encouraging demand for high-margin products through low-cost sales channels. In order to achieve that, companies must not only analyze and manage pricing and promotions to optimize their effectiveness, they also need to develop the co-operation

between sales and marketing together with supply chain. In other words, the goal is not only to match supply and demand, but also to do that in a way that maximizes profitability.

Budd et al. (2012, 4) emphasize four key pillars for a DDSC:

- **visibility**: transparent demand and inventory levels across the supply chain
- **infrastructure**: when built strong, the supply chain can adapt to short term changes in supply and demand quickly
- **coordination**: flawless and cost-effective execution of strategies
- **optimization**: not only reduction of costs but also delivering best customer service and gaining financial benefits

According to Budd et al. (2012, 4), following these above mentioned key points allows the supply chain to react quicker to changing markers, to minimize its stock outs and lost sales, maintain lower inventory levels, ensure faster and more accurate order fulfillment with lower costs and above all, gain higher rates of customer satisfaction and make better use of its operating assets.

Chase and Cecere (2012, 38) state that the largest benefit of a Demand-Driven Value Network is assessing and building the value network to meet upcoming demand. By value network they mean a strategic network of trading partners that focuses outside-in to drive value-based outcomes. They say that the use of technologies to sense market insights from unstructured data has helped companies to sense potential supplier failures before the issue percolated into the supply chain.

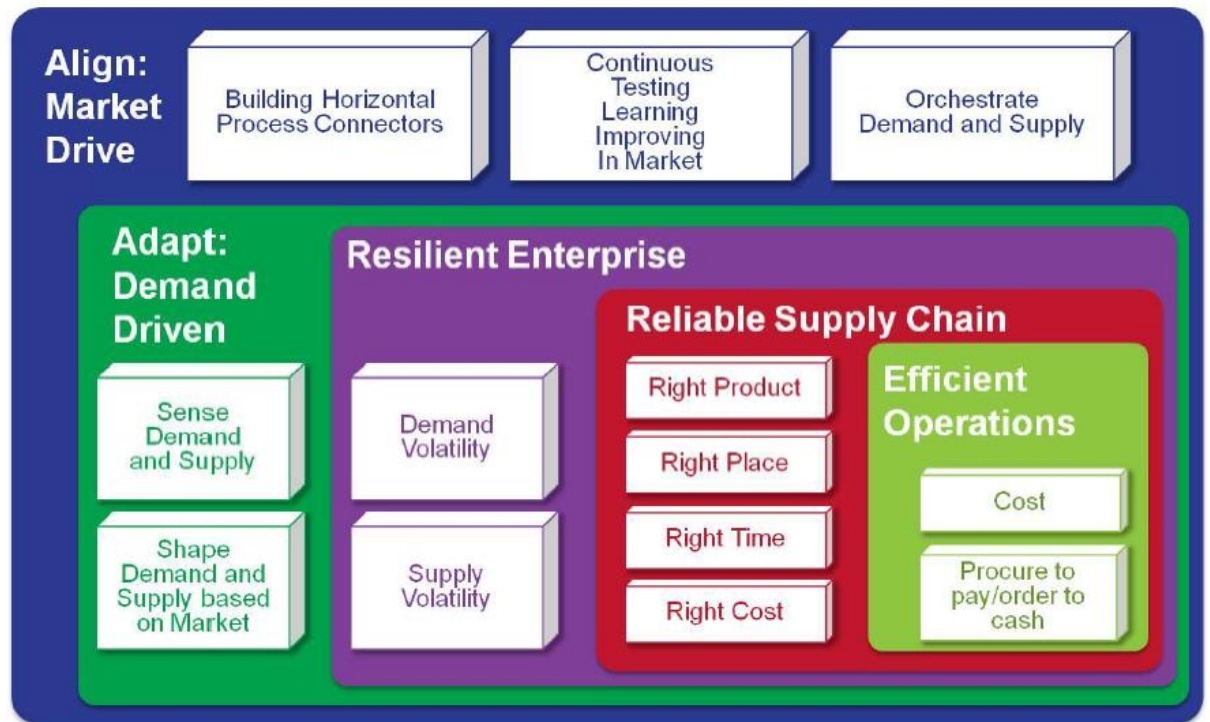
3.2.2 Market-Driven Supply Chain

When the concept of a Demand-Driven Supply Chain or Value Network is developed further, the next stage is considered as a Market-Driven Value Network. Cecere (2012, 3) defines it as follows:

Market-Driven Value Networks are adaptive supply chains that can quickly align organizations market-to-market to focus on the delivery of a value-based outcome. They sense and translate market changes (buy- and sell-side markets) bidirectionally with near real-time data latency to better optimize and align sell, deliver, make and sourcing operations to the goal. The focus is on horizontal process orchestration.

Cecere (2012, 15-21) introduces five phases of Supply Chain evolution (Figure 4).

1. The Efficient Supply Chain, where supply chain excellence was defined as the lowest manufactured cost.
2. The Reliable Supply Chain, where consideration of customer satisfaction and trustworthy deliveries drove the change. Focus changed to balancing costs with reliable customer service and working capital management.
3. The Resilient Supply Chain, where supply chains became networks and they started sensing the changes in demand and supply as well as market conditions.
4. The Demand-Driven Supply Chain, where after sensing the changes in demand the supply chains started shaping and adapting based on them.
5. The Market-Driven Supply Chain, where the Supply Chain is aligned market-to-market.



Source: Supply Chain Insights LLC

FIGURE 4. The Five Stage Evolution Model of Supply Chain Processes (Cecere 2012, 16)

Cecere (2012, 21) sees the Market-Driven Supply Network as a future state aspiration for supply chain leaders. The concentration is on developing strong horizontal processes, effective value networks, redesigning supply chain processes and retraining the organization. In a market-driven value network the focus needs to be on value-based outcomes and the processes need to be constructed from the customer to supply chain.

3.2.3 MTO and MTS production strategies

All companies need to have an inventory strategy. According to Sheldon (2006, 4), defining an inventory strategy means that the company needs to carefully consider where it wants to have its buffer inventory, raw materials or finished goods, or if it is possible to avoid it completely. Depending on the industry, companies can even have several inventory strategies and it should always be considered for each product separately. It is rare that a manufacturing plant could manage completely without buffer inventory, but if its flexibility and responsiveness within the supply chain matches the customers' needs, it can be possible.

In complex supply chains that have production in several facilities, inventory costs often form a significant part of total networking costs (Kaminsky & Kaya 2008a, 276-277). They see that one way to efficiently manage the inventory is to wait for customer orders before starting the production process; a facility managed in this way is called a Make-To-Order (MTO) principle. The other alternative is to produce the goods according to the best estimation of demand and hold it in inventory until customer orders are received, this is known as Make-To-Stock (MTS) principle. If the manufacturing company is not able to build inventory but is able to arrange relatively short production runs flexibly and with short notice it can steer its production to function according to MTO principle.

Short notice is essential due to customer lead times, so that the time between order placement and delivery is reasonable. Ability to build up inventory does not depend only on the financial possibilities to have enough capital to tie to it but also the uncertainty of demand. If the demand is well known and relatively sure, the product does not need to be very customized and the company is able to build some inventory, it works according to MTS principle.

MTS production is normally required when the production time of single item is too long compared to the lead time the customer is expecting to get. However, the less inventory is needed to run the business and meet the customers' demands, the more positive the effect to manufacturing costs usually is. Therefore many companies target to minimize the indirect costs caused by the inventories. Just as well also the customers want to invest their capital to something else than inventories, requiring shorter ordering and lead times from their suppliers. Therefore a supplier offering finished items from stock is the most feasible choice for them and depending on the competition in the industry, the lead time can easily be the factor to seal the decision regarding supplier.

MTO production is a challenge especially when the specifications vary significantly and regularly and the lots are small. In addition, the longer lead time can end up being a bottleneck due to the fact that the production is planned from scratch. It is a prerequisite that companies that work according to MTO principle are able to turn raw materials into a finished product within a time frame that satisfies the customer. Characteristic for the business is that there is some stock for raw materials which is converted to customer orders once they are received.

According to Davis (2013, 26-31) there can be as much customization as required in the MTO-production, because each unit of production is based on a known order. The customer has already agreed to take the good so there is no need to fear that the order would be cancelled and the stock would be left to manufacturing company's hands. It should be a standard rule in the supplying company, that the customer keeps its commitments and takes the products he has ordered in the first place. Some benefits of MTO-production are that the company can not only customize the product as needed but also it is able to optimize delivery scheduling and inventory costs when demand is known exactly. If the company is unable to predict end-user demand and it needs to provide high service level with even shorter notice, the required inventory will end up rising regardless of the efficiency of the production system.

In addition to MTO and MTS strategies some companies utilize Assemble-To-Order (ATO) strategy, which combines parts of both strategies. In practice it means that part of the products is already prepared as semi-finished goods but will be completely assembled and finished only after the customer's order arrives. Sheldon (2006, 27) sees that MTS strategy has more cost associated with it due to inventory requirements. Lean processes drive flexibility and speed, reducing inventory requirement and allowing more SKUs at the finished goods level to be moved to ATO-strategy. ATO-strategy however does not work in all industries or in case the end product is completely customized. The advantage of it however compared to a MTO-strategy is shorter lead time due to semi-prepared products.

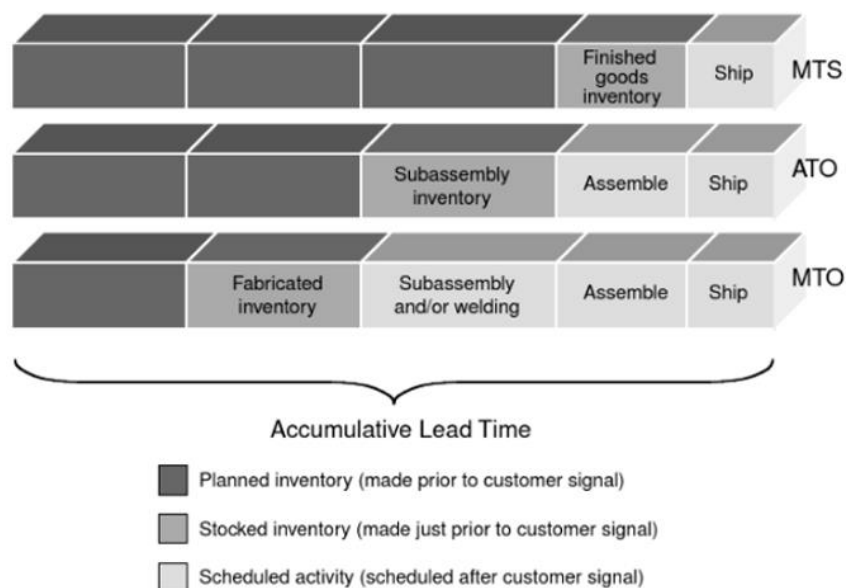


FIGURE 5. Inventory strategy (Sheldon 2006, 5). A modified copy.

Kaminsky and Kaya (2008b, 445) state that the most critical performance measure for any company operating a MTO-system is fast and on-time delivery. According to them the amount of companies directing their functions to MTO-strategy direction was growing as they were targeting to satisfy customer with customization-based approach and also decrease inventory costs.

At UPM absolute majority of the production is prepared according to MTO-principle and directly to customer orders. For CMR-side only Augsburg PM3 is producing Stock-keeping units (SKU's) that are quantities are made to stock according to MTS-principle. Due to the nature of the business where the volumes are very high and specifications vary a lot, MTS-production is not a preferred option in a bigger scale. Current SKU's are determined based on the most common specification where volumes are high and which are used by several customers. These SKU's allow quick deliveries when customers have an urgent need but can be flexible regarding on the grade or specifications. Having any semi-finished products i.e. unwinded machine reels as an intermediate stock in the production line to allow quick deliveries is not an option. Because of high volumes, these stocks would block the production line within a few hours and end up causing a machine downtime.

The whole paper industry is continuously facing a lot of pressure from the market to reduce the customer lead times which will keep the business challenging also in future. In order to survive in the challenging environment UPM has to ensure it is able to serve its customers better, quicker and more reliable than its competitors.

3.2.4 JIT –production

Sometimes inventories are understood mostly as a raw-material supply but it also includes Work-In-Progress (WIP) and the inventories for finished goods. Inventory is money that could be invested elsewhere earning a return instead of standing in a warehouse in form of unnecessary inventories. It ties up working capital and affects the company's cash flow.

Muller (2011, 2-3) sees that inventory costs consist of direct and indirect ordering and handling costs, i.e. money and physical warehouse space tied to inventories, costs of labour (handling, checking, shipping, packing and managing the goods), deterioration, damage, obsolescence and possible risk of theft. However, the advantages and biggest reasons for holding inventory are predictability, fluctuations in demand, unreliability of supply, price protection, quantity discounts and lower ordering costs.

Inventory is one of the most important flows in the supply chain and how it is managed can significantly impact a company's success. Mangan et al. (2016, 184-185) see there are four key principles how a company can pursue to effectively manage and reduce inventory holdings.

- 1. Pool inventory:** When demand for inventory can be combined, the safety stock can be lowered by inventory centralization. Also production can be centralized by delayed product differentiation in order to benefit from combined raw materials and common components.
- 2. Reduction of variation:** Decreasing variation in various factors like lead time, demand, supply or quality, which all contribute to safety stock. When variation can be reduced, so can safety stock, as less anticipation is needed.
- 3. Reduction of lead time:** When the lead time is long, there is need to forecast further in the future. However the further it is forecasted, the less accurate the forecast is and often higher safety stock is needed.
- 4. Following Just-In-Time –principle.**

Even though inventory is essential, it always means increased costs. It is an essential task for a supply chain to reduce these costs while succeeding to keep its customer service at a suitable level. In a Just-In-Time (JIT) manufacturing environment inventory is considered as waste. JIT is rather a philosophy than an inventory management technique.

It is not a modern concept, its roots originate to 1980's and Japanese manufacturing industries. However still, after over 30 years, many companies are not able to utilize the full benefit of JIT ideology but are struggling with optimal production scheduling.

JIT production means that the right products are produced and delivered in right amount, at the right time using minimum necessary resources (TPS Handbook). Therefore the amount of money and space tied to inventories is kept to minimum and early and overproduction prevented. In addition, according to Muller (2011, 146) the many benefits of JIT system include:

- Reduction of stockouts
- Reduction of inventory levels
- Reduction of need for material handling equipment
- Reduction of time frames between delivery and production
- Significant quality improvement
- Employee inclusion in continuous quality improvement

According to Mangan et al. (2016, 185) JIT has two core concepts, first one being the problems inventory hides. Inventory is needed because of variation that can for example be caused by equipment failure or bad quality and inventory is needed to cover these variations. However, it would be essential to eliminate the root causes for this variation so that safety stock to cover variation is not needed in the first place.

The second core concept is small lot production. It means that JIT seeks to reduce order processing costs so that the idea of small quantity ordering can be accomplished. This usually requires that the suppliers are close and the ordering protocol is simplified. Small lot production enables lower average warehouse level as it eliminates early and pre-production.

JIT-principle targets to raise the company's efficiency by eliminating variety of waste. According to Muller (2011, 147) and TPS Handbook (2006) there are seven types of waste JIT systems strive to eliminate:

1. **Overproduction** — producing either more than what actually is needed or producing the goods too early. Overproduction is wasted money as raw materials are not used to produce only essential goods, wasted effort with work, that could have been avoided, that is needed to handle the overproduction and wasted warehouse space that the goods tie when they will not be shipped to customers.
2. **Waiting time** — Time is a limited resource and in a production environment time is money. All waste of time and waiting time of employees should be eliminated as it decreases productivity and efficiency.
3. **Transportation or conveyance** — Inefficient production or warehouse layout, extra handling or moving of the inventories, unnecessary transport of goods.
4. **Processing** — Over or insufficient processing should be avoided to save time and effort in the manufacturing process.
5. **Inventory** — Redundant inventory ties up assets such as capital and space and requires additional handling, which again requires additional labor and equipment.
6. **Motion** — Eliminating unnecessary movement of people, like turning and reaching, to improve efficiency.
7. **Defects or corrections** — A result of poor internal quality. Defective goods do not only cost money directly as financial loss related to the part but also as wasted labor by holding and handling defected inventory in the warehouse. In addition, it always includes the risk of inferior product accidentally being given to the customer.

In a JIT-production environment it is essential to make sure that information flow, whether it is manual or electronical, is smooth throughout the whole process in order to have integrated manufacturing activities. One key concept in a JIT-production environment is Kanban, introduced by TPS Handbook. It is a visual sign or signal that gives instructions to withdraw parts or to produce a certain product. It is commonly understood as a card that moves between processes while passing the information of what materials need to be replenished and its main purpose it to ensure a constant information flow through the organization.

Minimizing the money tied to raw materials and reducing its turnover time requires reliable raw material deliveries from suppliers. The whole process is only as strong as its weakest link and if any part of the process is unreliable the whole process is at risk.

Trustworthy suppliers, subcontractors and production process itself are key elements to a successful supply. With successful production scheduling the turnover time of raw materials and finished goods can be reduced significantly. Producing right items in right quantities and keeping it in safety stock is easy and reliable from the customer's point of view but it also ties money and space making it most expensive option for the manufacturing company. The amount of so called buffer or safety inventories to secure demand and supply uncertainties should be carefully considered. Setting maximum inventory and alert levels can help the organization follow up and prevent the fluctuations and major changes in its inventory level. The companies should target to ship finished goods out of its premises as soon after production as possible. The most feasible solution would be to ship the goods immediately after production. Not only would it minimize the warehousing time but it would also prevent additional waste of labor time and damaged products by avoiding extra handling.

3.3 Inventory optimization

Inventory itself is not waste. Only unnecessary inventory that cannot be cost-efficiently utilized is waste. According to McDonald (2009, 28) one key management responsibility of a good materials organization is to reduce and manage the inventory to the lowest possible level without hindering productions. It requires exceptional planning, high inventory accuracy and proper Materials Requirement Planning (MRP) system maintenance to lower inventories.

McDonald defines five areas to which inventory categories are usually broken down:

1. Finished goods
2. Work in process (WIP)
3. Raw materials
4. In-transit
5. Obsolete or inactive

It is important to know the total monetary value of inventory tied into each of these major categories in order to understand and identify any apparent issues. If one class of inventory is out of control, a thorough investigation is necessary in order to understand and correct the problems that are causing the imbalance. The amount of capital tied to

obsolete inventories is a factor that may prevent a plant from attaining its inventory goals. Many plants are reluctant to present the total monetary amount of obsolete material since this is a direct reflection on how well the plant is managed and obsolescence directly affects the profit margins. Consequently, many materials organizations are faced with unrealistic inventory reduction goals that will never be attained. (McDonald, 2009).

In order to make inventory targets motivating they should certainly be reachable. However, it is clear that in different kinds of production environments the acceptable inventory levels can vary significantly. The inventory level always depends on nature of the business. If the company's product palette consists of only few very similar products, predicting the amount of needed raw materials should be relatively easy. Also the rotation of finished goods should be rather quick and avoiding obsolescence easy as finished goods can always be used – the only question is to whom.

Blanchard (2010, 102-103) has collected best practices that companies have taken to maximize the productivity of their distribution facilities:

- Reducing the inventory
- Running as lean operation as possible, elimination of obsolete products and dead inventory.
- Working closely with suppliers to optimize accurate deliveries
- Selective stocking, considering what to stock and where
- Adding working hours of shifts in short term demand peaks instead of investing in technology
- Scheduling deliveries for more predictable operation
- Saving time by skipping the distribution centre entirely, strategy known as DC bypass. Delivering straight to retail stores instead of via warehouse
- Outsourcing warehousing to a third-party logistics provider.

3.4 Obsolescence

Obsolete inventory is inventory for which there is no future plan or which serves no purpose in its current status. Further actions are always needed in order to diminish this stock. The understanding of obsolete inventory varies depending on the company and industry where it is operating. In general, it means inventory that is not expected to be used within a reasonable time frame. Some industries are more sensitive to fluctuations in the market and consider unnecessary inventories as obsolete or aged after a relatively short time frame. In these industries inventory can turn to obsolete for example due to changing market or technology that improves quickly. In some industries on the other hand inventories can remain as usable and prime quality even after few years. In a MTO production environment the inventories that cannot be used for the specific order are generally considered as obsolete right after production.

Obsolete inventory that is allowed to build up without any plan to scrap, rework or sell the excess reserve serves no purpose other than to overstate a company's total assets. A bad scenario occurs when the company's sale results in the acquirer inheriting a large amount of obsolete material, a situation that happens too often. Materials control needs to assign the highest priority to managing obsolescence in plants without incurring an excessive amount of obsolete inventory. Some obsolescence issues are caused by a simple lack of communication between plant and customer and between plant and suppliers. Other obsolescence issues are caused by a general failure to manage releases and inventory properly. (McDonald 2009, 57).

Bragg (2010, 213-222) claims that even though inventory may be a company's largest asset, it should not be considered as an asset at all. According to him it is really a liability because it may become obsolete, it does not necessarily produce revenue and its value is constantly declining, and for these reasons a considerable amount of analysis is needed to keep inventory levels as low as possible without damaging profitability. In case a considerable proportion of a company's inventory is obsolete, there should be a system to sell this off for the best possible price, even though it would result in a loss. Otherwise the inventory will continue to lose value over time. A robust inventory dispositioning system can result in the recovery of a substantial amount of cash. Therefore it requires continuous and regular attention.

Finished goods inventory levels vary depending on the nature of the business and customer demands. The higher the stock, the higher the danger of inventory turning to obsolete. In order to prevent discrepancies in physical inventory a continuous and solid follow-up is required. Only by attacking the problems early an aged inventory problem can be prevented. Customer-created obsolescence should never be accepted and the customers should be committed in taking the goods they have purchased.

4 DEFINITION OF CMR INVENTORIES AT UPM

Paper production in general is very large scale production. UPM's CMR paper machines produce machine reels with 30 to 50 tons of paper. The widths of these machine reels vary between 5,7 meters to 9,5 meters depending on the paper machine specifications. Customers order significantly smaller reels depending on the specifications of their printing machines, print works and printing methods. In general the widths of the customer reels vary between 36 centimetres and 4,3 meters. Machine reels are converted to customer reels at winders and production planner is responsible for optimizing the trimming and avoiding unnecessary waste.

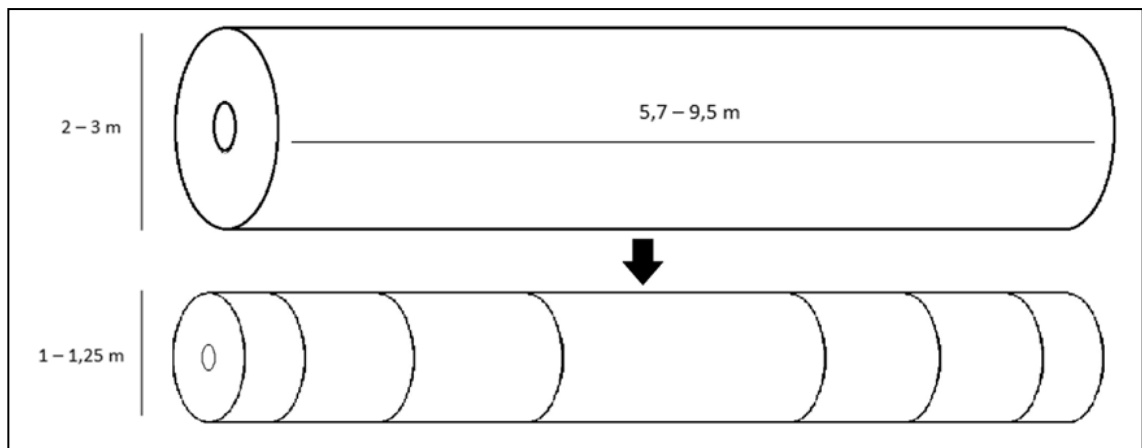


FIGURE 6. Machine reel is wound to customer specifications (Anna Lammi, 29.1.2017)

4.1 Non-sound inventories

Non-sound inventories includes all stocks that are not planned to be delivered to customer in their current status and will stay under UPM's responsibility. These stocks are also considered as sideflows and are unavoidable quantities caused by production needs or events within the supply chain, for example quality issues, damages or customer needs. Sideflows consists of prime and non-prime goods, which for some reason fall off from the supply chain main flow (UPM Business Disciplines 2016). Non-sound prime goods consist of obsolete stocks and non-prime goods of reels classified as faulty, damaged, suspected and missing, two last of which should be used only as a temporary classification.

Further actions are always needed in order to clear these stocks. Some of them can be sold as prime or secondary quality as they are, some are rewinded to new specifications to prime orders or sold with a lower price as stocklots and finally if needed, some quantities can be repulped at mills. Due to the nature of the business, the capital tied to these inventories is often quite significant and if it cannot be released it serves no purpose. Not only do the inventories tie capital but also reserves space at the mill warehouses as well as ports and other external warehouses where after a certain agreed free period UPM will pay for storage and handling directly to a third party. When diminishing unneeded stock, the actions of reels being rewinded to new specifications or relabelled for new orders tie both personnel and machinery. If these actions are done outside mill warehouses UPM pays external parties directly for performing these activities.

Within UPM CMR supply teams the most commonly followed Key Performance Indicator (KPI) regarding inventories is over 60 days non-sound stocks. This is reported weekly by inventory team to supply teams. The primary people in charge of the inventories located in overflow warehouses are production planners. Overflow warehouses consist of mill warehouses and in case of Finnish mills also ports of Rauma and Kotka where the goods are stored before shipment to the customer or next warehouse.

The total amount of non-sound inventories of eight CMR paper machines was 7 807 tons on 5.7.2016 when first materials for this study was collected (UPM internal reporting). The total non-sound stock amounts per paper machine divided to age groups can be seen in table 1 and further with stock classification in table 2. In following chapters the most common characteristics and root causes of birth are clarified for each stock classification.

TABLE 1. Total non-sound CMR inventories on 5.7.2016 (UPM internal reporting)

SBU	PM	Age							Total
		under 30 d	over 30 d	over 60 d	over 90 d	over 180 d	over 365 d	over 500 d	
MMO	PM1	145	86	265	144	948			1588
	PM2	280	165	64	71	56	1	4	640
	PM3	337	154	204	88	38	11	4	836
	PM4	185	463	131	399	34	46	9	1267
	PM5	138	211	240	249	177	47	3	1064
	PM6	209	175	32	57	41	1	2	518
	PM7	536	477	169	180	65			1428
	PM8	57	32	82	188	98	4	6	467
Total stock		1887	1762	1187	1376	1457	110	27	7807

TABLE 2. Total non-sound CMR inventories on 5.7.2016 by reel classification (UPM internal reporting)

SBU	PM	Class	Age							Total	
			under 30 d	over 30 d	over 60 d	over 90 d	over 180 d	over 365 d	over 500 d		
MMO	PM1	Faulty	32	6	176	128	911			1252	
		Obsolete	113	80	89	6	37			326	
		Suspect				10				10	
	PM2	Faulty	13	34	52	51	4	1		156	
		Obsolete	267	131	11	19	52		4	484	
	PM3	Faulty	52	22	39	14	12			138	
		Obsolete	286	130	127	69	27	11	3	652	
		Suspect		2	37	5			1	46	
	PM4	Faulty	23	54	63	103	24	32	9	308	
		Obsolete	154	328	31	290	7	13		824	
		Suspect	8	81	37	6	3			135	
	PM5	Faulty	68	78	182	81	96	47	3	555	
		Obsolete	65	75	56	109	81			386	
		Suspect	4	57	2	60				123	
	PM6	Faulty	92	75	23	21	16	1	2	231	
		Obsolete	117	93	9	32	24			274	
		Suspect		6	0	4	1			12	
	PM7	Faulty	151	247	33	52	60			543	
		Obsolete	232	215	136	21	5			609	
		Suspect	153	15		107				276	
	PM8	Faulty	8	14	32	92	86	4	6	242	
		Obsolete	49	18	50	96	12			225	
	Total stock			1887	1762	1187	1376	1457	110	27	7807

4.1.1 Faulty inventories

Faulty inventories consist mostly of mill's production waste that cannot be repulped straight away but is either left to mill floor or packed to warehouse while waiting for the opportunity. Quite often these are caused by some quality issues with i.e. coating or bad winding or the target values have not been reached. The quality fault can also be in only a part of the reel, which allows part of the reel be utilized to further prime usage by converting the reel to new specifications by rewinding.

Sometimes the faulty quality is noticed too late when the reels can already be on their way from mill to port or in worst case even to the customer. Unfortunately common in these cases is that the amount of faulty reels can be quite significant if the problems are noticed only very late instead of fixing them straight away in order to avoid further waste. Returning these stocks to mill means always additional logistics and labour costs, not to mention the challenge of producing replacing goods in time to reach the required customer delivery.

4.1.2 Obsolete inventories

Obsolete inventories are reels of prime quality which are not delivered to customer. Usually they are either overproduction of an order or a production run, or siderun orders that have not yet been sold. The most common reason for producing random individual reels is that the production planner has trimmed extra reels to full the pattern. Too often also the winders produce extra reels when they do manual trims after waste reels due to bad cutting and miscount the amount of needed reels.

When talking about bigger quantities of obsolete reels one big reason common for most paper machines occurs. For some paper machines it is more challenging to optimize the need of paper exactly to trimmed quantity due to the waste during the production process and at different machine phases between the paper machine and winders, like coaters, calanders and possible re-reelers. Therefore some additional paper is produced always to make sure the customer orders are fulfilled as leaving them short would afterwards require arranging balancing short runs, which is not optimal from machine runnability point of view and usually end up causing even more overproduction. Additional paper is usually cut to future orders should there be ones already released, but usually their Mill Ready Dates (MRD's) are at least few weeks further so they stand in warehouse. Sometimes, when there are no orders that have been released for production in the system, the extra paper is either cut to specifications of stop orders hoping that they will be released accordingly or, if specifications are not known, the extra paper is cut to wide mother reels to warehouse and rewinded when suitable orders are released. In some cases, if the grade is produced only very rarely or there are no orders to expect in near future, the additional paper can be straight away sold through Siderun and Stocklot Sales or Inventory teams.

In case of Finnish paper mills, reels that are overproduced from the winders get obsolete classification automatically. Global Manufacturing Execution System (GMES) compares the ordered quantity to the produced one at winding phase and automatically changes the reel status so that manual classification changes are rarely needed. This feature was taken into use in 2012 and it had back then a big impact on inventory levels. Whereas earlier supply teams had checked with customer service if the customer could use also possible overproduced reels and usually they were sent out, now the reels were automatically left to mill warehouse waiting until production planner found some other use for them. In 2014 an additional feature was taken into use that allowed obsolete reels to be packed

automatically to next order with the same specifications, should there be one. This feature requires manual acceptance from winder personnel so it is still not necessarily used as much as it could at all mills, but would be only a training issue. However, it has reduced significantly the amount of single obsolete reels. There is a plan to take both features to use also for CE mills but the schedule is not yet determined.

Especially for machines producing gravure grades the need for siderun is quite a common topic. Only very rarely the reel width customer would need for its printing machine makes a full trim at winders. Usually there are other orders with different reel widths which are combined to same pattern to reach a better trim, but still the combination does not always meet the maximum trim width. Particularly common the trim problems are with grades that are seldom in production or where the volumes are low. In these cases, if the edge waste is more than 400 mm's it is usually sold as a siderun. End use for a siderun can be for example a gift wrap.

On gravure machines old sideruns that have not been sold are raising the obsolete inventories significantly. If the edge waste reel cannot be sold right away but it is wide enough and it is not sensible to repulp it immediately, the reel is cut to a pre-determined width and packed to warehouse. These reels are classified as obsolete and released to sale in Paper Trading which is a tool that Siderun and Stocklot Sales and Inventory teams use for selling the already produced paper lots, often with a reduced price.

It is very common that there are issues with ordered quantity not matching the maximum payload of the transport mode. This problem is related to both truck and container deliveries. Very often there are cases where customers from overseas markets order bigger quantities, but customer service does not usually check that the amount matches with full container loads. Due to cost optimization only full container loads are shipped. Until now production planning has been instructed to always make sure that ordered quantity should be fulfilled from production. Therefore it is very common that there at least a few, sometimes more reels leftover from containers. Often the specifications are regular and the reels can be used for future orders, but because of order number and shipping marks they need to be relabelled which adds manual work and costs. A new way of working would be needed to avoid these overproductions. In case of Central European mills, the production planner checks the amount of reels that is planned for container shipment before they trim the order. Therefore they can already beforehand avoid

producing reels that anyway could not fit to the container. For Finnish mills this has not been checked separately but the orders have always been produced full. From 11.8. onwards a piloting for the same way of working started with container loads from Kaukas and will gradually be implemented also to other mills.

Same overload issue relates also for some businesses that are delivered by truck. Usually customer service places orders according to the country specific maximum payload of a truck, but tolerance rule is not correct. For example, if the country's maximum payload is 25 tons, customer service might place the order with tolerance minimum 25 tons. Therefore production planning will make sure that at least 25 tons are produced to the order, but if it is exceeded with even few hundred kilos the reel will not be loaded to truck due to maximum payload but is left to warehouse. The correct way of working in order to avoid producing unnecessary reels should be clarified in supply and customer service teams together with process owners.

There are also several other reasons which cause obsolete inventories, luckily not very common ones, but the impact can be big. For instance, customer may want to change or even completely cancel an order that has already been produced. As a principle it is not allowed, but sometimes exceptions are made for certain customers. Also in this challenging market situation some customers have suddenly gone bankrupt and were not able to pay for the goods UPM had already produced and in the worst case already shipped. Therefore a common solution to utilize the reels in a best possible way and without additional costs for the customer has always been searched.

Sometimes after facing quality issues the customers might refuse to take the stock that has already been produced and in worst case shipped. If there is an existing claim and a threat of new one coming, the customer is allowed to cancel the order and already produced reels will be used elsewhere. Normally Inventory team is responsible for selling these kinds of stocklots if they are located outside Finland in case of Finnish mills or outside mill warehouse in case of Central European mills. In 2016 some bigger lots were brought from Europe back to mill in Finland to rewind the reels to other prime orders.

One, luckily quite rare reason for occasional stock increase can be for example human error in order placement. If this error has happened in UPM's end it is clear that UPM is responsible for correcting the mistake and finding new use for the reels. If it was the

customer's mistake they normally should take the paper, but if the reels can easily be used for other purposes it is done to keep the customer satisfied. Also, if due to problems with production or external factors the confirmed delivery time of the order is missed and the customer finds a replacement from another supplier, UPM finds a new use for the reels.

4.1.3 Damaged inventories

Third biggest reason for non-sound stocks are reels that have been damaged in transportation, loading or unloading or during warehousing. The less the reels are handled during the delivery, the less likely it is that they suffer damages. Normally only single reels are damaged but in some occasions also several at a time, which might cause urgent challenges in arranging the replacement. UPM Seaways Damage Handling / Cargo Care does a regular follow-up for the development of damaged reels in external warehouses, especially ports. These damage reels are, depending on where they are located, either brought back to mills for repulping or sold by Inventory team.

4.1.4 Missing and suspect reels

In addition to above reel class there are two temporary reel classifications: Missing and Suspect reels. The time limit is maximum 2 weeks, after this further actions need to be carried out. In case of missing reels an intensive search period is required and in case the reel is not found, it is to be deleted. For suspect reels the quality needs to be inspected and according to the result the reel needs to be re-classified as either sound, obsolete or faulty. In case of some mills the concept for suspect reels is a bit flexible, for example trial reels that are kept for future trials may remain as suspect for longer periods as they need extra attention due to i.e. technical properties. If these reels would be classified as obsolete there is danger that they could accidentally be moved to customer orders.

4.2 Roles and responsibilities in stock handling

When the inventory is located at mill warehouse, the production planner is responsible for all obsolete stocks as well as faulty and damage stocks that have been redirected to

rewinder. The production planner is supposed to find a use for these reels, preferably to be converted to prime reels if possible or by selling via Inventory team or Siderun and Stocklot Sales team. If the faulty or damaged reels have been redirected to guillotine the mill is responsible for repulping them. Missing and suspect classifications are officially mills responsibility as they are the only possible parties to comment i.e. on the quality of the reels or search for them.

In case of Finnish mills the production planner is also responsible for non-sound inventories located in Finland, in practise meaning ports and Cargo East Terminal (CET) located in Kouvola. Non-sound inventories outside Finland is then again under Inventory team's control, like also all non-sound inventories outside mill warehouse in case of Central European paper machines.

5 RESEARCH PROBLEM AND METHODOLOGY

5.1 Research background and limitations

Due to reasons explained in previous chapters there was clearly a need to study how the amount of working capital tied to inventories could be reduced and above all, prevented in the first place. The amount of WOC tied to inventories is directly associated with the amount of the inventory. UPM has a long term Smart Cash project which is a program that focuses on improving the working capital performance. One target is to improve the return on capital employed. One way to support this is to reduce all inventories that are under UPM responsibility. This study was planned to support this project targets from Supply Chain point of view and therefore it was decided that the study will concentrate on the inventories that are under supply chain responsibility. In practise it means that prime stocks on the way to customer are excluded from the scrutiny.

Together with the company representative it was decided that the research would be limited to consider only finished goods and non-sound CMR inventories. Other product families as well as raw materials were left out of scope, as otherwise it would have been too vast. In addition, due to the differences between different product areas it would have been very challenging to gain common benefit.

5.2 Research objectives and question

The study had three objectives. First objective was to gain in-depth familiarity with the problem and its causes as well as understanding of the current processes. Second objective was to gather ideas how to improve the current status of the problem. Third objective was to find ideas and plans how the problem could be prevented and the causes attacked before they occur.

This study will give an answer to following question:

How can we reduce the amount of non-sound inventories and hence the amount of working capital tied to them?

The outcome of the study will be a list of suggested actions. A separate action plan list will be provided for the commissioning company with responsibilities. These will provide ideas and suggestions how the case company should manage these topics more efficiently in future in order to gain better results.

5.3 Research method

There are several different types of research methodologies. Kothari (2004, 3) defines the main differences between quantitative and qualitative research methodologies as follows:

Quantitative research is based on the measurement of quantity or amount. It is applicable to phenomena that can be expressed in terms of quantity.

Qualitative research, on the other hand, is concerned with qualitative phenomenon, i.e., phenomena relating to or involving quality or kind.

The study was an applied research trying to find for a solution to an already existing problem facing the organization. In addition ideas that could prevent it from occurring in future were sought. The main purpose was to understand the process, factors influencing it and find out how it could be improved in future. Due to its nature it was clear that the study would be carried out with a qualitative research approach as the main source of information and method of data collection were interviews. In addition some quantitative data available from UPM information systems was used for analysing and supporting the qualitative results.

5.4 Collecting the research data

Research data can be collected from different sources and in different ways. There are two types of data: **primary** and **secondary**. According to Kothari (2004, 95) the difference between primary and secondary data is that the primary data is data that is collected afresh and for the first time and thus happen to be original in character. The secondary data then again is data that has already been collected by someone else and that has already been passed through the statistical process.

The research data was formed from several sources. Primary data that was obtained through first-hand investigation and used in this study was qualitative and it was collected from four sources:

- **Interviews:** In order to gather the needed information from people working daily with the problem which this study investigates, internal interviews were carried out. The main sources for this information were production planners as well as production managers or superintendents from all six mills (tables 3 and 4). Along the way also managers for Siderun and Stocklot Sales and Inventory teams, controller and head of RCP (Recycled Paper Sourcing) were shortly consulted.
- **Experience:** A large share of the qualitative data included in this study (chapter 4) is based on the author's personal experience gathered during working several years in CMR department and with the problems presented in this study almost on a daily basis.
- **UPM's internal information:** Qualitative data consisted of information available at UPM intranet, of UPM's Paper Business Disciplines as well as determined processes and work instructions.
- **Numerical data:** Also data available in UPM information systems was analysed to follow up the development and changes as well as to support with understanding the general situation.

Secondary data was qualitative information that was gathered to support the process of the study and to give additional background information. The requirements for the available information were that it needed to be reliable, suitable for the purpose and adequate. Therefore the sources were critically scrutinised. This data was collected from two sources:

- **Publically available information:** Secondary qualitative data was collected from UPM website and annual reports.
- **Literature:** In addition a study based on already existing literature, articles and studies was conducted in order to provide the theoretical part of the thesis. This was all qualitative data.

5.4.1 Interviews

Altogether 8 interviews were carried out with production planners working with CMR paper machines. They were all interviewed in person and apart from one by the author. Due to language barriers one of the interviews was carried out by another team leader from the same organisation, also very familiar with the inventory topics. The interviews were carried out in Finnish or English and the durations varied between 50 minutes and 1 hour 24 minutes.

The interview question list for production planners concentrated on three bigger themes: understanding the current stock management processes, the biggest reasons causing non-sound inventories and ideas to prevent and reduce stocks. The purpose of the interviews was to find out how efficiently production planners are managing their inventories and by which methods and identify possible improvement areas, as well as to find out what kind of support they need in order to carry out these tasks successfully. In addition the target was to gather information on mill performance on the subject and get supporting information in order to carry out the interviews with mill representatives efficiently. The question list for production planners is presented in attachment 1.

TABLE 3. Interviewed production planners

Name	Position	Date	Length
Juha Valli	Production Planner Kai06	18.08.2016	0:50:04
Jaana Kemppi-Räty	Production Planner Kau01	23.08.2016	1:11:01
Minna Silvan	Production Planner Rau01	19.08.2016	1:03:27
Tuomas Pihlainen	Production Planner Rau04	18.08.2016	1:09:08
Robert Schäfer	Production Planner Pla10	06.09.2016	0:53:48
Andrew Ivinson	Production Planner Cal01	06.09.2016	1:24:52
Stefanie Rauchbauer	Production Planner Pla11	07.09.2016	1:06:54
Anton Schapfl	Production Planner Aug03	07.09.2016	

To get a precise overview about the current processes and possible areas for improvement also relevant mill personnel was interviewed. The questions for mill personnel were formed based on the production planner's comments and the improvement areas identified in these interviews. The structure and main questions were same for all mills but in case of some mills there were also a few additional mill-relevant questions. Also the questions for production representatives were divided to two major topics concentrating on obsolete and faulty stocks birth and management as well as a third minor topic regarding general processes.

6 separate interview sessions lasting from 36 minutes to 1 hour 13 minutes were carried out with mills and altogether 14 people interviewed. 3 of the interviews were carried out in person and 3 via Skype due to geographical distances. The interviewees were mostly production managers or superintendents, but also one process engineer, one warehouse supervisor, one finishing supervisor and one technical service manager joined the discussions. The mill personnel's responsibility areas vary slightly depending on the mill, so regarding some mills it was beneficial to have several people included in the discussion to gather all potential aspects. In the interviews the current inventory situation was first presented to the mills and after that the question list (attachement 2) was gone through.

TABLE 4. Interviewed mill representatives

Mill	Name	Position	Date	Length
Plattling PM10 & PM11	Emmi Heinonen	Superintendent	14.09.2016	1:13:41
Rauma PM1 & PM4	Ilkka Savolainen Toni Talsi	Production Manager Superintendent	28.09.2016	0:37:13
Kaipola PM6	Veli-Matti Hulkko Mikko Huhtanen	Production Manager Superintendent	10.10.2016	0:36:23
Kaukas PM1	Tommi Seppälä Juha Turkki Kimmo Kettunen Petri Lohvansuu	Process Engineer Superintendent Superintendent Warehouse Supervisor	03.10.2016	0:54:42
Augsburg PM3	Karlheinz Hannen	Production Manager	16.12.2016	0:44:20
Caledonia PM1	Andrew Johnston Colin Fletcher Steven Macdonald Alan Hair	Production Manager Technical Service Manager Superintendent Finishing Supervisor	19.12.2016	0:50:48

5.4.2 Data from UPM's information systems

Several UPM's internal information systems were used as a source of numerical data. These systems were Cognos, Package Tracking Data interface (PTDi), SAP as well as GMES'es. These systems provided information about the general inventory levels and locations, detailed information about the specifications of the reels in stock and the age of the inventories. One key source of information was the inventory report provided weekly by UPM's Inventory team. Most of the follow-up was made based on this inventory report. Normally the report is targeted for production planners in order to follow and target aged, over 60 days old non-sound inventories.

6 RESEARCH FINDINGS AND ANALYSIS

At the beginning of July 2016 when the work for this research began, the inventories were remarkably high. The total non-sound stocks of eight CMR paper machines were 7 807 tons and over 60 days stocks was 4157 tons (Table 1). At the time of reporting there were a few bigger cases that partly explained the figure higher than normally, like returns from customers or bigger aged faulty lots. These are challenges that still occur every now and then even though a lot of work is done to prevent it, so it is not a completely exceptional situation.

6.1 Findings from production planners interviews

The interview question list for production planners concentrated on three bigger themes:

1. Understanding the current stock management processes
2. The biggest reasons causing non-sound inventories and
3. Ideas to prevent and reduce stocks

The purpose of the interviews was to find out how efficiently production planners are managing their inventories and by which methods as well as identify possible improvement areas. In addition the target was to find out what kind of support they need and from which parties in order to carry out this task successfully. Also the idea was to gather information on mill performance in this task and get supporting information for forming the interview questions for mill representatives in order to carry out the interviews with them efficiently.

According to the production planners there were two clear reasons that caused most of the obsolete inventories: sideruns and overproduced paper. Sideruns are needed when customer's reel widths are not optimal and do not fulfil the trim width of the machine. Planners did not find the amount of siderun needed a problem itself, but rather the lots that have to stand in the warehouse long before a customer for them is found. This is often related to the lightest grammages that are harder to sell. The topic is difficult as usually customers are not able to change their reel widths as they are usually defined based on

their paginations and printing machinery. If UPM does not accept the orders with challenging widths, the customers will usually get the paper from a competitor. If the grade is produced on more than one machine the planners can together check for which machine it would trim best or on which machine there are most other orders for feasible trim combinations. The production planners of gravure machines had a clear opinion that the widths confirmed to production would need to be considered more carefully already before offering and customers challenged more. This requires a lot of co-operation and discussion between supply, customer service and sales but in order to reach best development it should be considered as a normal way of working.

The production planners separated overproduction to two types: overproduced paper from the paper machine and overproduced customer reels from winders. Almost all mills produce some extra paper from the machine as often the amount of waste is difficult to estimate during the long process. This is done to ensure that customer orders are fulfilled. In the interviews also mills admitted this, but two mills also commented that they could try to reduce the amount of overproduced paper from the machine. If there are future orders where the extra paper can be cut to, the excess paper is normally not seen as a problem. However, if there are no coming orders, the extra paper will be cut to most common specifications and will remain in warehouse as obsolete until the next order is received, raising the non-sound inventory totals.

The amount of overproduced reels from winders varies a lot. In case of Finnish mills they should be packed to next orders in case there would be one (feature explained in chapter 4.1.2.), but if there are no future orders they will stay as obsolete in the warehouse. In case of German mills they stay as sound until production planner checks them after shipment of the order. In case of at least three machines the winders occasionally produce additional reels from winders when they miscalculate the amount of needed reels when making manual patterns to fulfil the orders that have been left short. Surprising for the author was, that in case of one of the mills the winder personnel does not make manual trims in case of rejected reels, but instead reproduce the whole set. This can mean that in case only one reel from the set was rejected, there will be extra reels for each other order that were trimmed to the same set. This was something that also the interviewed mill representative saw as an improvement area and was discussed separately with the production people later in autumn 2016 to change the way of working.

Other, luckily more smaller reasons for obsolete stock birth according to production planners were reels that do not fit to containers or trucks and are left to the mill, inventories that customer does not take as well as human errors if the order has been placed incorrectly. Although these are quite common situations, the impact is not huge but only some reels instead of tens of tons.

All production planners seemed to check their stocks often and regularly. For almost everyone it was daily work like it should be. A common way of working was that always when trimming the production runs the planners run a stock check in system and in addition follow the inventory report indicating each specification in the warehouse. The source for the inventory report varied, for most planners it was a GMES report but some of the planners were following mainly PTDi report or Paper Trading in Customer Online. All of the planners considered one of these reports as a main source of information but followed reports provided by Inventory team on a weekly basis. Still when asking about the need for additional reporting, half of the production planners said it would be beneficial, two were not able to comment and two felt it would not bring additional value. Because 50 % of the planners saw it could be useful and later on also mills commented that they did not feel getting enough information about current inventory situation, a stock follow-up reporting for CMR reels was developed to support both parties.

Roles and responsibilities between stock locations and inventory classification were clear for all production planners and later on they were highlighted also for the mills.

There were big differences regarding selling faulty paper as a secondary quality. On one machine almost all faulty paper was sold as secondary quality. On three machines it was done occasionally or more in the past. In case of two machines it was sold only rarely or never but rather repulped at the mill. Almost all machines had delivered their faulty or damaged reels to other paper machines to be repulped or external parties to be shredded and used as raw material on UPM's machines. One planner had a strong opinion that waste reels could definitely be sold more efficiently. Waste sales is a difficult topic, as it can be very beneficial business, but there is also the danger that the paper could end up as a competitors' raw material. Usually it is also seen as a free raw material for the mill if they have enough repulping capacity to utilize it. Therefore it would make sense to conduct an analysis to confirm with which price it is more beneficial to clear old stocks by selling them to an external party than to keep them in inventory until repulping.

When discussing more about the single reels left from trucks, two possible development areas occurred. First one considered businesses that are delivered by trucks. Often customer service placed orders for minimum i.e. 25 tons for delivery countries where the maximum payload of a truck was 25 tons. In these cases the order had to be fully produced even though all reels did not necessarily fit to the truck. Production planners were able to point out certain markets on which this is a biggest problem and especially Scandinavian markets were pointed out. In February 2017 it was taken up with them if they could review the way the orders are placed to that producing extra reels could be avoided.

The second point considered orders delivered by containers and different ways of working. That was also related to customer services way of placing the orders according to the customer orders. Most of the orders for overseas markets are placed in tons but logistics is planned according to the amount of reels and often these two factors do not correlate. Company policy is to ship only full container loads and therefore reels that are left over are always left to mill as obsolete. There were different ways of working between different mills. In case of Finnish mills and Caledonia production was always planned according to ordered tonnage. Then again at German mills the production was planned according to the amount of reels that were planned for logistics, even though it would mean that the ordered quantity would be left short. This same way of working was started first at Kaukas in the beginning of September 2016 and gradually after that also on other Finnish paper machines. Of course this way of working requires more manual work in trimming and follow-up, as system only understands ordered quantity and not quantity that has been booked for logistics.

When asking for ideas to reduce the non-sound stock quantity, there were no big improvement ideas from production planners. One point taken up by two planners was the amount of faulty production and noticing it too late. There were cases in 2016 when few paper machines had produced hundreds of tons of paper of faulty quality before the issue was noticed and fixed. Eventually these quantities had to be repulped, which tied a lot of manpower in addition to the cost of lost production time, raw materials and money in the first place. Therefore the need for quicker reaction and decision making in follow up of faulty production was highlighted by production planners and was later taken up with mills..

Overall the interviews with production planners did not brought big surprises but luckily some ideas which could be worked on more in detail. The initial purposes of the interviews were filled. All production planners were quite well aware of all of their stock related tasks and working very actively towards them. Methods were clear but along the way some other reporting possibilities were introduced. The production planners are doing their task very proactively but saw that additional reporting and development follow-up would be beneficial. Some improvement areas were found but most of all the production planners' interviews formed a good base information for the mill interviews.

6.2 Findings from mill's interviews

The questions for mill personnel were formed based on the results of production planner's interviews explained in the previous chapter. The structure and main questions were same for all mills but in case of some mills there were also a few additional mill-relevant questions. Also the questions for production representatives were divided to two major topics concentrating on obsolete and faulty stocks birth and management as well as a third minor topic regarding general processes. In the beginning of each interview the current inventory situation was presented to the mills.

When discussing with mills about obsolete stocks and extra paper, almost all mills admitted producing some extra paper from each run but also highlighted that usually it is needed due to the waste during the production process. In case of two mills the possibilities of reducing the extra paper was discussed briefly in the interviews and the idea of producing only half machine reels of paper instead of full ones considered. Although the extra paper can be cut to future customer orders, it is often early production of which at least a part could be avoided.

One question in the interviews considered old prime reels that had been cut and packed to the warehouse and when their quality starts to suffer due to the age, i.e. how long they can be utilized for prime orders. Some mills mentioned that as long as the packing is solid and not damaged the quality should not suffer for up to several years. One mill commented that six months would be the most realistic timing and that especially reels with joins often suffer earlier. In the end almost all mills agreed that we should clear all reels that are older than one year.

According to the mills the biggest reasons for faulty paper were different technical quality issues, like coating or profile faults, holes, streak, shade or brightness, but also too many joins or too small diameter of the customer reels. In case of some machines the faulty inventories also include old prime reels that have been rejected because of the age and were waiting to be repulped.

One of the bigger discussion topics was the repulping capacity at each mill. Repulped waste is returned to process and can be utilized in production of fresh paper. In case of all mills it is not a manned resource but done as an extra job by a person who has been allocated elsewhere, usually at the winder or rewinder, or as overtime. Almost all mills mentioned the resources being the most limiting factor of repulping capacity. For the gravure machines, especially for Plattling PM11, a big share of the repulping capacity is tied for repulping the trim losses that are too narrow to be sold as sideruns. Normally mills repulp these quantities first, then reels that have been left to the floors and only as last option and when needed the waste reels that have already been packed to the warehouse.

Almost all mills mentioned the best time for repulping being during the production of heavy grammages, as then the waste can usually be utilized most effectively for the paper content. Rauma mill has managed to utilize waste very efficiently and the repulping capacity is quite high there. That is one reason why inventories of Rauma mill are on very good level, as waste reels can be cleared very quickly. To some extent machines can also utilize each other's waste reels, but in all cases it is not possible due to differences in the production process. Production planner should always make sure there are reels defined for repulping and give a signal to mill when there is need to utilize repulping on maximum level. When asking about possibilities to develop repulping capacity, half of the mills commented that it could be increased if there were more resources. For one mill in order to repulp more the average grammage of production should be higher. According to one mill it can be developed with current resources if there should be need and one mill saw no need for improvement.

Selling waste to external parties like de-inking plants or other mills seemed to be a sensitive topic for the mills. The paper is sold normally only with a raw material price and mills saw this as too low a price. Even though the stocks do not belong to the mills

directly but finished products are under ownership of UPM Sales GmbH, the mills were often very reluctant in giving them away. This is a topic that could be considered more carefully by management if i.e. pricing should be reconsidered to increase the rotation and quicker turnover of faulty stocks.

Selling faulty stocks that are usable quality but i.e. shade is not within target values was recognized as a topic that could possibly be done more efficiently. This is done quite a lot on UPM's Central European mills but could also be utilized more on UPM's Northern European mills. Normally from Finnish mills faulty paper was sold as secondary quality with a reduced price only in case of very big lots, but during the interviews it was agreed that also smaller lots could be put to sale if the paper is printable and mills do not have possibilities to repulp it in the short term. In these cases the specifications of the faulty paper always need to be checked carefully by the mill so that the faulty reason can be correctly communicated to customers when offering it.

One topic that has occasionally caused some confusion in Supply Chain end has been the correct information in the system and how up-to-date it is. According to the production planners, quite often some reels that actually have already been repulped are still visible in the system. System and the actual situation should always match. Most mills delete the reels also from the system directly after repulping but some mills still struggle with this task. This is a topic that is mostly a training issue and regularly highlighted to the mills, but nevertheless there is still work to do. Therefore mills were asked how often the warehouse inventory as well as inventory for the reels on floor is done. There seemed to be no clear rules. Some mills checked the reels on the floor once a week, some once a month and some were not able to give a precise guideline or did it only when there were not too many reels. Warehouse inventory was done mostly once a year. From supply point of view if follow-up and needed actions are done continuously there should be no big discrepancies between system and actual situation. However the more up to date the system is, the easier it is to carry out actions to clear the floor. Therefore it could be a good idea to push the mills to do a weekly inventory for the reels on floor.

When mills were asked how they see the inventory management in collaboration with Supply Chain could be improved in order to reduce non-sound inventories, they had some ideas. People representing Kaukas thought they could start doing more follow-up for extra paper and comparing what has been trimmed and eventually produced. In addition they

considered the possibility of leaving extra paper to machine reels in case there are no orders where to cut the excess paper so that it could be sold and cut to any specifications and rewinding could be avoided. They also promised to highlight the responsibility of personnel at rewinder in utilizing reels on the floor. Rauma also planned a follow-up for extra paper and considered the possibility of running half machine reels in the end of production in order to avoid the extra paper. Caledonia highlighted that inventory management should not be a sole responsibility of the planner but rather a common task. Augsburg and Plattling emphasised the system's support in avoiding manual work, like correct tolerance calculation and automatic class change of extra reels to obsolete and packing the reels to future orders with same specifications (feature presented in chapter 4.1.2.). This feature is not yet in use at the German mills but the mills seemed to find it quite interesting. In general most of the mills were curious to hear how their fellow mills were handling the same issues and what the current inventory situation at other mills was.

Probably one of the most important finding of the research was that more than half of the mills felt that they did not get enough information about the current inventory situation or what they should be targeting. Most of the mill representatives receive the inventory report supplied by UPM's inventory team on a weekly basis, but this report is considered as information sharing, not an action plan. Currently the production planners are doing their stock management quite independently and although it works according to normal processes, there are no clear rules when heavier than normal daily actions should be carried out by management, meaning i.e. decisions about moving old stocks to another mill to be repulped.

Therefore it was clear that there would be need to implement a new kind of reporting providing exact information of the development of the inventories per each paper machine and stock classification. This would help the production planners, mills as well as management to follow the progress and understand what the status of a certain machine is in comparison to the others.

Second key finding was unclear or non-existing targets. If there are no targets, there cannot be official follow-up. If non-sound inventories would need to be reduced, there would need to be a KPI following non-sound inventories. Currently there are stock-related targets in production planner's incentives, but not in form of non-sounds inventories. Furthermore, in mills' targets the inventories are not included at all. The

inventories are under UPM Sales GmbH and supply chain's responsibility, but in case of inventories located at the mill sites the mills are the party that can affect the stock clearing and development in practise the most. Two production planners out of eight pointed out very strongly that in order to engage also mills with inventory development and management, the inventories should definitely be mentioned also in their incentives, not only the production planners'.

6.2.1 Case Kaukas

Kaukas, not only because of having one of the highest stocks in summer 2016 but also being probably the most familiar mill for the author, ended up as a guinea pig for the biggest stock management exercises. Extra attention was paid to Kau01 by the production planner and the author in order to see what kind of an impact this has on the machine's inventories. Also from the mill side few people participated this rehearsal. The general manager of the mill engaged to this task and from his side pushed the mill personnel. The process engineer reported mill personnel about development and results.

Additional actions to normal daily responsibilities were first started after the production planner's interview on 23.8. She started doing stock follow-up on daily basis and working very proactively also against the newest stocks to prevent them from aging. In addition, she started planning the quantities for container orders based on logistics planned reel quantity. One of the bigger actions at this point was that also part of the faulty stocks was put to sale as secondary quality. These actions allowed a slight reduction in inventory levels but only in a very short term.

Six weeks later, on 3.10., the interview with mill representatives took place at the mill. Although good points were discussed, there was no positive change in the inventory. On the contrary, the inventory levels rose almost to the same level as the previous summer despite the actions from planners' side were continued. Therefore four weeks later the discussion of delivering the oldest stocks to de-inking plant in Kaipola to be used as recycled fibre was started. This was clearly the critical point, as after the discussion the mill started putting more effort in repulping the old reels instead of delivering them elsewhere. After that the inventory levels were reduced almost every week. On week 49 there was a high peak due to return of 300 tons of old stocks from a European port back

to Finland, but this whole quantity was rewinded during only one week. Since then the trend has been descendent and current level is almost as good as it can be. On 8.12. a S-Imple mill target setting for next year a common target for over 60 days stocks was placed: maximum level of over 60 days non-sound inventories should be 200 tons in 2017.

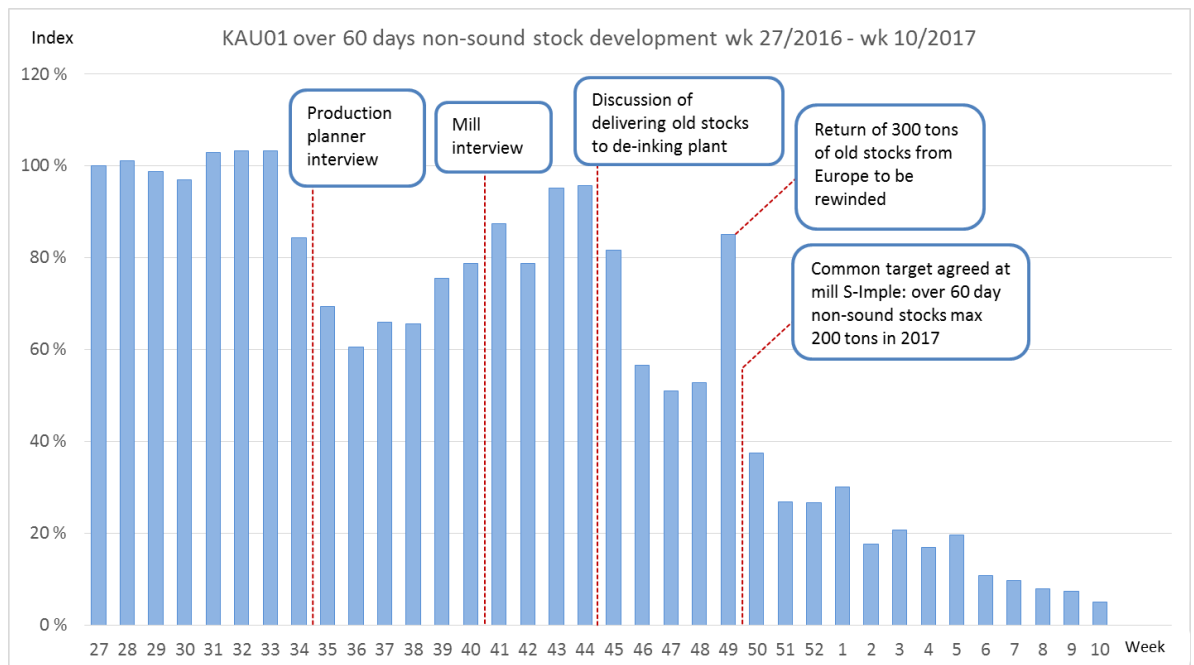


FIGURE 7. Development of Kau01 inventories (Anna Lammi 11.4.2017)

This rehearsal proved that when the problem was properly addressed, communicated and made a common target for both Supply Chain and mill, results were actually reached. It required a lot of work for many people involved but remarkable results, a decrease of 95 % in total over 60 days non-sound inventories was achieved in the end. For sure results, even though not necessary as good ones, can be achieved also on other machines which currently have a higher stock than they should.

7 SUGGESTED ACTIONS

Like mentioned in chapter 6.2., after the mill interviews it was clear that one of the biggest problems was the lack of transparency and awareness of current situation. There was no targeted reporting for mills about inventories, only for Supply Chain. There is no doubt that already when all parties understand the problem, they are more engaged to solving it. Like American writer and editor Dorothea Brande said, "A problem clearly stated is a problem half solved". When there are no clear targets for the inventories, communicating the problem is even more difficult. Therefore first suggestion would be:

1. Clear targets to be set and communicated also to mills

Although inventories officially are under UPM Sales ownership, the supply chain and the mills need to work seamlessly together in order to reduce them. As mills are the party who take care of most of the actions in practise, like rewinding and repulping, they would also need to be aware of which targets the supply chain should be working for and why. The importance of this target would need to be highlighted to mills significantly more than in past. In addition it might make sense to start the discussion if the inventories could in some way be also included in the mills targets, for example like Kaukas has done with setting maximum level of 200 tons for over 60 days non-sound inventories as a S-Imple target. Since setting this target the inventory level has been significantly lower.

2. Continuous follow-up for the set targets

Only creating the target is not enough, but naturally it also needs to be followed up regularly. Supply Chain receives reporting from Inventory team on a weekly basis and also some mills get this information, but it is not considered as an official follow-up. Also, it is on very general level and includes all paper machines but does not give very detailed information on paper machine-level. Therefore it would make sense to decide and highlight how this is followed and whose responsibility it is especially.

3. More efficient inventory management in Supply teams and mills

Although during the interviews it was clear that the production planners are taking good care of their inventory management tasks, it would be good to highlight them that checking both obsolete and faulty stocks that can be utilized via rewinder should be a daily task and done even more proactively than currently. To encourage this, in 2017 the total amount of non-sound over 60 days CMR stocks will be part of the production planners' personal incentives. Also, as half of the production planners said that support from the team leaders would help them in their work, it was agreed in March 2017 that they would start to send a list of needed actions to help planners know which inventories especially should be cleared soonest. The data is the same that is used for the stock follow-up reporting, so it is easily available.

While Suspect and Missing are supposed to be only temporary classifications and actions should take place within 14 days, both mills and Supply Chain struggle to complete this task in time. The stock follow-up reporting will also highlight the amount and development of these inventories and will make monitoring not only easier but also quicker. Mills will be advised of the required reaction times. Also the process of handling Missing reels will need to be clarified in the Supply Chain end.

4. Conducting an analysis to give guidance when it is more profitable to sell faulty stocks as secondary quality or waste to external parties instead of repulping them

This analysis should not only consider the sales price but also the cost of needed resources and time. It should also study which is more feasible, selling the faulty reels as secondary quality to customers, as waste directly to other mills or to repulp it. Due to the lack of recycled fibre the industry faces every summer, the possibilities to utilize faulty stocks located in Europe as a recycled fibre source instead of selling as secondary quality should also be analysed carefully. This could be an option to gather more recycled fibre through an external grinder for UPM's own use. Also, a price comparison between delivering paper back from Europe to mills in Finland for rewinding and selling directly in Europe as faulty stock or recycled fibre could help in quicker decision making.

Mills need to make sure that all required actions and trainings are done in order to make sure that after repulping reels are deleted from the systems immediately to prevent discrepancies in reporting.

5. Questioning challenging customer widths that require large amounts of siderun

According to production planners interviews one of the biggest reasons for obsolete inventories were sideruns that were not yet sold. Their idea was to question these widths more, especially in a tight booking situation, and possibly ask UPM's Customer Service Specialists to check if the customers could be flexible with their specifications in order to have better trims. Always this is not possible as the reel widths required by customers vary depending on their printing equipment and the pagination of the end product, but in some cases customers are able to adjust specifications. This is a topic regarding which guidance from management would be needed, to which extent Supply Chain is allowed to request this from the customers. Also general guidance for the sales teams could help work more proactively already when making offers in the first place.

Another challenge regarding the same topic is the support provided by UPM's systems, or more precisely lack of it. As a matter of fact, the development of current systems is making proactive work regarding feasible reel widths even more challenging in the future. Whereas now when Supply team has received an order, it has been able to suggest Customer Service Specialists to place the order to a paper machine where the trimming possibilities were best. However in future the system would place the order automatically to a machine where the customer has allocations. These allocations are given often months before the production based on the sales deals and future reel widths are not yet known at this point. Therefore optimizing the widths for machines will in future be a lot more challenging and amount of sideruns can be expected to grow even more. Changing the orders that have been placed through the new system requires a lot of manual work when the trimming combinations need to be first checked, then order cancelled, allocation moved to another machine and the order placed again. This will mean not only increased amount of sideruns but also a lot of waste in form of time if the process cannot be improved.

6. Customer Service to place orders with reasonable tolerance rules to avoid leftovers from trucks and containers

Like explained in previous chapters, there are often cases where customer service places orders with tolerance rules that do not correlate with maximum payloads of the trucks. If the customer orders i.e. one truckload of paper to Denmark, Customer Service tends to place the order as minimum 25 tons although the trucks payload is maximum 25 tons. The order is produced full according to the ordered quantity and one reel needs to be left to mill in order not to exceed the payload. Customer is happy with the one truckload of paper and the reel left to mill needs to be moved and relabelled to next order with same specifications. This would be a very easy change in the way of working and would prevent occasional leftover reels.

Since autumn 2016 also in case of almost all Northern European paper machines the container orders have been trimmed according to the logistics planned amount of reels. As the amount of container orders is significantly lower than truck, checking the quantities manually is still possible but of course extra work. Best solution would be if Customer Service was able to calculate correct reel amounts based on container loads, but it is a training issue. In case of Finnish mills Australian orders are already placed based on reels that match container loads, but in case of German mills they are placed based on tons. This would be a very easy point to start the harmonization as specifications are mostly the same.

7. Auto-obsolete feature to use also for German mills

In order to speed up the rotation of extra reels and avoid manual work, the feature of classifying excess reels automatically as obsolete and packing them to future orders would need to be taken to use also at German mills. A prerequisite for this to work correctly is that the system tolerance calculation rule is changed. This update to tolerance rule calculation should be available in spring 2017 after which the feature for auto-obsolete can be taken to use.

8. Amount of reels damaged by Rauma port needs to be studied

This problem seemed to relate especially to US orders that have been produced at Kaipola mill. The production planners felt that the amount of damaged US-reels in Rauma port is higher than for other markets. Volumes for this market area are high which could explain the high amount of broken reels even though the percentual share would be the same, but this topic could be investigated more together with Rauma port and UPM Seaways Damage handling/Cargo care.

9. No customer created obsolescence should be accepted

As a general rule UPM should not accept any obsolete stocks created by the customers. If the customer has placed an order that is free for production it should be engaged to taking everything produced against the order. If the order would need to be cancelled after production, only acceptable reasons should be an error in order entry or change request by UPM or that customer has gone bankrupt and is not able to pay for the ordered goods anymore. Any other problematic case should be directly escalated to management and UPM's sales representatives should not make these decisions.

There were also several other ideas that are worth considering but have smaller impact to inventory levels. Most of these ideas were not presented earlier in chapter 6 as an interview result as they were either presented by only one person or not analysed more in that situation. Also some ideas came up after the interviews.

8 CONCLUSIONS

8.1 Outcome of the study

This study had three objectives: to gain in-depth familiarity with the problem and its causes as well as understanding of the current processes, to gather ideas how to improve the current status of the problem and to find ideas and plans how the problem could be prevented and the causes attacked before they occur. They were collected mostly from paper machine's production planners and relevant mill personnel. The target was to get an answer to following research question:

How can we reduce the amount of non-sound inventories and hence the amount of working capital tied to them?

During the research process it was noticed quite quickly that simply raising the awareness of the current situation and targets has a major impact on the inventory level. The mills were not aware of desired inventory levels as it was not reported from supply chain side. Also there was poor follow-up for the development. Inventory management was solely a responsibility of the production planner.

Even though there were no huge actions carried out, the development of non-sound over 60 days inventories during the nine-month follow-up period of the study was remarkable. Altogether these inventories were reduced by 63 %. Some paper machines reached a better inventory level than they had ever managed to reach before. The weekly development of the total quantity can be seen in figure 8.

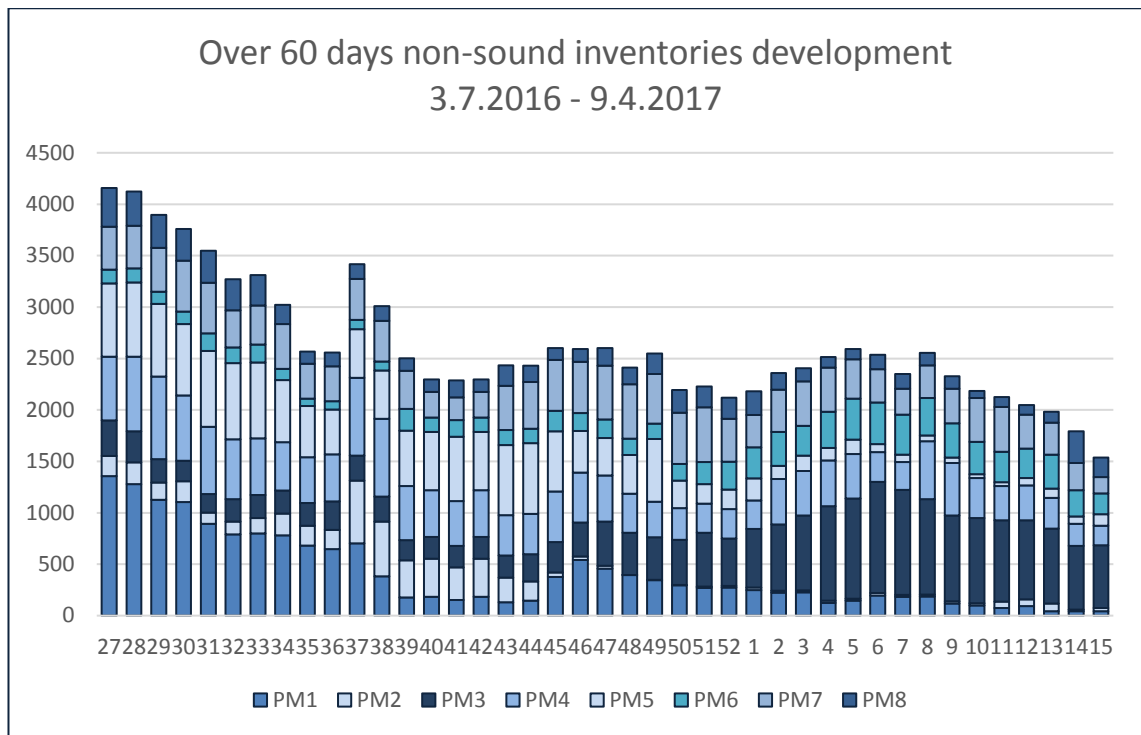


FIGURE 8. Over 60 days non-sound CMR inventories development week 27/2016 – 15/2017 (Anna Lammi 12.4.2017)

It was emphasised to the mills that inventory management is supposed to be a common task between both supply chains and mills. In order to gain results co-operation between all parties is needed. Biggest results were achieved keeping this in mind. None of the other points on the suggested action plans could allow as big impact to the inventory level. A very positive surprise during the process was that also mills were showing a lot of interest towards the topic. Particularly curious they were in finding out what is their position compared to their fellow mills and how they are positioned compared to current target.

TABLE 5. Total non-sound CMR inventories on 9.4.2017

SBU	PM	Age Group							Total
		under 30 d	over 30 d	over 60 d	over 90 d	over 180 d	over 365 d	over 500 d	
MMO	PM1	153	20	8	14	11	10		216
	PM2	120	18	24	5	2			170
	PM3	494	451	149	302	138	9	13	1556
	PM4	531	149	26	114	39		9	870
	PM5	331	98	63	49				541
	PM6	201	192	78	113	12			596
	PM7	392	214	46	28	84			765
	PM8	118	27	113	76				334
Total stock		2339	1172	506	702	286	18	22	5047

Total inventory level, including also fresh inventories between 0 and 60 days, had reduced with 35 % since 3.7.2016 (Table 5). The reduction in inventories less than 60 days was about 4 %, but there was a slight improvement anyway. The less old stocks there are, the more attention production planners are able to pay on the fresh inventories. If the development continuous as it has been between July 2016 and March 2017, gradually it should be possible to see improvements also in under 60 day inventories. This would release significant amounts of capital for other purposes and that way improve the financial performance.

8.2 Recommendations for future research

The inventory management process is clear in supply chain and as long as all parties know which levels they are targeting it should be easily reachable. In case future researches regarding the same topic want to be carried out, one suggestion from the author would be to study how the side flows and inventories can be utilized more cost efficiently or find out alternative ways how to benefit from them that maybe have not been thought of before. There could be some potential ways that have not been discovered earlier as the challenges in past concentrated mainly on simply utilizing the huge stock amounts in any way possible and stop the growth.

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APPENDIX 1. Question list for production planners

Current inventory management processes:

- How often do you go through obsolete/faulty/missing/damage/suspect stocks?
 - o Are other than mill stock under your responsibility?
- Which warehouse list do you follow, GMES or PTDi (or something else)?
Advances of each?
- Is the way of working same in each mill?
 - o Faulty directed to RW: production planners responsibility?
 - o Faulty directed to GU: mills's responsibility to kill?
- How efficient is use of PT?
 - o How quickly do we put obsolete/faulty lots to PT for sale? What all is released for sale straight away/what's not?
- How carefully do production planners go through inventory list (biggest/oldest lots)
 - o Is the current follow-up sufficient or could it be done better?
 - o Should TL's send a checklist certain lots to get rid of?
- How often does the planner go through old sound reels, or is there need?

Biggest reasons causing non-sound inventories:

- What are the reasons for birth of obsolete and faulty stocks?
 - o Which of these could the production planner affect and how?
- Faulty stocks: how often usable width or waste reason are defined by mill?
 - o How often and how big lots of waste are sold as secondary quality? Could it be done more efficiently?
 - o The biggest current faulty lots, is there something that could be rewinded to prime orders or sold as secondary quality, or has it already been checked?
 - o Old faulty lots, possibility of delivery to de-inking plants/ use as recycled fiber?
- How often are reels on floor cleaned at mill? Can we always trust that system is up-to-date? How often is warehouse inventory done?

Ideas to reduce inventories:

- How could container loads and trucks be optimized to avoid overproductions that cannot fit in the container (also for Finnish mills) or is it already noted? How much obsolete stock is left from these?
- More sets for winders to avoid obsolete reels from production?
- How often does winder produce extra obsolete reels that were not trimmed?
 - o How does the planner follow it?
- GMES automatic obsolete and packing to next order
 - o How well does it work for mills where it is already used > follow up?
 - o Expected impact when taken to use on CE machines?
- How can the non-sound stock amount be reduced on your machines, is there something that could be done more efficiently, what would it require and from which parties?

APPENDIX 2. Question list for mills

Prime stock:

- On average, how much overproduced paper we have from each run? Which factors create obsolete stocks?
- At what point does the quality of old reels start to suffer? When can the reels not be used for prime orders because of the age?
- How often and why mill produces sometimes unneeded obsolete reels from the winders?

Faulty stock:

- What are the biggest reasons for birth of Faulty stocks?
 - o What do current faulty stocks consist of? How much does mill follow it?
 - o How are responsibilities between planner and mill divided (reels on floor/warehouse > directed to RW / GU)
- What is the average repulping capacity? What are the best times/grades to repulp waste?
 - o Are there always reels defined for repulping and how does the mill ensure that as much is repulped as possible?
 - o Is it somehow possible to develop repulping capacity?
- How often waste or secondary quality reels are sold to external parties/other mills for repulping/deinking plants or as recycled fiber?
 - o Why not done more?
- How often is usable width defined on faulty reels directed to winders? Is the feature in use or if it is managed otherwise, how is it done?

General:

- How often are floor and warehouse inventory done? Can we always trust that system is up-to-date?
- How does mill see that we could improve our stock management and decrease our non-sound stocks?