

# OPERATIONAL EFFECTS OF ERP REPLACEMENT ON MATERIAL FLOW

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Abstract <p>The purpose of the thesis was to determine the operational difficulties on material flow caused by ERP replacement at the production units of BillerudKorsnäs. The objective was to highlight these issues and suggest solutions for them from a functional aspect. The thesis raised the company's awareness of the most critical parts in its delivery chain from mill to customer.</p> <p>Methods applied in the thesis were qualitative and quantitative. Warehouse personnel were interviewed in order to find operational issues at the mill. The new ERP was used to search data for determination of material flow volumes. Two major problems were discovered: multiple delivery plans cannot be loaded on the same wagon, and shipping allotment to German ports of Rostock and Lübeck do not match the production volume.</p> <p>The results showed that the loading model of the company does not match the operational expectations of mill warehouses. A list determining the delivery plan for each production phase was created for the warehouses. In terms of shipping, the allotment needs to be increased to enable a balanced material flow onwards from the port of loading. The study was assigned by a Swedish packaging paper company BillerudKorsnäs. The company acquired two paper machines from the Finnish company UPM. This thesis can also be used as a consultative example of logistics-related operational effects of ERP replacement in paper industry.</p>		
Keywords ERP, delivery planning, paper logistics, shipping, capacity management, warehousing, SWOT, transportation, logistics, supply chain management, SCM, material flow		
Miscellaneous  Appendices are not included in online publication.		

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## **ABBREVIATIONS**

<b>4PL</b>	<b>Fourth-party logistics</b>
<b>BAF</b>	<b>Bunker Adjustment Factor</b>
<b>BonD</b>	<b>Billerud on Demand</b>
<b>CEPI</b>	<b>Confederation of European Paper Industry</b>
<b>ERP</b>	<b>Enterprise Resource Planning</b>
<b>ETA</b>	<b>Estimated Time of Arrival</b>
<b>FTL</b>	<b>Full Truck Load</b>
<b>MES</b>	<b>Manufacturing Execution System</b>
<b>PM</b>	<b>Paper Machine</b>
<b>TIPS</b>	<b>Tieto Integrated Paper Solutions</b>
<b>SWOT</b>	<b>Strengths, Weaknesses, Opportunities and Threats</b>



# 1 INTRODUCTION

## 1.1 Case background

To streamline its business, Finnish paper manufacturer UPM sold its packaging paper production units to Swedish packaging paper company Billerud on 1 June 2012. UPM was increasing its focus on graphic and other specialty papers, whereas Billerud was specialized in producing packaging materials. The acquisition made it possible for both companies to concentrate more on their core businesses. On the basis of the transaction, Billerud took over two paper machines in Finland: Pietarsaari PM1 and Tervasaari PM7 with a combined annual production capacity of approximately 300,000 tonnes. UPM agreed on providing supply of raw materials and services at the mill-sites as part of the transaction as Billerud did not have any existing organization in Finland (UPM, 2012).

The acquisition of the two paper machines strengthened Billerud's product portfolio consisting of various packaging materials used for manufacturing a variety of products, such as coffee cups, food product and beverage packages, cement sacks, shopping bags and luxury goods packages.

Soon after the European Commission had approved the acquisition, Billerud announced a strategic merger with its Swedish competitor Korsnäs AB in November 2012. In addition to also being specialized in food and luxury goods packaging materials, Korsnäs had also produced materials for liquids packaging.

## 1.2 Company description

Today BillerudKorsnäs is a world-leading manufacturer of packaging materials, with over 1,500 customers in over 100 countries. Its strategic focus is to lead the development of fiber-based packaging materials and objective to generate profitable growth. The company operates in three business areas: containerboard, packaging paper and consumer board. Its market categories can be divided to food & beverages, consumer & luxury goods, medical & hygiene and industrial materials. After acquiring the paper machines in Finland and completing the merger with Korsnäs AB, the company's product portfolio comprises a wide range of high quality packaging materials, such as kraft paper, carton board, liquid packaging board and strong sack paper. In addition to various packaging materials, the company also sells its pulp to the markets (BillerudKorsnäs, 2012).

BillerudKorsnäs has eight production units in three countries:

### 1. Sweden

- Gruvön (685 ktons/year; kraft and sack paper, container and liquid board)
- Skärblacka (400 ktons/year; kraft and sack paper, containerboard)
- Karlsborg (300 ktons/year; kraft and sack paper)
- Gävle (700 ktons/year; kraft and sack paper, liquid board)
- Frövi/Rockhammar (430 ktons/year; carton and liquid board)

### 2. Finland

- Pietarsaari (200 ktons/year; kraft and sack paper)
- Tervasaari (100 ktons/ year; kraft paper)

### 3. United Kingdom

- Beetham (45 ktons/year; kraft paper)

### 1.3 Research objectives

The purpose of this study was to evaluate how the acquisition and the ERP replacement affected the material flow in the Finnish logistics organization of BillerudKorsnäs. The objective was to highlight the possible bottlenecks and operational difficulties that can be considered to be a result of implementing the new system, and present suggestions how to overcome these difficulties from a functional aspect. Determining the possible financial benefits was an asset that would support the results.

The following questions were the basis for the research:

1. What has changed in delivery planning after BonD was implemented?
  - What caused these changes?
  - What operational effects do the issues have on material flow?
  - What is the severity of these issues? Do they need immediate treatment or would it only be nice to get them fixed?
2. Is there a way to financially support the solutions for observed issues?
  - If yes, how?

From the basis of the observed issues, the company is aware of the most significant functions that need to be improved in order to obtain a more efficient way of coordinating its logistics operations. Solutions to these issues should be analyzed with the help of existing data and personnel experiences.

The study can also be used as a consultative example of how the implementation of a new ERP and company culture may affect the material flow if the logistical arrangements in the migrated organization have previously been different. For

BillerudKorsnäs, these kinds of implementations in the future could be carried out in the paper mill in Beetham, for instance. These implementations could also take place if BonD would be implemented to the entire Korsnäs organization.

#### **1.4 Research methods**

This study is based on both qualitative and quantitative research. The qualitative part includes personnel interviews and SWOT analysis to evaluate current situation of the company in terms of Finnish material flow. The personnel were interviewed in personal meetings and also via email or telephone discussions. The quantitative part includes the production and transportation volume analysis of data collected from the company's ERP system. Data mining for production volumes was performed manually by browsing each production run in both machines' mill execution systems and summing up the weekly totals. Dispatch volumes were also traced in the same systems. Weekly sea and road transportation volumes were found in the ERP system, as well as the transportation cost data.

#### **1.5 Focus and limitation**

The study focused on discovering operative solutions to problems that occurred after the cutover. Although some financial reasoning is assessed to support the discovered results (Chapter 7.), the main focus of the study was not to evaluate cost-efficiency or profitability of the improvements, but to have a functional approach to the discovered issues.

Calculations to determine transportation costs were limited to data available in the transportation cost module of the ERP system.

## 2 PAPER BUSINESS AND PRODUCTION

The most essential raw material for paper manufacturing is wood. Bark is stripped off the log and used for energy, while the fibers are separated from woodchips by cooking or grinding. The resultant is called pulp, which can be used for paper production after it has been washed, screened and dried. Pulp is then mixed with water by 100 times its weight and squirted as an extremely thin layer to run through the paper machine. Extra liquid is removed on the wire section where the mixture runs on a thin mat. The process is called *sheet formation* since the mixture spreads and consolidates on the mat. The press section in the middle of the paper machine squeezes the mixture by lowering its water content by 50%. Finally the mixture is dried by running it through hot cast-iron cylinders located at the end of the machine. The manufactured paper is rolled automatically, after which it can be coated and calendered to add color, gloss or to improve printing properties. Finally the paper is cut into ordered dimensions. The finished product is a paper reel, where the material is tightly rolled around a hollow core. After cutting, the reels are securely wrapped and transferred to mill warehouse on a conveyor line. From the warehouse the order can be delivered onwards (CEPI, 2012).



FIGURE 1. Paper machine reel being lifted to cutter

The end result of production does not always turn out as originally planned. Deviations are often caused by urgent orders from important customers, or delays in raw material supply forcing to switch to produce another paper quality. Normally white and brown qualities are not manufactured in the same production cycles, as the transition from one quality to another requires time as well as more radical changes in the machine configurations. After the manufacturing is changed to a different type of paper, the quality is checked to ensure desired characteristics of the paper.

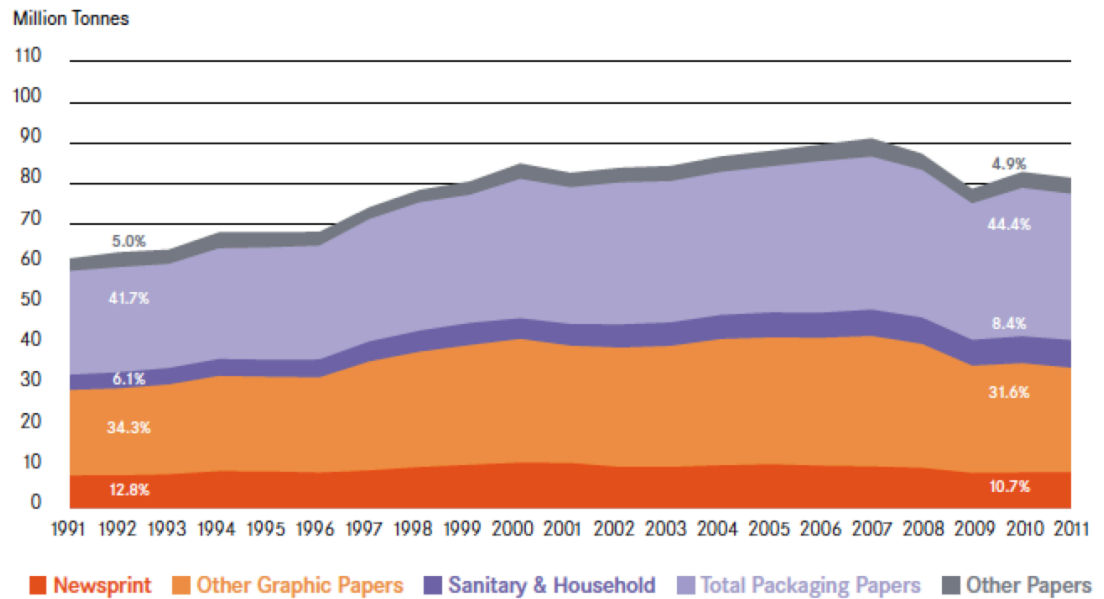


FIGURE 2. Paper & board consumption in CEPI countries (CEPI, 2012)

According to Figure 2., paper and board consumption has experienced a decrease of approximately 10 million tonnes since 2007. In CEPI (Confederation of European Paper Industries) countries, only the total consumption of packaging papers has increased since 2011.

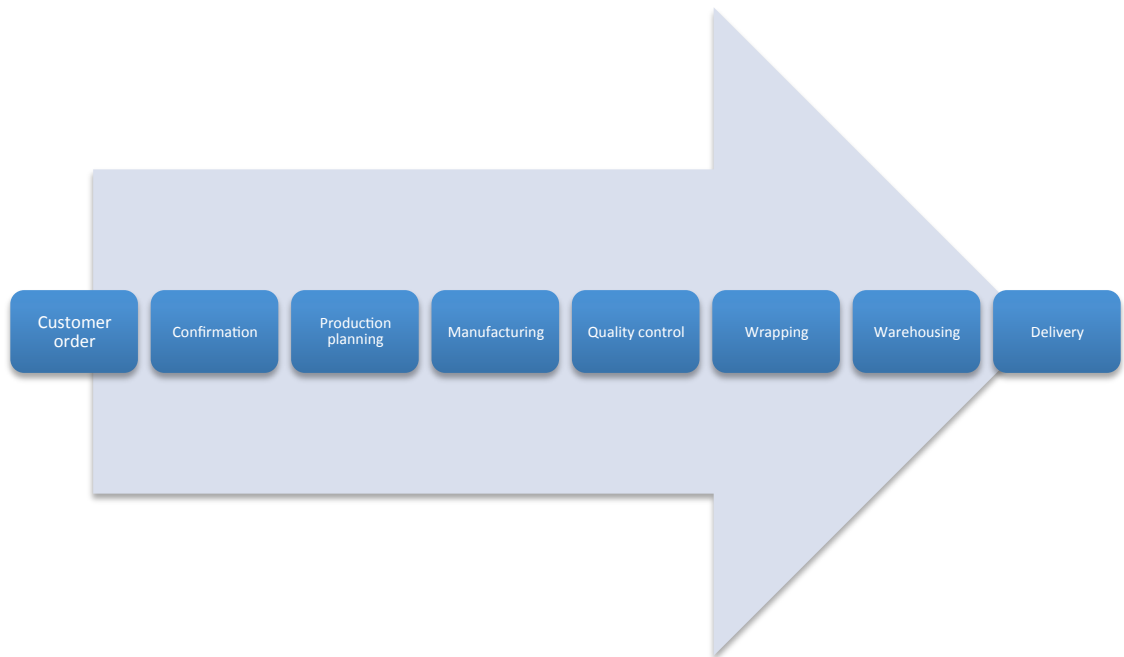


FIGURE 3. Make-to-order process

Customer orders normally consist of several order rows with different specifications. The most important specifications of the reels are width, diameter, quantity and square-meter weight of the particular paper quality. The diameter of the reels produced in the Finnish mills of Pietarsaari and Tervasaari usually varies from 800 mm to 1,300 mm. Since orders typically consist of several reels, the volume is expressed in tonnage due to extremely high density of paper reels.

A paper machine produces a giant *paper machine reel* (see Figure 1.), which is always the total width of the machine. Smaller customer reels are cut from the paper machine reel. In order to achieve the most economical manufacturing, the order dimensions are negotiated with the customer. After both parties have agreed to the dimensions, the order is confirmed and a production run is created to the machine. The make-to-order process is visualized in Figure 3.



## 3 ENTERPRISE RESOURCE PLANNING

### 3.1 Definition

According to the statement of Murthy (2008, 3-4.):

1. **Enterprise** is a group of people with common goals involving the complete business consisting of

- functions
- divisions
- other components.

These are used to accomplish goals and objectives.

2. **Resources** are at enterprise's disposal to achieve the goals. These could be for example

- materials
- funds
- labor hours
- machine hours.

**Enterprise Resources Planning (ERP)** aims to connect all functions and departments of a company into one computer-based system. Its purpose is to enable access to the same database across the company making it easier to communicate and share information within the system. The software itself converts data to visible information to be used from single operations to business decision-making. Understanding the difference between various ERP systems is important in system-selection process, because selecting the right system can lead to tremendous

payback. Companies benefit directly from ERP because it improves their efficiency in terms of system integration, improved planning capabilities and flexibility. Common indirect benefits of ERP are customer satisfaction, better corporate image and customer goodwill. (Parthasarthy, 2007, 1-2.)

In the organization of BillerudKorsnäs, the benefits of ERP could mean interaction between production, delivery planning and invoicing; truck and rail wagon loadings are planned on the basis of up-to-date production data advising the dimensions, loading method, order number and produced weight of each reel at the mill. After the delivery has reached the customer, same system is used for invoicing the order, since exact volumes transported on each departure are visible in the system's database.

When a company is producing goods to customer requirements, more planning is needed than if the produced goods were pre-determined by the manufacturer, and customer would order the reels directly from stock. Basically the production is planned on the basis of specifications demanded by the customer and common production economics. According to Murthy (2008, 253), selecting the most suitable production method can be done with the help of an ERP system that supports the entire range of production strategies.

*Sharing information resources across the functional units of an organization is the main function of ERP.*

*(Murthy, 2008, 4)*

### 3.2 Implementation of ERP

When a company starts the implementation process, at first it should look for a suitable package to correspond its selection criteria. There are thousands of packages available in the market making the selection process difficult and time consuming. Since the evaluation process is the most crucial phase of the implementation, strengths and weaknesses of each system should be carefully taken into account. After the most suitable package is found, the implementation process has to be designed in terms of time schedules, deadlines, selection of suitable team for the project and identification of roles and responsibilities. ERP is brought to its planned shape by configuration. In this phase, it is important that business processes are properly understood to achieve the company's goals. Simultaneously the implementation team is training end users and testing the system in order to ensure its proper functionality. (Murthy, 2008, 266-268.)

In order to build a good team to effectively run the system themselves, the company should select employees with the right attitude for change and learning new things. The post-implementation phase is important since the trained organization has to take over the system. It is a fact that even the best custom tailored ERPs meet only 80% of company's needs. The remaining 20% could be solved by looking for a third-party product to fill the gap, designing a custom program, altering the source code, hoping for upgrades, or simply agreeing to continue without the missing functions. (Murthy, 2008, 268-271.)

Costs and risks of a failed ERP implementation are substantial. Some companies have experienced heavy damages in their business because of ERP implementation failure.

Typical problems have been lost orders and shipments, incorrect inventory data and financial losses. (Murthy, 2008, 279-280.)

### **3.3 Introducing BonD in Finland**

After BillerudKorsnäs acquired the two paper machines in Finland, all production and logistics operations were still performed in the IT-systems of UPM. BillerudKorsnäs wanted its Finnish organization to be integrated into BonD - the ERP system that was already in use in Sweden.

The first step in learning how to use BonD was to create a super-user team who would be the first ones to learn how to use the new system. The team consisted of four people, each representing a specific role in the market support team: production planner, customer service specialist, delivery planner and lead planner. At the mill-site in Sweden, the super-users learned basic navigation in BonD and were introduced to the most general functions needed in their own work. Later on, the team was trained by using a web-based messaging tool and test-version of BonD. After the system became more familiar to the super-users, they started to educate colleagues on how to use BonD in their own working tasks. The delivery planner training started three weeks before the cutover. Two delivery planners also visited the Karlsborg mill to receive in-depth training from their Swedish colleagues.

In addition to BonD, the company uses a MES (Manufacturing Execution System) called TIPS (Tieto Integrated Paper Solutions). TIPS offers real-time production data to be used for production planning with help of detailed customer order information. It also provides real-time warehouse data to be used for inventory management and load planning. The learning curve for TIPS was not long since the previously used

system for Finnish machines was practically identical. The final transition to the ERP system of BillerudKorsnäs took place on 19 October 2012.

## **4 TRANSPORTATION MANAGEMENT**

### **4.1 Transportation in logistics**

Even though seeing trucks and trains moving or parked at a distribution facility allows visual understanding of transportation, it does not deliver deeper knowledge required to comprehend the role of transportation in logistics. The primary function of transportation is product movement; materials, components, assemblies, work-in-processes and finished goods require transportation in order to be moved to the next phase of manufacturing, assembly, or closer to the final customer. As transportation utilizes financial, temporal and environmental resources, it is important that movement should only occur when it increases value of the product. (Bhatnagar, 2009, 133.)

There are often five parties involved in transportation transactions: the shipper (the sending party), the consignee (the receiving party), the carrier, the government and the public. The shipper and consignee have a common objective of transporting the goods from the place of origin to the destination at the lowest possible cost within a certain time frame. The carrier's goal is to maximize the revenue and minimize costs of its service. This means charging the highest rate the shipper or consignee is willing to pay. Due to transportation's high impact on the economy, the government maintains high interest rate in transactions. A stable and efficient environment for transportation allows better economic growth by enabling movement of goods and better product availability on the markets. To maintain competition in carriers'

profitable supply of services, the government controls the transportation business by setting regulations and price levels. The public is concerned about standards regarding safety and environmental issues, as well as effectiveness and accessibility of transportation. The amount of negative environmental effects, such as oil spills and pollution has decreased recently, but still remains significant. (Bhatnagar, 2009, 135-136.)

## **4.2 Transportation modes**

The five general transportation modes are road, railway, maritime, air and pipeline. Pipelines operate 24 hours a day and seven days per week. The obvious disadvantage of pipeline transportation is the lack of its flexibility as only commodities in form of liquid, gas or slurry can be transported. (Bhatnagar, 2009, 138-140.)

Maritime transportation is capable of shipping extremely large volumes. Vessels are able to carry large tonnages at low price, even though the fixed costs in shipping business are relatively high. Maritime transportation is a highly considerable transportation mode when cargo expenses need to be minimized and lead-time is a secondary criterium. Big carriers designed for ocean shipments require specific deep-water ports for access, but for instance diesel-towed barges operating on rivers and canals are more flexible in this matter. (Bhatnagar, 2009, 139-140.)

Often shipping lines add BAF (Bunker Adjustment Factor) surcharge to general shipping costs. Bunker is the name for shipping fuel, and its surcharge costs vary between different areas. Shipping lines are obliged to use only low sulphur oil in Baltic Sea operations, resulting in higher BAF due to its price (DFDS Seaways, 2012).

Railway carriers are also capable of transporting large volumes efficiently over long distances. Even though fixed costs in rail operations are higher than in shipping due to expensive equipment, terminals, switching yards and right-of-way, the operating costs have been experienced to be relatively low especially after electrification of infrastructure. (Bhatnagar, 2009, 138.)

Door-to-door operations and fast intercity movement have caused rapid growth of road transportation. The carriers are flexible due to the possibility of transporting goods on all types of roads. In comparison to railway carriage, fixed investments in road transportation are relatively low. Even though license fees and tolls should be considered, these expenses are not directly related to the distance traveled or volume transported. However, the cost per distance traveled is high because a separate power unit and driver are needed for every trailer or a combination of two trailers. Safety regulations for drivers have resulted in high labor requirements. Distributive organizations or high-value product manufacturers often favor road transportation especially for short distances. (Bhatnagar, 2009, 138-139.)

According to Bhatnagar (2009, 140-141.), air transportation is the least used mode. Its advantage lies on the speed by which the goods can be transported. High speed allows inventory to be reduced, which compensates the high costs involved in air transportation. The mode is expensive because of fuel, maintenance and labor costs for both in-flight and on-ground activities. The cargo is limited by load size constraints determined by the lifting capacity of an aircraft. Large air carrier companies have built air hubs where centralized distribution centers are located in order to extend their delivery network and increase flexibility.

### 4.3 Cargo types

According to Bonacich and Wilson (2008, 14), Müller (1999) states that packing goods into a container in order to enable transportation by rail, truck and vessel without the need for reloading the cargo during each transition to the next mode is called intermodal transportation.

The International Organization for Standardization (ISO) defines a freight container as an article of transport equipment that is specially designed to facilitate the carriage of goods by one or more modes of transport, strong enough to be suitable for repeated use, easy to fill and empty and has internal volume of 1 m<sup>3</sup> or more. The most common lengths of containers are 20 ft and 40 ft, whereas 65-70% of world fleet consists of 20 ft containers with inside volume of around 33 m<sup>3</sup>. (Muthiah, 2010, 119-120.) Containerization saves time and costs in handling, loading, discharging and transporting the cargo. This seamless movement increases the productivity of the entire transport chain and reduces risk of damaging the transported goods (Benefits of the Combined Transport, 2008.).

In contrast to container and break bulk cargo, ro-ro shipping (roll-on/roll-off) is the way of moving cargo that does not require cranes for loading. The cargo is driven on and off the vessel by using ramps that are usually provided by the vessel itself. Typical ro-ro cargo may consist of trucks, trailers and other wheeled equipment (Ro-Ro Shipping (Roll-on / Roll-off), 2012). A fast and cost-efficient way to handle ro-ro cargo is using a cassette. The cassette method has higher loading capacity than any other handling method. The cargo is stacked on cassettes and securely covered at the terminal before the vessel arrives. When the loading begins, the cassettes can be rolled directly onto the vessel. The cassette system enables faster handling as several



units can be loaded at once. In addition, lashing the cargo is faster and does not require additional space between each unit like in single-unit break bulk shipping (An edge for RoRo shipments, 2012).

Products not stuffed into containers or cassettes, but shipped as single units are considered as break bulk cargo. The reason for not containerizing this type of cargo could be unsuitable dimensions or unit weight. Even though some products fit well into containers, it might be more efficient and cost effective to load and transport them as break bulk. General equipment for handling break bulk cargo are forklifts and cranes. The disadvantage in especially weather sensitive units is the risk of having too little weatherproof facilities at ports and warehouses. Proper storage and handling is essential, because break bulk cargo often consists of high-value products (Break Bulk Cargo, 2012).

#### **4.4 Economics in transportation**

The costs and rates of transportation are determined by pricing and economics along with different factors and characteristics of various transportation modes. It is important to understand the economies of industries to negotiate successful agreements and to be able to develop effective logistics strategies. (Bhatnagar, 2009, 142)

One of the major economic influences on transportation is distance. Its significance can easily be explained since it contributes directly to fuel, maintenance and labor costs of the carrier. In spite of delivered distance, fixed costs associated with loading and unloading of shipments means that the cost curve does not begin at the origin. So-called tapering principle, where the cost curve is increasing at a decreasing rate, is

also closely related to economic function of distance. The principle is a result from the fact that shipments with longer distance tend to use more intercity connections than urban routes. Intercity kilometers are less expensive because more distance is traveled with the same amount of fuel than in urban areas due to continuous movement. (Bhatnagar, 2009, 142)

According to Bhatnagar (2009, 142), fuel and labor expenses are not dramatically influenced by the weight of the load. Therefore goods with higher density allow relatively fixed transportation costs to be spread across additional weight. Generally goods with high density can be loaded in a way that the volume capacity of a trailer can be maximized more efficiently (see Chapter 4.4.2). Higher density of goods allows more units to be loaded into same space. On the other hand, if the cargo density decreases, the cost per unit of weight will be more expensive. In case the maximum payload capacity of cargo space is reached, no more load should be added even though the space does not look like full. In tanker vehicles, the trailer is *weighed out* even though half of the tank's volume capacity is not used when liquids are transported.

If special equipment is required for loading and unloading the goods, the cost of handling affects the total cost of transportation. The way of combining goods together, such as loaded on pallets or taped together for transportation and storage also affects handling costs. The risk of damage results in possibility for claims. The liability of goods includes characteristics such as susceptibility for damage, perishability, risk of theft, chemical characteristics (e.g. flammability), or value per weight unit. Improved protection in packaging phase is one way for the shipper to reduce the risk of damages leading to higher transportation costs. (Bhatnagar, 2009, 142-143.)

Balanced lane volume has a market-based influence on transportation costs, meaning that movement between origin and the point of destination should both have an equal amount of cargo on the way back and forth. The vehicle must also return from its first delivery destination. Otherwise distance-related expenses will be charged against the original one-way delivery. In the manufacturing industry, this is the case only in rare occasions, because the demand is not balanced to support so-called *back-haul* deliveries. Therefore logistics systems should be designed by taking back-haul movement in consideration. (Bhatnagar, 2009, 143)

## **4.5 Delivery planning**

### **4.5.1 Selection process**

According to Bhatnagar (2009, 138-141.), choosing the most suitable transportation mode is subject to measurable values such as distance, volume, revenue and the nature of traffic composition. Other factors affecting the selection of a transportation mode are

- strengths and weaknesses of the company in terms of marketing, financial and production resources
- prevailing market characteristics, including the competitive scenario, geographical and territorial structure
- proved equity of company's products in the eyes of customers to bear with a stock-out situation
- product suitability to various transportation modes such as size and shape
- total cost for various transportation modes.

#### **4.5.2 Load planning and optimization**

According to Bhatnagar (2009, 149), load planning and optimization is creating efficient transportation plans by aiming to reduce transportation costs. This involves typically the use of a transport management system, where its optimization capabilities select the best option for a shipment based on specific criteria including cost, transit time and overall mode. Sometimes also longer planning horizon may be used allowing orders to be evaluated in combination with others. Bhatnagar (2009, 135) also states that the principles of transport economics are important to be taken into consideration since the objective is to maximize the size of the load and distance shipped while still providing the expected service level.

#### **4.5.3 Freight forwarding**

Muthiah (2012, 78) explains that the position of a freight forwarder is between the shipper and the carrier. Its main role is to assist the shipper in exporting goods by taking responsibility of transportation arrangements. A freight forwarder typically assists the shipper by booking cargo space, preparing transport documentation and arranging customs clearance.

*4PL* is a fourth-party logistics provider contracting different haulers and taking responsibility for transportation capacity, service performance and quality. The arranged transportation is bid on the open market. With a wide network of various available haulers, 4PLs speed up the transportation booking process of the customer (DB Schenker, 2012).

## 5 CURRENT STATE OF DELIVERY PLANNING IN BOND

### 5.1 Transport chain

The transport chain from the mill to the destination usually consists of two or three transportation steps involving different transportation modes. The chain is always planned in a pull-method starting from the final delivery to the customer or terminal. The final transport in the delivery chain is the actual main transport to the final destination. Main transports are planned to match the requested delivery date of the order. The first step in the transport chain is a supporting transport. Normally this is a rail or truck delivery carrying the reels from the mill to a place where they are loaded on either the next supporting transport or a main transport. Figure 4. presents a typical transport chain planned to arrive in Lübeck on 29 October 2012. The supporting rail transport delivers the reels to the port of Rauma, where they are loaded onto the main transport vessel. Orders can also be split to be delivered to the port of loading in two different supporting transports. Splitting occurs when the order needs to be produced in two different production runs, for example to achieve better trimming. There are no supporting transports in chains where the order is delivered directly to the customer by truck.

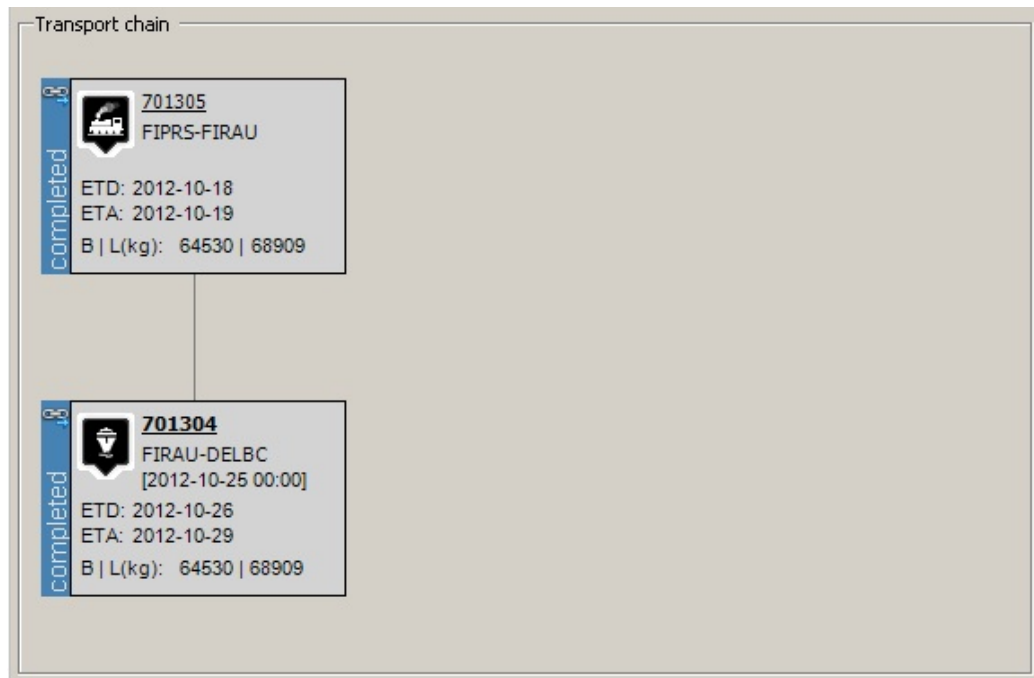


FIGURE 4. Two-step transport chain with supporting transport 701305 and main transport 701304

The number of shipping destinations was reduced when logistics operations were taken over by BillerudKorsnäs. Most of the vessels are loaded in the Port of Rauma, from where they are shipped to a destination port serving nearby market areas. After the vessel has arrived to a destination port, the cargo is unloaded and stored in the port warehouse. Some customers prefer calling off the orders from the terminal by themselves, but some want the orders to be delivered all the way to their premises. This should not be mixed with the main transport since a separate call-off needs to be created in BonD for a customer delivery from terminal.

## 5.2 Composition and market share of the delivery planning team

The need for delivery planning resources increased dramatically after BillerudKorsnäs introduced its operating model to the Finnish organization. Currently, seven delivery

planners take care of transportation arrangements, whereas only one was needed in UPM. On the other hand, UPM had its own shipping line focusing only on maritime transportation, hence reducing workload of in-house delivery planners.

Material flow from the company's Finnish mills is coordinated in the market support team in Tampere, Finland. The greatest difference to the Swedish organization structure is that Swedish delivery planners are located at the mill-site. Despite the distance between the mills and delivery planners in Finland, day-to-day contact with the warehouse is essential to keep both parties up-to-date with logistical deviations affecting loading, production or transport documentation.

Export countries have been divided into different market areas, each served by one or two ports with direct shipping connection from Finland. The market share in the team has been divided in a way that each delivery planner is specialized in certain area. Almost all shipping to European destinations is break bulk or ro-ro type departing from Rauma. Goods to Central and Eastern European markets are shipped via the ports of Lübeck and Rostock in Northern Germany. Poland is an exception from other Eastern European countries, since the goods are shipped via its domestic port of Gdynia. These three ports have also been divided between three delivery planners. Italian orders are also shipped via Lübeck and transported onwards by rail.

Shipping to Western European markets including Spain, France and Benelux countries is organized via the Belgian port of Antwerp, and two Spanish ports Santander and El Ferrol. Delivery planning to Western Europe is the responsibility of two employees, one taking care of Antwerp and the other of the two Spanish ports. The last short-sea shipping market consists of the British Isles, with the destination port located in Immingham. The difference to all previously mentioned European

markets is that goods heading for Immingham are loaded in the port of Helsinki, not Rauma.

Shipping to other continents is containerized. Vessels sailing between different continents are mostly large container carriers that only call some of the largest ports in the world. Containers stuffed in Rauma are transported on feeder vessels to a major European port, where they are loaded onwards to a larger container vessel. The only exception to containerized overseas markets is North America, as the goods going to North America are shipped as break bulk from Rauma. Two delivery planners have divided the overseas markets by continents.

Since track gauge between Finland and Russia is practically the same, orders to Russia and Ukraine are usually transported by rail. Finnish, Scandinavian and Baltic customers are served by direct truck deliveries from the mills. Railways are not used because loading and unloading wagons in rail yards extends the lead-time. The lead-time to these countries normally varies between one and three days.



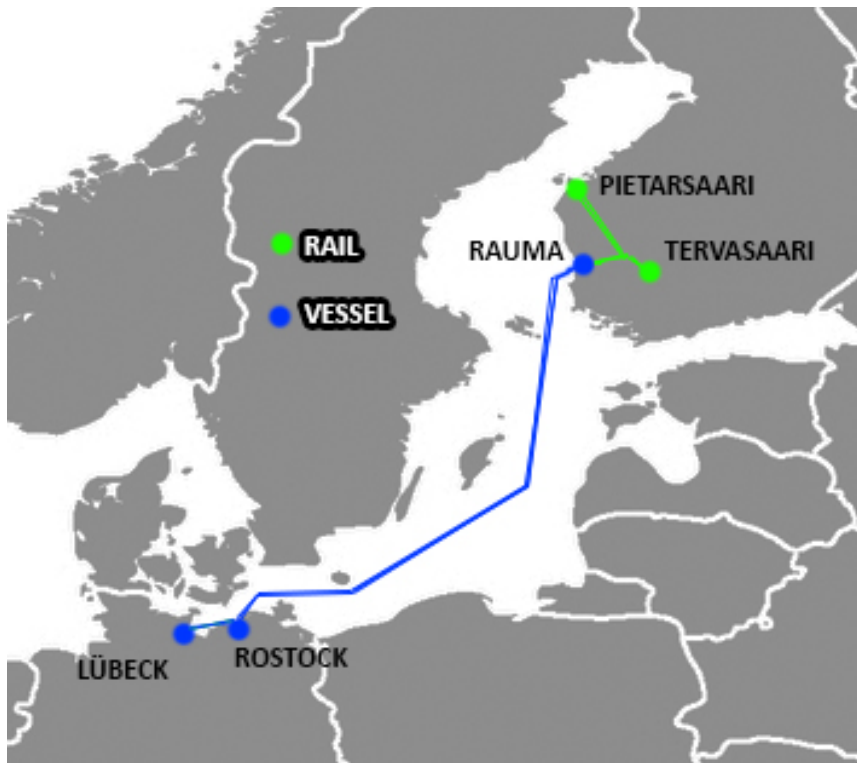


FIGURE 5. Transport chain from the Finnish mills to the ports of Lübeck and Rostock

### 5.3 Loading process

Rail wagons are always loaded according to an active delivery plan created by a delivery planner in Tampere. If a plan is not active, it is not visible to forklift drivers. The delivery plan includes different customer orders that are going to be delivered to the customer or external warehouse, such as a port terminal. Tervasaari and Pietarsaari mills use two kinds of wagons: G-wagons (max. payload 27 tonnes/unit) and Sim-wagons (max. payload 62 tonnes/unit).

The mill warehouse had more influence and flexibility on wagon loadings when UPM still organized the logistics. Forklift drivers were able to create additional load fills

from random orders in stock, or reels arriving to the warehouse without an active delivery plan. For these *hot-loads*, it was only important that the reels were supposed to be delivered to the same destination as the currently active delivery plan. After scanning, the MES would automatically recognize the loaded reels and adjust the delivery plan accordingly. Therefore it was possible to load wagons directly after a reel from another delivery plan arrived on the conveyor.

BillerudKorsnäs uses a slightly different approach to loading in its Swedish mills. While in UPM, the basis for loading was created by the reels arriving on the conveyor, BillerudKorsnäs is used to load wagons on the basis of loading instructions of the currently active delivery plan. If reels from another plan arrive on the conveyor, they cannot be loaded directly but should be put in stock until the loading of the correct plan starts. Spontaneous load fill cannot be used as the wagon should only contain orders from a single delivery plan. BonD does not support UPM's hot-loading approach. Since wagons are only loaded according to instructions, risk of mixing delivery plans and loading incorrect reels is relatively low. However, sometimes it may be time-consuming to find a reel that has been in stock for a longer period of time. The difference between BillerudKorsnäs and UPM loading models is clarified in Figure 6.

The Tervasaari mill includes three paper machines: PM7 owned by BillerudKorsnäs, PM5 and PM8 owned by UPM. The machines are only operated by employees from the company managing the particular machine. However, the wrapping line and warehouse facilities are in mutual use for PM5 and PM7. If both machines are running, the wrapping line puts reels through in approximately the same order as they arrive from cutting. Therefore reels from both companies arrive to the warehouse almost simultaneously. Forklift drivers find it troublesome to load several

delivery plans at the same time. It is not possible to plan mutual delivery plans, since both companies use different ERP.

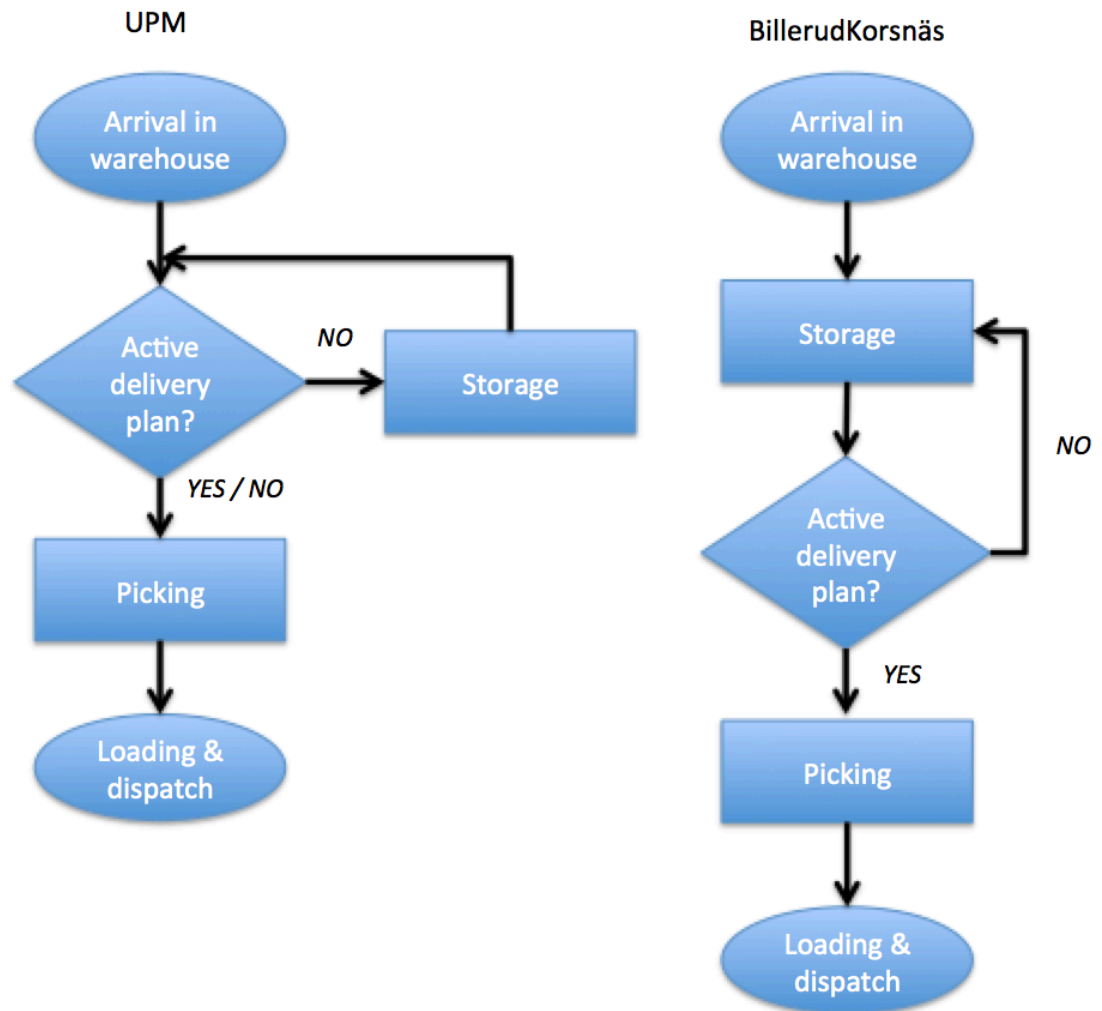


FIGURE 6. Loading model comparison

## 5.4 Road transportation

Sometimes the capacity limit of rail wagons is not optimal for the desired quantity. In practice, this means not being able to utilize the full payload of a wagon. Such occasion generates need for delivering the excess quantity by road. When the reels need to be delivered by road, the transportation is often arranged on a short notice. Selection of the most suitable transport provider for truck deliveries abroad is conducted by a 4PL service provider, who evaluates different alternatives in terms of price and lead time from the hauler's confirmation to ETA at the final destination. The full payload of a truck is 24 tonnes in international deliveries, and 38 tonnes in domestic.

Depending on the final destination, BillerudKorsnäs uses different approaches to road delivery bookings. Transportation is requested directly from the hauler if the cargo is delivered directly to the port of Rauma. In case the cargo is delivered to another destination, such as foreign customers, the transportation is arranged by the 4PL service provider. In both cases, the role of delivery planners is to optimize the transported volume by aiming to reach full payload. Maximum capacity should be utilized in order to avoid costs resulted from empty cargo space. If the maximum capacity is not achieved with the planned volume, smaller orders are added to fill up the loading capacity. Currently used load fills are usually orders that are already produced but are not in a hurry and would therefore be delivered later by rail.

Reels can be loaded either standing or lying. Standing reels are faster to load, but require a forklift with specialized clamps for lifting (see Figure 7.). Most of the trucks are loaded with standing reels, but direct deliveries to some smaller customers may

require loading only lying reels because they do not always have the necessary equipment.



FIGURE 7. Forklift with clamps carrying reels

## 5.5 Capacity management in shipping

After acquiring Pietarsaari and Tervasaari mills, the company had to determine annual volumes produced and transported to each country. The estimations were based on the data from the previous year when transportation was still organized by UPM. The estimated capacities were agreed with railway and shipping companies, resulting in weekly allotments for each destination.

The cargo space in vessels is booked on a weekly basis, and even the pre-determined allotment has to be confirmed few days beforehand. This way the shipping line has realistic up-to-date information of how much volume is currently booked on a vessel.

Awareness of the booked capacity is important to the shipping line, especially if the given allotment will not be fulfilled and could be used by another shipper.

## **6 CASE 1: MIXING MULTIPLE DELIVERY PLANS INTO THE SAME WAGON**

### **6.1 Background**

Since different vessels call different destinations, the port of Rauma includes several terminals that have been divided according to the final destination of the goods, hence enabling more efficient loading of vessels. The terminals have not only been divided in the system, but also physically making it very more efficient to load a vessel by picking goods from one particular terminal. Supporting transports from mills to Rauma are planned in accordance to terminal locations. Orders to different terminals cannot be mixed in the same wagon as each one is directed to the designated terminal. It is also very time-consuming for the port to unload a wagon into a different terminal than where it arrived in the first place.

According to the current agreement, the rail carrier assumes only one single delivery plan to be loaded on each wagon. The risk of double invoicing increases always when the forklift drivers are looking for load fill from another active delivery plan. A wagon should only contain reels from one delivery plan. It is not allowed to mix multiple delivery plans into the same wagon, even if the cargo is going to the same terminal. Forklift drivers are willing to add load fill from other active delivery plans if necessary. If the last wagon in the delivery plan cannot be filled up completely, the company will pay the full price for a wagon that is less than full payload. Another

reason for adding load fill from other delivery plans is to avoid damages during transportation. Reels are typically loaded very close to each other in order to optimize space utilization inside the wagon. If the reels can be loaded tightly next to each other, the risk for shaking and falling during transportation also decreases.

## **6.2 Warehouse interviews**

According to Cameron and Green (2009, 60-61.), a person is very focused on performance when it comes to learning new things. After new things have been learnt, the consciousness of one's own performance decreases significantly. In this way, a person becomes unconsciously competent, which continues until the person does something wrong or when a new challenge appears. Therefore learning to do something new usually reduces performance for a while. A key factor in a person's ability of adapting to changes is his or her personality. Other examples of factors affecting the response are personal history, company background and the type or consequences of the change.

An important aspect in solving operational problems is to know how the employees feel about their daily work. Delivery planning is conducted in Tampere, and the delivery planners are in contact with the warehouse only via telephone and email. In order to highlight and connect the consequences of the company's ERP replacement, an interview regarding experiences and opinions was carried out with both warehouse managers and two forklift drivers. The following questions were presented to each participant:

1. What kind of problems have occurred in the warehouse operations after the new loading principle was introduced?

2. If any problems occurred, do they affect your daily work?
3. Do you find it necessary to pay more attention to finding a solution to these problems?

### **6.3 Problem definition**

Outcome of the interview shows that the thoughts of Cameron and Green (see Chapter 6.2) are partially reflected in the responses of the warehouse and delivery planning personnel. After BonD was introduced in Finland, also the new way of loading at the mill had to be adopted in the process. The loading model experienced a remarkable change after the cutover, but its consequences were not noticed until the logistics and ERP management in Sweden reviewed the delivery notes of dispatched wagons. Loading was still done according to the UPM loading model, even though BonD requires a different approach. The reason for still operating the warehouse according to the UPM model is that the processes were clear and the personnel had been working the same way already for several years. After it became clear that the new model did not fit well into the old UPM warehouses (see Figure 6.), both warehouse workers and delivery planners started to closely follow loading performance and related matters. Even though only two forklift drivers were interviewed, the information gathered is enough to highlight the problems as each driver is working with the same tasks. A summary of the results is presented later in this chapter.

In order to keep stock levels low, it is essential to maintain constant and balanced material flow onwards from the mill. The delivery planners in Tampere started facing difficulties when they needed to plan shared supporting transports to different terminals in Rauma. Scheduling delivery plans according to production was



problematic because of uncertainties about the current stage of loading in the warehouses, poor parallel information flow with each other and the lack of experience with the new ERP system. The delivery planners were never confident about the correct supporting transport to use because planning was not organized. Illogical planning resulted in reels from several different plans arriving on the conveyor at the same time. Three delivery planners share the same supporting transports to Terminal 15 in the port of Rauma. The situation was often alarming as sometimes there were three different delivery plans on reels produced in the same run. Terminal 15 is used for orders to the ports of Lübeck, Rostock, Gdynia and Antwerp, which comprise the majority of the produced volume.

When new reels arrive on the conveyor, the most efficient way is to load them directly onto wagons. Orders arriving without an active delivery plan should be put in stock. Since the UPM loading model enabled direct loading from the conveyor, large storage space was not needed in the warehouse. Most of the reels arriving on the conveyor practically never even touched the floor of the warehouse.

According to the results from warehouse interviews, the highlights of the loading problems are following:

1. Reels arriving on the conveyor do not always have active delivery plan
  - Reels need to be put in stock before loading
  - Especially during weekends
2. Loading wagons is difficult as several delivery plans are simultaneously active
  - Wagons need to be filled in a logical order before they can be changed to empty ones
  - Multiple plans to the same terminal should be merged to load more arriving reels

- In case an empty wagon is left in the middle, they cannot be changed
  - Not allowed to mix delivery plans in a wagon, therefore wagons are not always loaded up to their full payload
3. The new model is too complex
    - Reels need to be put in stock before loading
    - The UPM model enabled mixing, now everything has to be planned
  4. The Tervasaari warehouse has to adapt to two different models simultaneously
    - The UPM model is used for reels arriving from PM5.

The mentioned problems have strong effect on the workflow in the warehouse, since continuous follow-up is required to synchronize production and delivery planning together. In case only one forklift driver is working per shift, it is difficult to manage a complex loading model since the production volume is relatively large. The delivery planning from Pietarsaari has already improved remarkably since BonD was introduced, but Tervasaari is still struggling with severe difficulties. The Tervasaari loadings require even more detailed planning, since the warehouse is smaller and shared with UPM.

#### **6.4 Suggestions for improvement**

Wagon loadings turned out to be a challenging task to be planned efficiently beforehand. The optimal loading situation is to have production runs only containing orders from one delivery plan. In this way the risk of mixing multiple plans into the same wagon is lower. Both warehouses lack the capacity to lay reels directly in stock after arriving on the conveyor – sometimes even for a short period of time. The forklift driver should have the possibility to avoid unnecessary lying of reels. The most distinguishable advantage in direct loading is the reduction in unit handling

times. When laying the reel in stock and loading it later, also the risk for handling damages doubles – especially when working in cramped space.

Loading needs to be planned more carefully by selecting a suitable span of production runs to be included in the same supporting transport. The basis for the loading model solution is built up based on the following key requirements:

1. Direct loading always when possible
  - Each supporting transport should be planned only for a fixed period of time in order to avoid simultaneous production of orders to the same destination on different plans
2. Only one active delivery plan when loading in progress
  - Multiple active delivery plans complicate making changes in BonD and give the forklift driver freedom of choice to add external load fill from inactive plans
3. Splitting leftovers to the next delivery plan has to be efficient and logical
  - The warehouse manager and delivery planners should be aware of the ongoing splitting process

In order to have more control over loading operations, a simple loading schedule list was created. The list contains information about the production runs, loading dates and transport numbers used for each delivery plan. Always when updated, a new list would be sent to the people involved in delivery planning and loading process. The list includes three separate delivery plans that are divided for selected dates for each week. An example of the list is shown in Table 1.

The list would be primarily used for delivery plans to Rauma Terminal 15, since the majority of production of both mills is continuously loaded towards it. To achieve a

logical way to load, the last day of loading for orders produced on Monday and Tuesday is planned to be dispatched by latest on Wednesday, orders produced on Wednesday and Thursday are planned for Friday, and the ones produced during the weekend for the following Monday. After the last run of the particular delivery plan has ended and reels have arrived, the warehouse manager should complete the loading in TIPS and inform the delivery planners. The manager should also inform all involved parties about the leftover reels that have not been loaded against the delivery plan and thus need to be split to the next one. Currently there is no need to continuously use the list for other terminals so far, as the volumes are relatively small and production takes place only for short periods at once.

TABLE 1. Example of loading schedule list

<b>TRANSPORT NUMBER</b>	<b>LAST LOADING DATE</b>	<b>FROM PROD. RUN</b>	<b>TO PROD. RUN</b>
705266	WEDNESDAY 12/12	SS-007 / 20230	SS-007 / 20370
703199	FRIDAY 14/12	SS-007 / 20371	NATP-2-006 / 20030
704334	MONDAY 17/12	NATP-2-006 / 20031	SHI-008 / 30341

The essence of the list is based on its simplicity. Forklift drivers are constantly loading on the basis of the information that is visible in the delivery plan. As long as each

plan is correctly updated in BonD, the information should also be available in loading instructions.

## **6.5 Disadvantages of load schedule list dependency**

Production deviations are the main concern of the model, as sometimes changes in the production plan are made on a short notice. Such changes often require rapid actions from the delivery planner in order to add the new production run to the correct delivery plan.

Often the total volume of a delivery plan is not equally dividable to result only as full-payload wagons. Suitable load fill should always be looked up in case the capacity of the last wagon is not fulfilled. The warehouse manager should inform about the lack of load fill, leading to corrective delivery planning actions. If each reel from the active delivery plan has been loaded but the last wagon is not filled up to its full payload, the delivery planner can either search for an existing load fill from the warehouse, or move the required quantity of reels from the forthcoming delivery plan. This may, however, delay the dispatch of the last wagon especially if the production is currently switching to another paper quality. Another payload-related challenge is to manage production stops caused by unexpected failure. If the loading of the last wagon in the delivery plan has already started when the failure occurs, it might take an unacceptable amount of time until the production is running again. In the worst-case scenario, the wagon needs to be dispatched urgently in order to deliver reels to the port on time before the cargo arrival deadline of the vessel. If suitable load fill cannot be found in the warehouse, the wagon has to be dispatched without reaching full payload. Otherwise the cargo would be delayed.

Even the splitting process might take a long time if the delivery plan is connected to several other transports in the system. Transport chains connecting multiple main and supporting transports increase the required network capacity to handle the information flow in BonD.

If the delivery plan in Tervasaari with the latest dispatch on Monday comprises large volume, switching to the next plan may become challenging since the rail carrier cannot replace full wagons with empty ones more than three times a day, at most. Often the carrier is in such a hurry during the weekend that replacements can be done only twice a day. Therefore several reels produced during the weekend need to be put in stock in case the warehouse runs out of wagon space for a massive delivery plan. The risk is highest when the production is running on both paper machines at the same time. If white paper is produced in the Tervasaari PM7, the risk becomes even higher since the manufacturing mostly consists of orders to Terminal 15.

## **7 CASE 2: BALANCING THE MATERIAL FLOW TO LÜBECK**

### **7.1 Background**

The company came across difficulties in balancing the material flow to Lübeck. Since both Italy and Germany are served via the port of Lübeck, the connection from Rauma is a very crucial part of the transport chain. Italy and Germany are the most important foreign markets for the company's products so it is important to emphasize the importance of maintaining the supply as good as possible. However,

several customers from both markets have complained about delayed orders after the cutover.

## **7.2 Transported volumes**

Departures from Rauma are divided into two vessels each week. In normal circumstances Vessel 1 sails on Tuesday and Vessel 2 on Friday. Vessel 1 calls both Rostock and Lübeck, thus requiring more attention since the 600-tonne allotment should be split between both destinations. There are currently two delivery planners issuing bookings on Vessel 1, as one is responsible for the traffic to Lübeck and the other to Rostock. Continuous communication between the two is essential in order to keep both planners updated about the total volume and remaining capacity of the vessel. Vessel 2 calls only the port of Lübeck, making it simpler for the delivery planner to manage the capacity. Current allotment of 850 tonnes is remarkably higher, and receiving extra-capacity on this vessel is easier due to its higher payload. Today the allotment of both vessels together is 1,450 tonnes, and the shipping line allows extra capacity in case the vessel is not fully booked. Table 2. presents the total volumes shipped from Rauma to Rostock and Lübeck during the first nine weeks after the cutover. It can be noticed that the given allotment has been exceeded several times.

TABLE 2. Total volumes shipped to Rostock and Lübeck in tonnes

WEEK	LÜBECK (t)	ROSTOCK (t)	TOTAL (t)	ALLOTMENT (t)
1	955	-	955	700
2	1,290	135	1,425	1,300
3	1,520	650	2,170	1,300
4	865	450	1,315	1,450
5	945	345	1,290	1,450
6	1,330	290	1,620	1,450
7	1,450	320	1,770	1,450
8	1,050	530	1,580	1,450
9	1,250	320	1,570	1,450
<b>TOTAL</b>	10,655	3,040	13,695	12,000

The shipping line had split the allotment to pre-determined cargo type capacities, since 150 tonnes of the weekly allotment was only reserved for ro-ro cargo. The rest was used for break bulk cargo, meaning reels with diameter equal or more than 900 mm. The estimation for the share between ro-ro and break bulk did not meet reality during the analyzed time frame, as the actual share of ro-ro cargo was surprisingly small (Table 2). The estimated ro-ro share would utilize 13% of the total capacity unless the shipping line was not able to give extra capacity for break bulk. Thanks to the carrier's flexibility, BillerudKorsnäs received more extra capacity during these three weeks, after which the fixed split between ro-ro and break bulk was removed.

TABLE 3. Share of ro-ro and break-bulk cargo

	RO-RO (t)	BREAK-BULK (t)	RO-RO SHARE
<b>ESTIMATION</b>	1,350	9,900	13.6%
<b>REAL</b>	92	10,873	0.9%



If the delivery chain from the mill to Rauma stopped for some reason in the beginning, it could make orders miss the vessel and move booking to the next departure. Then the next vessel would have two times the volume of a normal booking from BillerudKorsnäs. To prevent such scenario, the shipping line allowed higher capacity for the company during the startup. Already in the very beginning, the company found out that it was booking more than the allotment was set to. As a result, the company renegotiated a 150-tonne increase to its weekly total. The increase, however, only affected on Vessel 2 due to limited capacity in Vessel 1. In order to find out whether the allotment has been enough to carry booked volumes on the selected time frame, an average excess rate was calculated. An allotment of 700 tonnes is used for week 1, since only Vessel 2 was planned by the logistics organization of BillerudKorsnäs for that week.

$$\text{Avg. excess rate} = \frac{\text{total volume}}{\text{total allotment}} = \frac{13\,695}{12\,000} = 1.1413$$

The rate indicates that the allotment has been exceeded on average by approximately 14% during the first nine weeks. Since the allotment was increased from the original 1,300 tonnes after week 3, it is interesting to find out whether the total volume would still have exceeded the allotment if the 150-tonne increase was added already in the beginning.

$$\text{Avg. excess rate} = \frac{13\,695}{13\,050} = 1.049$$

The rate is still nearly 5% over the total allotment. The shipped volume would not have fitted in the agreed capacities, even though it was split equally to meet each vessel's given maximum capacity. Figure 9. visualizes the relation between the

allotment and the shipped volume per week. The first high peak in volumes is on week 3, when the company managed to book vessels by 66% over its allotment.

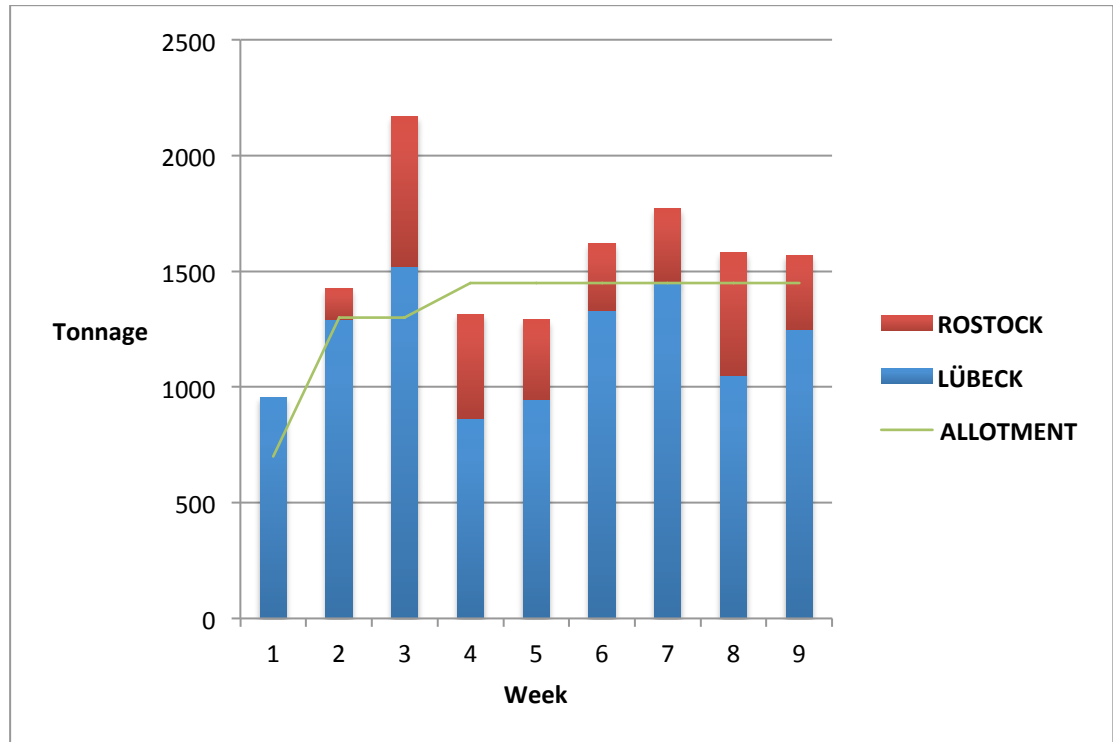


FIGURE 8. Total volumes shipped to Rostock and Lübeck

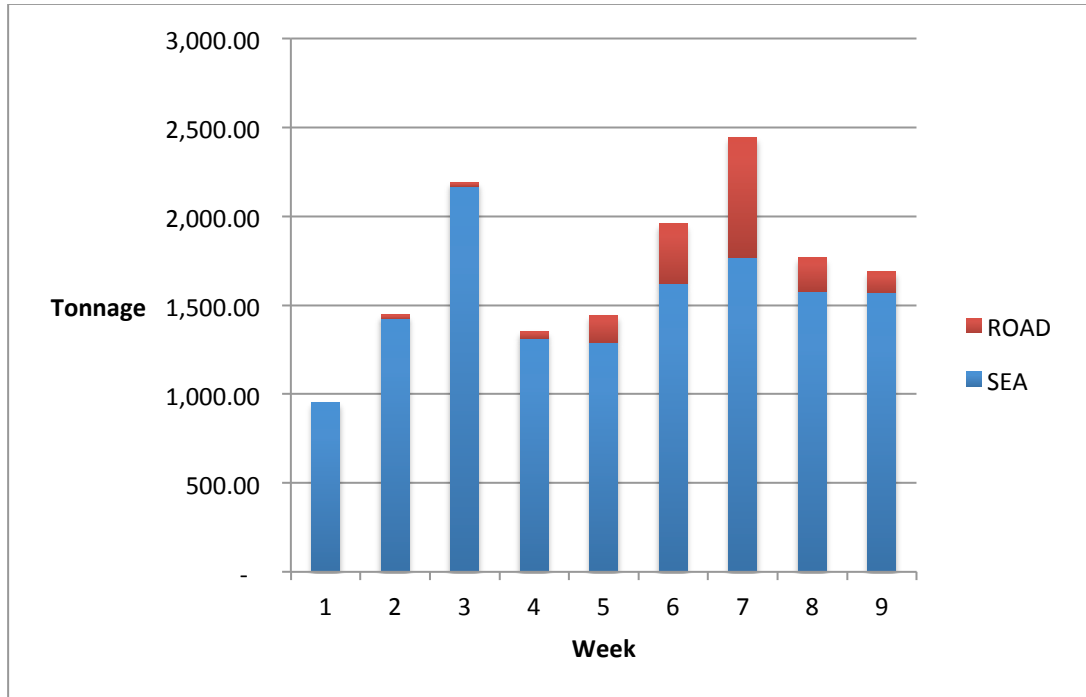


FIGURE 9. Comparison of sea and road transportation volumes

TABLE 4. Road transportation volumes

WEEK	RAUMA (t)	PIETARSAARI (t)	TERVASAARI (t)
1	-	-	-
2	-	-	21.7
3	-	21.6	-
4	15.4	-	24.2
5	88.1	64	2.9
6	244.2	73.5	19.6
7	305.9	278.2	91.7
8	69.0	118.8	-
9	118.9	-	-
<b>TOTAL</b>	<b>841.5</b>	<b>556.1</b>	<b>160.1</b>

If the carrier does not allow extra capacity, the leftovers need to be delivered by road. As seen in Figure 10., road transportation volumes have increased after it came clear that alternative transportation modes had to be used in order to deliver the goods to the customer on time. The greatest volumes have been delivered from Rauma, but also direct trucks from the mills have been used in case the vessel is fully booked already beforehand.

The main reason to avoid direct truck deliveries is their high price. Road transportation is more expensive alternative over long distances than shipping. Also the unit capacity is relatively small, as the maximum payload per truck is only 24 tonnes. The 4PL service provider organizes road deliveries on the basis of price and lead-time. Foreign haulers offer transportation for cheaper price than Finnish haulers so most truck deliveries abroad are done by foreign transportation companies. To some Eastern European countries a truck delivery can be cheaper than shipping, because the total price after adding cost of supporting transportation and material handling in ports might be higher than rates offered by foreign haulers. The Finnish winter is challenging for foreign trucks, since they are not usually equipped with snow tires. In snowy conditions, for instance blizzards, it may be difficult to organize a delivery for a large volume that requires several trucks.

### **7.3 Production volumes**

The actual requirement for transportation capacity is found from production volume data. Italian and German customers mostly consume white grades, explaining volume fluctuation in production. Each low peak takes place on brown-grade-production, high peaks on white.

TABLE 5. Produced and dispatched quantities from both mills

PIETAR SAARI	WEEK	LÜBECK PROD. (t)	ROSTOCK PROD. (t)	DISPATCHED (t)	ROAD
	1	1,043	311	1,618	-
	2	1,218	799	420	21.6
	3	299	261	1,765	-
	4	776	139	931	-
	5	1,832	538	2,139	64
	6	755	702	2,226	73.5
	7	345	118	795	278
	8	1,406	707	1,353	118
	9	2,033	587	2,036	118.9
	<b>TOTAL</b>	<b>9,707</b>	<b>4,162</b>	<b>13,957</b>	

TERVA SAARI	WEEK	LUBECK PROD. (t)	ROSTOCK PROD. (t)	DISPATCHED (t)	ROAD
	1	371	99	560	-
	2	192	17	-	21.7
	3	641	112	517	-
	4	278	5	532	24.2
	5	360	25	121	2.9
	6	373	24	802	20
	7	471	11	56	91.6
	8	230	46	547	-
	9	387	86	364	-
	<b>TOTAL</b>	<b>3303</b>	<b>425</b>	<b>3,659.4</b>	

Dispatched volumes seem to peak a week after high production volumes (see Figure 11.). The delay can be explained by weekend dispatch scheduling; most volumes produced during the weekend are dispatched on the following Monday. Wagons can be dispatched from Tervasaari also on Saturday, but in Pietarsaari not before the next week.

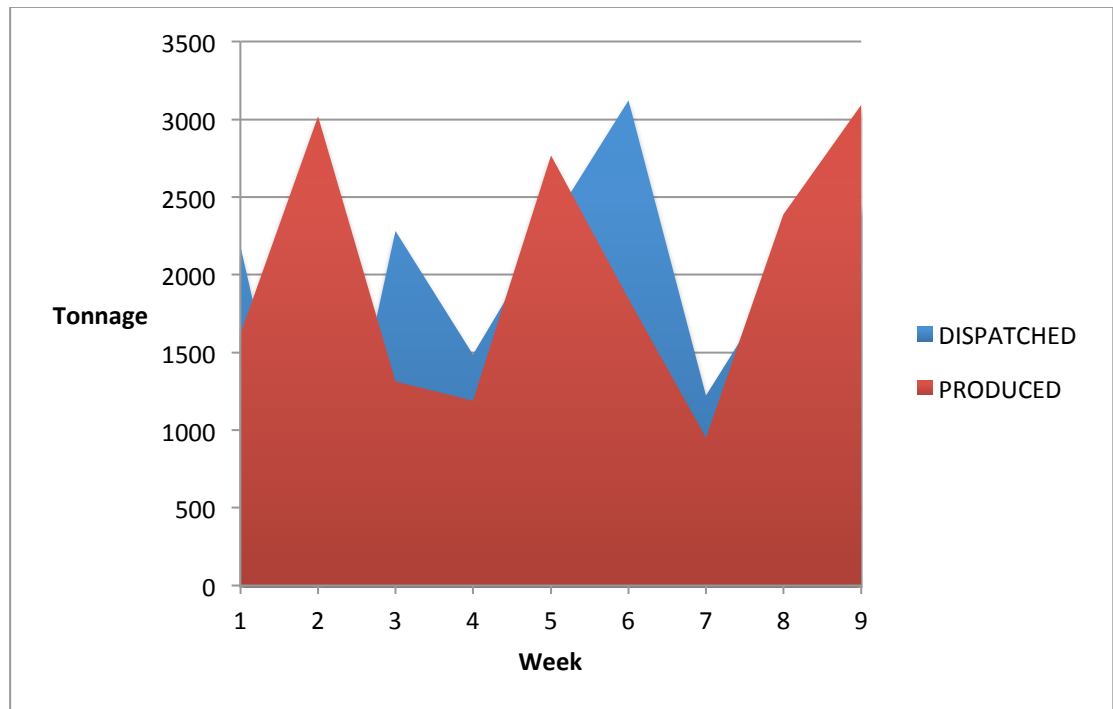


FIGURE 10. Production and dispatch peaks

## 7.4 Volume comparison

Total backlog volume in the port of Rauma is determined in the following calculation for the first nine weeks.

$$\text{Volume arrived in Rauma} = 17\,597 \text{ tonnes}$$

$$\text{Shipped volume} = 13\,695 \text{ tonnes}$$

$$\text{Backlog volume} = 17\,597 - 13\,695 \text{ t} = 3\,902 \text{ tonnes}$$

$$\text{Backlog per week} = \frac{3\,902 \text{ t}}{9} = 433.6 \text{ tonnes}$$

In case the shipping line would not have been flexible with booking capacities, the allotment-based backlog volume would have been

$$\text{Backlog volume} = 17\,597\,t - 12\,000\,t = 5\,597\,\text{tonnes}$$

$$\text{Avg. per week} = \frac{5\,597\,t}{9} = 621.9\,\text{tonnes}$$

The produced volume indicates that the demand for transportation to Lübeck and Rostock is greater than current allotment with the shipping line.

## 7.5 Suggestions for improvement

The leftover volume for alternative transportation is alarming. The company should not only rely on extra-capacity bookings because sometimes the shipping line might not be able to allow more bookings than agreed. BillerudKorsnäs should at first try negotiating increased allotment with the shipping line. During the analyzed time frame, average production per week was approximately 1,955 tonnes. This number should be the target for allotment update; otherwise backlog problem will not be completely solved. If the company is able to agree upon increased allotment, it should not fix the split between ro-ro and break bulk. Reels with diameter less than 900 mm are randomly produced, and the volumes are often small (see Table 3.). Ro-ro cargo is loaded on cassettes, and is not therefore directly exchangeable for more break bulk capacity. In case reels with smaller diameter are not produced for a certain departure, the fix only stands for empty allotment.

Calculations on the basis of the first nine weeks show that the average weekly production to Rostock was 510 tonnes, and weekly backlog from shipping 434

tonnes. As the volumes are relatively close to each other, alternative means of transportation to Rostock should be reconsidered. As most of the Eastern European countries are served via Rostock, it is possible to deliver goods by truck in case arranging more vessel capacity is not possible. Direct road transportation to some countries might not be more expensive than total cost of shipping, port operations, transit storage and customer delivery from the destination port. The company has better chances to find cheap road transportation in case the delivery can be used as back-haul for the particular carrier (see Chapter 4.4).

The total cost of transporting 24 tonnes (FTL) from the Pietarsaari mill to a Hungarian customer by shipping the goods via Rostock is calculated in Appendix 2. The cost is compared to a direct FTL delivery to the same customer. Rail transportation from the mill to Rauma is calculated for the most economic payload volume (see Appendix 1.), assuming that the majority of dispatched rail transports exceed the required weight limit. Since port handling fees are not visible in the transportation cost module in BonD, a break-even point for more economical alternative is calculated. Viability of direct road delivery is determined by reducing total cost of transportation from the direct delivery cost example. The result according to selected data, using the current delivery chain via Rostock is more expensive if the port handling costs of one voyage exceed the calculated limit value per transported tonne.

If the company is able to agree direct truck deliveries to certain customers in order to reduce weekly backlog by a share of 50% from Rostock production, need for total allotment is 1,700 tonnes. The split between destinations should be 255 tonnes to Rostock, and 1,445 tonnes to Lübeck. If the company is willing to reduce the allotment and operate even more direct deliveries by road, the loading capacity especially in the Pietarsaari mill warehouse should be carefully taken into account.



The warehouse is able to load a maximum of six trucks per day with current resources, and the capacity is already highly utilized.

## **7.6 Deficiencies in improvement suggestions**

All volumes and calculations are based on data collected from BonD and TIPS over the first nine weeks. The time frame is relatively short, which should be taken into account in final decision-making. Weekly volumes arriving in Rauma also included old UPM orders that were already in the mill stock during the cutover. Hence the indicated need for increased capacity is not entirely realistic. Also stock orders for certain customers were included in the total production volumes, which reduces the reliability of the suggested allotment of 1,955 tonnes. Changes in market trends reflect production volumes, either triggering an increase or decrease in demand for shipping capacity. Calculation for material handling costs (Appendix 2.) is based on selected cost examples in BonD. Additional warehousing costs will be added when ports are used as transit warehouses. If the company decides to increase direct deliveries by road, it should send requests for quotation to different haulers in the first place. When the most suitable transportation provider is selected, the calculation should be performed again to estimate total savings over longer time frame.

## **8 SWOT Analysis**

### **8.1 Definition**

SWOT stands for strengths, weaknesses, opportunities and threats. It is an analysis performed to point out the mentioned features in the company's business. Strengths and weaknesses are based on internal factors, whereas opportunities and threats are more related to external factors. For internal factors, the analysis draws attention to the current state of the company as well as finding reasons to why certain changes have or have not happened in the past years. It also involves critical examination of the level of following company's strategies. Analyzing external factors involves benchmarking the company against similar organizations in statistical and functional terms. Economic, industrial, technological or market share changes could be external factors. (Charney, 2005, 154-156.)

The current situation of the Finnish organization of BillerudKorsnäs is described in the following sub-chapters.

### **8.2 Strengths**

The company has obtained a strong position in the European packaging paper markets after the merger. Its high quality paper is known among the customers. Having several paper machines able to produce same paper qualities makes it easier to balance the demand between different mills. For instance, in case Karlsborg machine is overbooked with orders, some orders can be moved to Pietarsaari and vice versa. Balanced production scheduling also reflects to smooth logistics supply in

a way that planned allotments and cost-effective target capacities can be achieved. Multiple machines able to produce similar qualities also enable better planning of the material flow into certain countries. Finland is a better option for producing paper to the Russian markets because of direct rail connection, whereas Sweden has the same advantage to Central European markets.

Personnel in both warehouses are well-experienced individuals cooperating with delivery planners in order to enable continuous material flow onwards from the mill.

### **8.3 Weaknesses**

The delivery planning team consists of mostly inexperienced employees. There is still a risk that errors in everyday working tasks occur, resulting in delayed orders or sloppy follow-up of goods to their destination.

Reels arriving in Tervasaari warehouse in random order make it difficult for forklift drivers to load wagons, since often there might be need for wagons to different destinations for both UPM and BillerudKorsnäs. Implementing loading schedule list does not solve the reel supply problem from the mutual wrapping line.

Interviews conducted with the warehouse managers and forklift drivers show that the personnel are not satisfied with the current situation. Forklift drivers in Pietarsaari need more training with TIPS in order to understand its functionalities better. Currently the manager in Pietarsaari has no backup to take care of his tasks during sick leave or holidays. In such occasions, the responsibility and workload is transferred to the delivery planners in Tampere.

## 8.4 Opportunities

In cost-efficient limitation, possible agreements with trucking companies enable more efficient use of alternative transportation channels to Eastern Europe, since shipping capacity to Lübeck will increase inside the limits of current allotment.

In case the system is implemented to the former Korsnäs mills, implementation of BonD can be performed more carefully in terms of mill warehouse operations. Experiences from the Finnish production units raise the company's awareness about the functionality of different loading models.

## 8.5 Threats

In case the company is not able to solve the bottleneck problem for its Lübeck and Rostock traffic, more order delays will be seen in the future. Decreased customer satisfaction might be seen as reduced order volumes in the future, hence affecting the booking situation of the Finnish paper machines.

Shipping costs in the Baltic Sea are expected to increase paper and pulp product prices up to 10€/tonne by 2015 due to increase in BAF costs. Higher shipping costs from Finland are seen in poor competitiveness especially against competitors from China, Brazil and the US. Orders are also more likely to be transferred to the Swedish mills from where goods are transported by rail instead of vessels (CEPI, 2011).

## 9 CONCLUSION

The purpose of the study was to evaluate the consequences related to material flow caused by implementation of the new ERP system and operational model at the Finnish paper production units of BillerudKorsnäs. The study was performed to highlight the bottlenecks and operational issues in the company's supply chain. Solutions to overcome these difficulties from a functional aspect were suggested from the basis of personnel experiences, as well as production and transportation data analyzed from the ERP system. Two major problems were highlighted.

Loading model in the mill warehouse was changed after BillerudKorsnäs implemented its ERP to the mills acquired from UPM. Compared to previous way of loading, the new model lacks flexibility and is complex for the warehouse personnel and delivery planners to manage in an efficient way. Invoicing and system characteristics disable mixing of delivery plans into the same wagon, thus increasing handling of goods in the warehouse. Personnel interviews showed that a solution to the loading problem needs to be found. The solution was to apply the UPM model functionality to the implemented ERP by creating a loading schedule list that points out a specific delivery plan for different production phases. The list is regularly updated and distributed to each party involved in delivery planning and loading operations.

The second problem was the imbalanced relation between production and transportation capacities for goods shipped to the German ports of Rostock and Lübeck. Orders to Eastern Europe are shipped via Rostock, and orders to Germany and Italy via Lübeck. Production output was found out to be more than the pre-fixed allotment with the shipping line. Despite the shipping line's flexibility, goods were

still left at the port of loading due to capacity limitation of vessels. Production and transportation capacity data showed that the company should urgently increase its allotment with the shipping line. Direct truck delivery to certain customers in Eastern Europe was evaluated as an alternative to substantial increase in shipping allotment. Calculation based on the cost examples from randomly selected deliveries was performed to determine the maximum port handling costs that comprise shipping more cost-effective than direct truck delivery.

Production volumes presented in the analysis are only a sum of total tonnage manufactured to Lübeck and Rostock. The volumes were collected on a very short time frame decreasing the reliability of the outcome. Production output volumes should be compared with the capacities of material flow channels in order to obtain a more reliable result for total capacity requirements. The analysis does not take into account stock orders to be delivered only after several months. Also the prices available for the calculations were limited to data in transport cost module in the ERP system, hence further evaluation of expenses should be performed before the final decision of Rostock-Lübeck traffic is made.

In the future, BillerudKorsnäs should avoid the risk of facing similar difficulties when implementing its ERP to other mills. More careful observation of the mill warehouse operations is a key factor in preventing similar problems in loading model or inventory management. Agreements with the shipping line should include allotment that matches produced volumes from the beginning. Otherwise bottlenecks may occur resulting in delayed orders and increased inventory in both mill and external warehouses. Estimating the need for transportation capacity is difficult as the demand of packaging paper in the markets is currently fluctuating. Therefore production volumes from previous years compared with the estimated market trend should be taken into account when agreeing the final allotment.

Efficient delivery chain is crucial for paper companies, especially due to increasing transportation costs. The overall material flow of BillerudKorsnäs is working satisfactory. The transportation chain is manageable despite the operational issues highlighted in this thesis. However, the company has to improve and follow up the most critical parts of its supply chain in order to enhance its logistical effectiveness. More efficient loading model and increased shipping allotment will result in faster and simpler warehouse operations, as well as improved customer satisfaction.

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