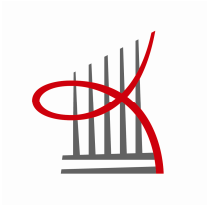

THE EFFECTS OF PACKAGING IN THE SUPPLY CHAIN

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ABSTRACT

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Metso Mining and Construction technology is a recognized distributor of spare and wear parts for the crushers. The products that Metso Mining and Construction Technology is supplying are occasionally transport sensitive and considering the volumes Metso Mining and Construction Technology is supplying sufficient packaging of the products is essential

The goal of the thesis is to demonstrate the total packaging costs in the supply chain and show what kind of effect damage during the transportation has in the total packaging cost.

The research method is the qualitative method of doing research and gathering information about the cost centers in the supply chain. Total quality cost calculator, provided by Metso Mining and Construction Technology, is used to analyze the total packaging costs. Two packaging solutions are compared.

The findings stated that investing to the packages, which are designed to the individual products have higher material costs, but transportations costs are lower. The total annual packaging costs are also higher with the packaging solution with higher material costs. A scenario was created where one product got damaged during the transportation and it had a tremendous impact to the total packaging cost.

When an investment and focus is drawn upon the packages, the final cost will be reduced since the possibility of damages during the transportation is reduced. This will increase the customer satisfaction and customer loyalty.

KEYWORDS: Packaging, Transportation, Supply Chain Management

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LIST OF ABBREVIATIONS

The following abbreviations are listed for the clarification of reading.

Metso Mining and Construction Technology: Metso MAC

Metso Service and Business Live: Metso SBL

Metso Distribution Center Europe: Metso DCE

Metso Sales and Service Organization: Metso SSO

1 INTRODUCTION

Metso Mining and Construction Technology is one of the largest segments in the Metso Corporation. The unit supplies globally spare and ware parts for crushers and many of the supplied products are globally sourced. One of the obvious reasons for this is the cost. Buying products from an external source that has lower raw-material costs, lower labor costs and lower transportation costs is more desirable than manufacturing the products in-house. Buying the products from a supplier that has years of experience is also more likely to make new innovations, which may enhance the processes of all who are part of the whole supply network.

This brings also complexity to the whole supply chain when the supplier is physically located in another country. Different culture, language and regulations come first in mind, but also one important factor has to be considered, the distance. The distance brings a lot of obstacles to the supply chain. For example longer delivery times because the products have to be transported first by road to the ports or airports from where they are then transported to our warehouses by air or by sea. Then we have to take to account that the products have to resist drastic sea conditions and of course air conditions can be rough sometimes. The importance of packaging steps in.

Packaging has become much more than it used to be. Today a package is not only designed to contain, preserve and transport the products; it also acts as an interface between the seller and the buyer. This means that the package requirements have escalated. The package should not only protect but also inform for example about the requirements that need to be clear when transporting the products. The package is the first thing that the customer sees when he or she receives the ordered product and therefore it should send a message about the qualities and values that the company represents and further more it should sell.

This thesis focuses to the importance of the packaging and like the name of the topic already indicates effects of the packaging in the supply chain. The reason for the survey is to demonstrate the impact that damage of a product creates during the transportation to the total packaging cost. More over the goal is to assure that investing to sufficient

packaging reduces the total annual packaging costs and overall delivery costs in the long term.

1.1 Metso

Metso is a global supplier of technology and services for it's three major segments that consist of mining, construction, power generation, oil and gas, recycling, and pulp and paper industries. (Metso. 2010. Updated May 03, 2010. www.metso.com)

Metso has engineering, production, procurement, services business, sales and other operations in over 300 units in more than 50 countries employing about 29,000 professionals serving customers in more than 100 countries. Today 45 percent of the net sales come from the services business. (Metso. 2010. Updated May 03, 2010. www.metso.com)

1.2 Mining and construction technology

Approximately 42% of Metsos net sales come from the mining and construction segment. It was reorganized in 2009 into two new business lines: services business line and equipment and systems business line. (Metso. 2010. Updated May 03, 2011. www.metso.com.)

Products and services offer a range of solutions form the mobile crushing and screening units to the expert and maintenance services. The business lines offer also a wide range of spare parts for crushers. Metso. 2011. Updated May 03, 2011. www.metso.com

The customers come from the mining and construction industry, which consists mainly from Quarries and contractors. Metso. 2010. Updated May 03, 2010. www.metso.com.

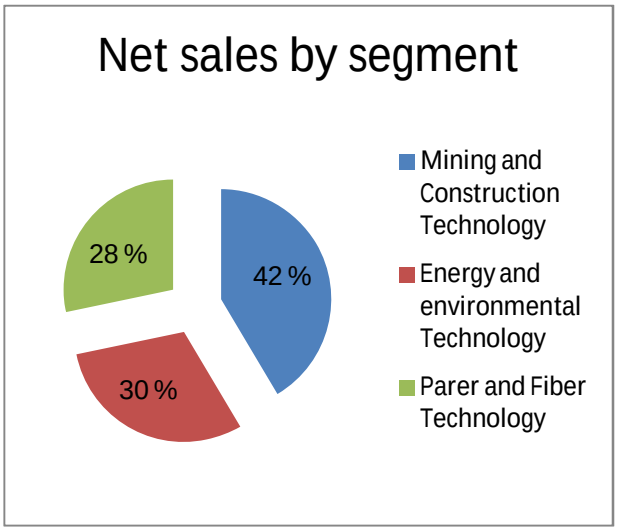


Figure 1 Net sales of Metso Corporation according to sectors 2011 (www.metso.com)

1.3 Service business line- DC

The main target set to the service business line is to enable customer's success. The strategy to accomplish the target can be divided to four linked factors, which are:

Customer service, which consists of internal and external customer service. Metso MAC has customers all around the world. The customers are consisting Metso own sales and service and organizations and of course private dealers and end customers. Cooperation in the supply chain and utilization of global and local organizations and systems. The supply chain of Metso MAC is consisting of third party logistical partners and global freight forwarders. Communication between these complex global functions is vital to keep the enterprise flexible to correspond to today's obstacles and market requirements.

Availability, which means ability to deliver in urgent customer cases. Usually when the customer needs spare parts, it means that their production suffers and in that case they tend to need the parts immediately, which requires flexible, fast and creative solutions to meet the customer requirements. Transportation plays an essential role in Metso MAC supply chain so the solutions and development of these services is really important. Since the transit times when the customer orders the product is occasionally really long and the distances can be very long the packaging solutions need to be planned carefully Report Metso MAC. Services Business Line DC Europe. 2011. Tampere..

Reliability, which means the ownership and reliability improvement in all areas and functions at the supply chain, which are consisting of suppliers, distribution center, transportation and warehousing partners. Since the supply chain is very long and complex it requires careful system and process improvements to satisfy today's market requirements.

Personnel care, which means the well being of Metsos Staff. Continuous competence improvements take place and the personnel is continuously trained and new projects are available for making the challenges interesting. Of course the overall well being of the employees is really seriously taken policy in Metso MAC. Report Metso MAC. Services Business Line DC Europe. 2011. Tampere.

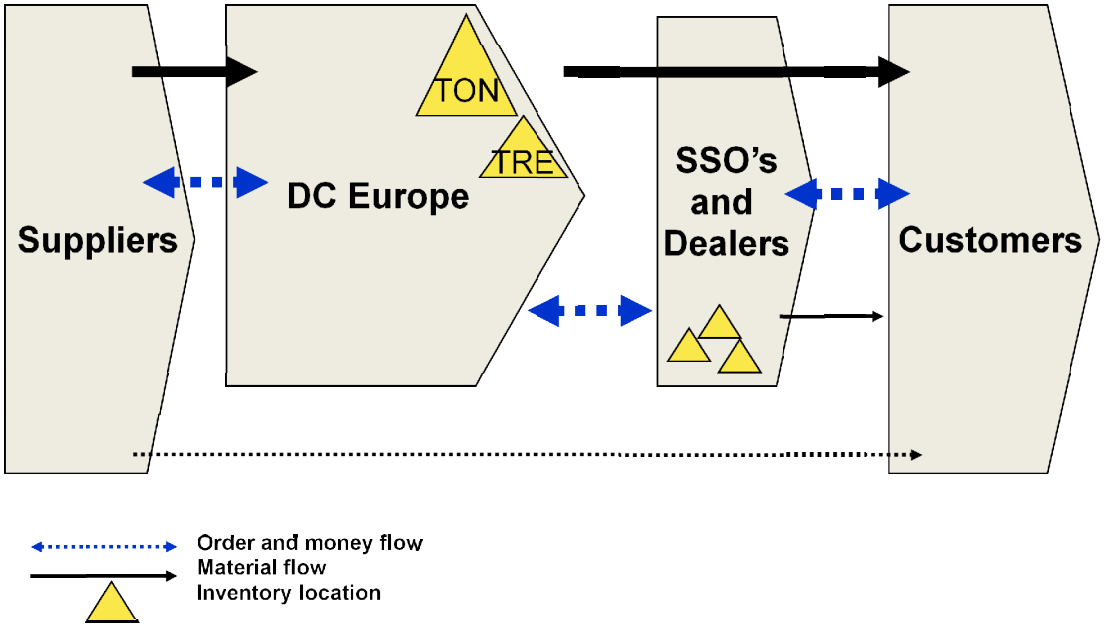


Figure 2 Business process DC Europe (2011)

1.4 DC Europe

The European distribution center consists of two warehouses, which are located in Tampere, Finland and Tongeren, Belgium. The main warehousing is focused in Tongeren, Belgium due to its outstanding directions to the Europe and really close harbors, which provide freight forwarding services.

Picture 2 Tampere warehouse

The warehousing function in Tongeren is completely outsourced, meaning that service is provided by third party logistical partner.

Picture 1 Tongeren warehouse

According to Susanne Herz and Monica Alfredsson (February 2003). Third party logistics providers usually specialize in integrated operations such as warehousing and transportation services that can be scaled and tailored to customers' needs based on market requirements and the demands and transportation service requirements for their products and materials. These services are not usually narrowed only to logistical services, but also include value- added services. Susanne Herz and Monica Alfredsson (February 2003).

The function in Tongeren provides warehousing services including value added services. The organization of Metso MAC is divided to supply, warehousing, logistics, product support and customer support. These operative functions are explained individually in the following chapters.

2 SUPPLY CHAIN MANAGEMENT

Logistics is defined in many terms and definitions throughout the time. Quite widely accepted view suggests that logistics is consisting of supply, materials management and distribution. This thesis gives emphasis to a modern definition that applies to most industries. Logistics is the efficient transfer of flows of goods, information and money from the source of supply to the place of manufacture to the point of consumption in most cost-efficient way and in the same time providing the best possible service to the customer. Alain Ruston, Phil Croucher & Peter Baker (2006, 4).

2.1 Network operations

According to the Nigel Slack, Stuart Chambers and Robert Johnson (2010) the basic supply network consists of two sides the supply side and demand side. The operation has its suppliers who are divided to first- tier suppliers who supply directly to the operation and then second tier-suppliers who in turn supply to the first-tier suppliers and so on.

In the demand side the operation has its customers who might have their own set of customers and again end-users. The first-tier customers are the main customer group in the demand side since they supply to the second-tier customers.

The immediate supply network consists of the suppliers and customers who have direct contact with an operation. Then again all the operations, which form network of suppliers and customers, are called a total supply network. Nigel Slack, Stuart Chambers and Robert Johnson (2010,140)

The supply side of Metso MAC consists of the manufacturers and suppliers, whereas in the demand side Metso MAC has its customers, dealers and end-users. In the immediate supply network Metso has also other MAC units in its supply side. The other MAC units then may have their second- tier suppliers. In the demand side the company has its first-tier customers, which consist of Metsos sales and service organizations, which

again supply to the second-tier customers and end-users. The supply side with all its suppliers and manufacturers and the demand side with its sales and service organizations and customers, forms the total supply network of Metso MAC DCE.

Metso MAC has distribution centers in Europe, Asia, South-America, United States, South- Africa and Australia. These distribution centers have also their own internal functions such as operative purchasing, warehouse support, logistics support and customer support.

Metso MAC has also sales and service organizations, customers and dealers who again supply to the end- customers in more than fifty countries. The network is highly global and this brings a lot of challenge to the operations.

2.1.1 Operative purchasing

Purchasing sometimes also called procurement is management of organizations external resources. Kari Iloranta & Hanna Pajunen-muhonen (2008, 60)

Purchasing is a strategic function. It supports an idea where the external resources enhance the internal processes. This means that the main function of purchasing is to ensure that a company has appropriate resources in every situation. Kari Iloranta & Hanna Pajunen-muhonen (2008, 65)

In the book of Hankintojen Johtaminen, Kari Iloranta and Hanna Pajunen- Muhonen (2008) state that the organizations operations, maintenance, management and development require various products and services and also different skills and knowledge from outside the organization. Purchasing attempts to benefit from the supplier market that the end- customer's needs are filled in a way that maximizes company's overall interest. Kari Iloranta and Hanna Pajunen- Muhonen (2008, 67).

The operative purchasing department of Metso MAC consists of the planner's team, which handle the purchase order executions and stock transfer order executions. Then there is the Supplier development team, which is in charge of strategic supplier control and operational procurement development. On top of these functions there is the man-

agement level, which is in charge of inventory planning, development and control and inventory management.

The need for such a hierarchical function is the volumes that are purchased and the amount of information that is handled in the process. The items that Metso MAC is purchasing are globally sourced which brings additional complexity to the purchasing process. The co-operation and common understanding of the agreed rules and processes between the supplier and buyer are vital, since the aim is to satisfy the end-customers' needs.

There are three types of orders; made to order items (MTO), which are ordered only in the occasions when they are needed from the customers. In other words these items are not meant for storage. Then there are the standard orders (PO), which are ordered to maintain the safety stock levels and guarantee steady flow of items. Finally there are stock transfer orders (STO), which are mainly used in situations when there is a shortage of items in one warehouse and another warehouse has available stock.

Metso MAC uses an inventory system where the materials resource plan (MRP) categorizes the products according how many times a particular product has been ordered. In other words, how many times the product has been picked from the warehouse. It is good to make a distinction between the picks and the volumes. Even though one order would consist of a hundred units of a product, it is still one pick.

The purchased items are also divided to categories, which are items that are meant for storage and items that are only purchased against a sales order. The products are also divided based on their turnover in the warehouse in the past year. Fast moving products are picked eight or more times, medium moving five to six times and slow moving just four times. Obsolete are not picked at all and create unnecessary inventory. The products are also classified based on their value, to the A- class, C- class and D- class. The value that is tied to the inventory in the warehouse and the term used to this is cost of goods sold (COGS).

The operative purchasing plays an essential role since it is the first linkage in the beginning of the supply chain. When an end- customer places an order it is immediate signal to the buyer to order more from the supplier and it triggers back a series of operations in

the supply chain. The procurement is carefully planned. Customer behavior is monitored and historical data of the demand is used to forecasting to avoid unnecessary inventories.

2.1.2 Warehousing

The prime objective of most warehouses is to facilitate the movement of goods through the supply chain to the end-customer. The improvements in technology and the increased competition have forced companies to evolve and create techniques to reduce inventories. Many of the techniques such as flexible manufacturing systems, supply chain visibility and express delivery and many others have involved a series of supply chain initiatives, in example Just-in-time (JIT), effective customer response (ECR) and collaborative planning, forecasting and replenishment (CPFR). Still, there are times that it is inevitable to hold inventories. Especially when the following conditions appear (Alain Ruston, Phil Croucher & Peter Baker 2006, 256):

Continual demand of the product. Most goods are offered for sale on a continual basis and therefore they are pulled through the supply chain based on customer demand. Alain Ruston, Phil Croucher & Peter Baker (2006, 256-257)

The supply demand is greater than the- lead time of the required product. There are occasions when the goods are offered to the customers on a next-day-delivery lead- time. In this case it is nearly impossible to source the materials, manufacture the goods and arrange the transport within this timescale. Hence the fact, that the goods must be supplied from inventory. Alain Ruston, Phil Croucher & Peter Baker (2006, 256-257)

Certain operations are similar for most of the warehouses even though the warehouse is manually operated with fairly basic equipment or highly automated with sophisticated storage and handling systems. Warehouses that hold inventory have typical functions and material flows such as (Alain Ruston, Phil Croucher & Peter Baker 2006, 256-257):

Receiving, this includes the physical unloading of incoming transportation, checking and recording of receipts. It could also include activities such as unpacking and repackaging which enhance the following warehouse operations. This activity may also in-

clude quality control checks. The goods are placed to the warehouse after these activities. Alain Ruston, Phil Croucher & Peter Baker (2006, 261-262)

Reserve storage, this means that the goods are normally taken to the reserve or back-up storage area, which is the largest space user in many warehouses. This area holds the bulk of warehouse inventory in identifiable locations. When required, the goods are taken from reserve storage either directly to arranging or to replenish a picking location. Alain Ruston, Phil Croucher & Peter Baker (2006, 261-262)

Order picking, means that the goods are selected from the stock in the required quantities and the required time to meet customer orders. Picking often involves break bulk operations, which means that when goods are received from suppliers in for example whole pallet quantities, but are ordered by customers in unit quantities or cases of items. Accurate order picking is important for achieving high levels of customer service. It also takes a high proportion of the total warehouse staff to complement this task and is therefore expensive. The good design and management of picking systems and operations are therefore vital to effective warehouse performance. Alain Ruston, Phil Croucher & Peter Baker (2006, 261-262)

Sorting, which means that for small sizes of order, it is sometimes appropriate to combine a number of orders together and treat them as one order for picking purposes. In this case, the picked batch will have to be sorted down to individual orders, for example secondary sorting, before dispatch. Alain Ruston, Phil Croucher & Peter Baker (2006, 261-262)

Value adding services which are processes that take place after picking, goods are brought together and consolidated as completed orders made ready for dispatch to customers. This can involve packing into dispatch outer cases and cartons, and stretch- and shrink- wrapping for load protection and stability. It may also involve final production postponement activities and value added services, such as kitting and labeling. Alain Ruston, Phil Croucher & Peter Baker (2006, 261-262)

Arranging and dispatch, which means that the goods are arranged together to form vehicle loads in the dispatch area and are then loaded on to on to outbound vehicles for further dispatch to the next phase in the supply chain or to a distribution centre, to port

or airport for the next freight forwarder, or directly to the final customer. Alain Ruston, Phil Croucher & Peter Baker (2006, 261-262)

Like mentioned before Metso MAC DC Europe has two warehouses. The main warehouse located in Tongeren, Belgium was established in 2008 a part of a project to support Metso MAC Service Business line (SBL) and a part of distribution and supply chain operations. Jussi-Pekka Nykänen, Warehouse Support Manager, Force Field Analysis (2011).

The warehouse operation in Tongeren is a 3PL partner (third party logistics partner), which means that it is a purchased logistical service, which was mentioned in the DC Europe section. The distribution operations put emphasis on storage and movement of products that require special facilities and services, and the distribution operation run by the third-party company is specialized to serve these requirements. Alain Ruston, Phil Croucher & Peter Baker (2006, 66). It also operates completely outsourced. The concept of outsourcing indicates that it allows a company to specialize in its own core business without spreading the resources to cover distribution as well. Alan Rushton, Phil Croucher & Peter Baker (2006, 92).

The unit Tongeren is a fully automated warehouse with some of the latest technology. The operations are coordinated with sophisticated warehouse management system. The main operational functions of the warehouse can be divided to four categories:

Inbound logistics. Include operations such as handling incoming goods, physical inspection and moving the goods to the actual storage area.

Warehousing. Covers the basic operations and functions such as receiving, sorting, stacking, picking and dispatching that are common to almost all warehouses.

Outbound logistics. This function handles the operations that are focused on handling the outgoing goods.

Customer service. It is set to dealing with daily errands, exchanges and complaints. Jussi-Pekka Nykänen, Warehouse Support Manager, Force Field Analysis (2011).

Because of today's enhanced quality control, basic warehouse functions are seen as a value added services. This concept was mentioned earlier in the text in the section ' value- added services' where these operations cover packing kitting and labeling. The warehouse function in Tongeren is providing services such as repacking the goods to Metso boxes, corrosion protection and advanced inspection on request.

2.1.3 Logistics support

According to Alain Ruston, Phil Corucher & Peter Baker (2006), the changing environment of logistics and the supply chain, particularly the movement by many companies towards global operations, has had on obvious impact on the relative importance of the different modes of transport. Products are transported far greater distances because companies have concentrated of producing in low-cost manufacturing locations. Long distance modes of transport have become much more important to the development of efficient logistics operations that have a global perspective. The importance to understand the difference when comparing sea freight against air freight, but for many localized final delivery operations, the road freight transport offers the only real option. There are several impacts that effect on the choice of transportation and many faces of transport modal choice have to be considered. Alain Ruston, Phil Corucher & Peter Baker (2006, 359)

Like already mentioned before Metso MAC DC Europe is globally operating enterprise with a regional focus. This sets a lot of pressure to the transportation, especially transit times. The choice of transportation is affected by two different order types, which include:

Standard order, which is a normal order placed by the customer and it is not placed in a hurry. The customer has a clear estimation, when the shipment is needed at the latest on site. This could mean that there is a lot of variety in the demand and certainty that the ordered product will be used at some point and more over when the product is needed there is absolutely no time to wait. This type of order is not focused in the transit time.

Express order, which is an emergency situation and the products are needed on site immediately. Obviously transit time is on the essence in this type of order and in majority of the cases the cost is a secondary factor.

There are also factors that are affecting to the modal choice of transportation. They are stated as external factors and factors that are affecting directly to the distribution by Alan Rushton, Phil Croucher & Peter Baker (2006, 363).

There might be factors such as basic infrastructure of a country, meaning for example that if there is a need to use the road transport the road network within a country has definitively an impact to the transportation process. There are customers with high importance for the company and the delivery must be handled at any cost. These are called the external factors. Alan Rushton, Phil Croucher & Peter Baker (2006, 363-364).

The factors that are directly related to the distribution might include the physical nature of the product, which refers how much cubic capacity the shipment requires and by a weight of the shipment. Also the value of the transported product has to be taken to account. The products might also consist hazardous materials, which requires special handling. There are also other logistics components that must be considered. These include for example supply points. The location of the supplier, which provides raw materials, will obviously effect on route and modal choice. Also majority of the products are globally sourced and this involve regular movement of finished product from supplier to warehouse and when there is an inventory and stock- holding policy involved it will surely have an impact on the modal choice of transportation. All of these external and direct distribution related factors are covering the operational factors that affects to the modal choice of transportation. Alan Rushton, Phil Croucher & Peter Baker (2006, 364-365).

The next emphasis is drawn upon the different transportation modes themselves. Metso MAC DSC Europe uses different alternatives such as sea freight, air freight and road freight transportation to fulfill the customer requirements.

Sea freight transportation is specialized on bulk goods for large package shipments that are going long distances, which makes it really cheap transportation mode. The speed of

service is not the essence, but has to be taken to account. It is good to make a distinction between the less than container load (LCL) and full container load (FCL).

Road freight transport, which is nationally the most important transportation mode in the European countries. This transportation mode can provide very fast delivery service and moreover its cargo space utilization is good form the origin to the destination point. Also the courier services provide faster deliveries if the situation requires urgent actions.

Air freight is very suitable comparing to other transport modes over longer international distances. The reason for this is the rapid airport-to-airport transit time over these long distances. The courier services guarantee really fast delivery time. This type of modal choice is usually used to transport individual items. Alan Rushton, Phil Croucher & Peter Baker (2006, 367-370).

Before the decision of the transportation mode choice is made there are main consignment or route factors to be taken to account. The responsible party of the cargo through the transit time has to be nominated before the consignment. Also the determination, who is paying the freight costs, has to be decided. If the direct route is stipulated by the customer a careful investigation has to be made if there are countries in the middle that does not allow trespassing. There are also other factors to be acknowledged such as distance, type of cargo, quantity, unit load, priority, and commodity value and how regular the shipment is. Alan Rushton, Phil Croucher & Peter Baker (2006, 372).

The final stage is the cost and service requirements. These two elements define the fundamental decision for modal choice, the logistics trade-off between the cost and the service. These have to be considered together with the operational factors, transport mode factors and consignment factors that were outlined before. Alan Rushton, Phil Croucher & Peter Baker (2006, 374).

It is important to be aware of the basic methods of conducting business internationally. There are a number of different ways in which products can be purchased and it is essential that both the buyer and the seller are aware of which terms have been agreed. Different terms mean very different responsibilities for both the company and the pay-

ment of the transportation of the supplied order. Most commonly used to define terms of transportation are Incoterms. Alan Rushton, Phil Croucher & Peter Baker (2006, 376).

The preferred incoterms used by Metso MCT outlined:

EXW- The seller must place the goods at the disposal of the buyer at the seller's premises or another named place. This term is not preferred in Metso MAC DSC Europe since it does not bind the consignor to prepare the shipment in any way. There would be no obligation to package the items or even prepare any kind of paperwork. Since the products Metso MAC require careful packaging and in the immediate dispatch they require lifters, trucks and even heavy cranes the more preferable term would be the following one.

FCA- The seller must deliver the goods, cleared for export, to the carrier nominated by the buyer at the named place.

CFR- The seller must pay the costs and freight necessary to bring the goods to the named port of destination.

CPT- The seller delivers the goods to the nominated carrier and must pay also the cost of carriage necessary to bring the goods to the named destination.

DDU- The seller must deliver the goods to the buyer, cleared for import, and not unloaded at the named place of destination. Alan Rushton, Phil Croucher & Peter Baker (2006, 377).

Metso MAC DC Europe logistics support is handling all the documentation needed in case of exporting the goods outside European Union. The common documents are export declaration, bill of lading, certificate of origin and packing list. Documentation types are very important when transporting globally. Requirements may vary from the origin and destination of the shipment and of course mode of transport used. It is crucial that all the documentation is done accurately and in time. Neglecting the documentation can lead delays and moreover significant additional costs and loss of business. Alan Rushton, Phil Croucher & Peter Baker (2006, 378-379).

Like many other large corporations Metso MAC DC Europe is using nominated freight forwarders. A freight forwarder is a person or company that organizes shipments for individuals or other companies and may also act as a carrier. In other words a third party logistics provider.

Metso MCT DCE logistics support co-operates daily with several freight forwarders. Typical daily basis operations include:

Preparation and checking shipping documents. The most common transportation documents were mentioned earlier.

Booking space with carriers. This includes a lot of co-operation with the dispatch office, since volumes and weights of the shipments are crucial when booking space from the carrier.

Arranging the order collection from the point of origin to the shipping port. Logistics support has completed the final booking at this stage and freight costs are requested at this point.

Arranging the customs clearance and final delivery at the destination country. Logistics support issues the invoice for export declaration and provides them along with the packing list to the freight forwarder. The freight forwarder sends the bill of lading to the logistics support, which is then forwarded to the customer along with the invoices.

2.1.4 Customer support of DC Europe

According to John L. Gattorna (1998) Customer support can be described primarily as an arrangement of after- sales activities that are aimed to enhance the total customer satisfaction and building enduring customer loyalty. Its main task is to provide value to the customer by delivering time-sensitive, user friendly and value- adding information and services that maximize product availability and productivity, as well as minimize customer expenditures of energy, time and cost. Customer service consists of three primary components that are (John L. Gattorna 1998, 60):

Service parts management, including managing the inventory, sourcing, transportation and distribution centre design required to provide services parts;

Service management, involving the technology, equipment, scheduling, information and design involved in servicing and repairs; and

Customer contact management: encompassing parts and service marketing, problem resolution, service staff recruitment and training and customer research. John L. Gattorna (1998, 60)

Importance of customer support can be determined with satisfied customers that behave in a way that benefits the company in the longer run. These customers can increase the company's product, service parts and service market share and help the company achieve a price premium over competitors. Purchasing loyalty showed by pleased buyers will reduce the sales and marketing costs associated with creating new customers. Large profits can be generated with a proper customer support. Finally, customer support activities used to support the assets used in their businesses can substantially improve both operational effectiveness and efficiency and financial performance. John L. Gattorna (1998, 61)

Metso MAC DC Europe customer support team is the main customer contact. Responsibilities include order handling and other order related issues that the customer might have. The clients consists mainly from other Metso MAC DC Europe Sales and Service Organizations that have already a clear understanding of the clients needs before they contact DC Europe customer support. There are although smaller dealers and en-

customers that need acknowledged even though the volumes are lot smaller than Sales and Service Organizations.

Customer Support is operating between all the other supply network functions in Metso MAC DC Europe. In other words it is co- operating with other interest groups such as logistics, purchasing and warehousing.

Other important duties in addition to order acknowledgement includes finding the right solutions in order to meet customers' needs. For example sourcing items from different Metso MAC locations together with the supply team or a situation might occur, where the supplied item becomes a critical to the customer due to break down in the site. This means that the most suitable transportation method needs to be found and very close co-operation with the logistics support team is required.

Customer support performs also activities such as order change requests, which means that the customer wants to make changes for example to the delivery date, quantity or transportation method etc. Like already mentioned in several times, Metso MAC DC Europe is supplying globally, which means that the customer requires a lot of information about the order status. Several obstacles might occur during the transportation and the customer support needs to inform the customer early enough about the possible order delays.

Metso MAC DC Europe customer support has one of the most important tasks in the supply network since it is acting as an interface between the customers and DCE. This means that they are the first linkage in the downstream network. The customer support needs to co-ordinate all the requests and needs that are 'swimming' upstream through the supply network.

2.2 Supply chain objective

After analyzing all parts included in the network operations, a supply chain can be defined as a strand of linked operations. Supply chain management is the management of the interconnection of organization that relate to each other through upstream and downstream linkages between the processes that produce value to the ultimate consumer in the form of products and services. Nigel Slack, Stuart Chambers and Robert Johnson (2010, 78)

All supply chain management shares one common, and central, objective- to satisfy the end-customer. All stages in a chain must eventually include consideration of the final customer, no matter how far an individual operation is from the end-customer. When a customer decides to make a purchase, he or she triggers action back along the whole chain. All the businesses in the supply chain pass on portions of that end-customer's money to each other, each retaining a margin that it has added. Each operation in the chain should be satisfying its own customer, but also making sure that eventually the end-customer is also satisfied. Nigel Slack, Stuart Chambers and Robert Johnson (2010, 90).

To meet the present requirements of the customers, the supply chain has to achieve optimum levels of the five operations performance objectives: quality, speed, dependability, flexibility and cost.

Quality- the quality determines the customer satisfaction. An error in a one stage of a process that contributes to the supply chain can multiply the effects in the end- customer service.

Speed- has two meanings in a supply chain context. The first is how fast customers can be served, an important element in any business's ability to compete.

Dependability- like speed, one can guarantee on-time delivery keeping excessive resources, such as inventory, within the chain. However, dependability of throughput time is much more desirable aim because it reduces uncertainty within the chain.

Flexibility- in a supply chain context is usually taken to mean the chain's ability to cope with changes and disturbances.

Cost- in addition to the costs that occur within each operation, the supply chain as a whole has additional costs that are caused by each operation in a chain doing business with each other. Nigel Slack, Stuart Chambers and Robert Johnson (2010, 120)

Metso MAC DC Europe replies to the challenge of meeting these requirements by choosing the best suppliers on the market after a thorough supplier analysis. The chosen suppliers supply tailor-made products, which are exclusively designed for the use of the crushers that Metso Minerals is manufacturing. By using freight forwarding companies' own transportation services, and by picking the most convenient one individually for each case from their large scale of services, the client can be sure the goods are delivered with expertise and speed. Metso MAC DSC Europe MRP system is designed to keep inventory levels for some products with an extremely high tendency of fluctuating demand, which guarantees constant availability of the parts for the customer. As known, emergency situations are rather common and Metso MAC DSCE has a clear protocol on how to act in these situations in order to correct the fault and meet the customers' needs as quickly as possible. One solution is to use express shipments, which guarantees the product to be delivered in a specific amount of time. Metso MAC DSC Europe increases its competitiveness by sourcing globally the items so that they are produced in the most beneficial place, meaning in a location which posses an excessive amount of resources and raw materials and lowest production costs.

3 PACKAGING

Alan Rushton, Phil Croucher & Peter Baker (2006) states that when talking about the physical nature of a product it is rarely seen in a logistics function in its primary form. The typical forms, which the final products are consisting in a logistics chain, are packages and unit loads. Hence, these two elements are bound to any relationship of the product and logistics. Alan Rushton, Phil Croucher & Peter Baker (2006, 116)

Broadly the packaging is defined as a product promotion or product protection. The latter function is particularly relevant to logistics. There are also other important factors that need to take under consideration when making the decision of the design of the packages for logistics purposes. In addition to product protection, packages should be simple to handle, convenient to store, promptly identifiable, secure and the shape should enhance the best use of space. Usually the cubical design is the most preferred form. Alan Rushton, Phil Croucher & Peter Baker (2006, 116)

It is important to understand that in logistical operation the package is the product that is stored and transported which means that in every possible occasion it should rather help than to be an obstacle to the logistical operation. Alan Rushton, Phil Croucher & Peter Baker (2006, 116)

Packaging is very much a part of the total logistics function, and the design and use of packaging has an impact to other functions such as production, marketing and quality control, as well as for the total logistics cost and performance. Alan Rushton, Phil Croucher & Peter Baker (2006, 117)

The other important form is the unit load, where use of a unit load enables goods and packages to be grouped together and then handled and transported more efficiently using mechanical equipment. Alan Rushton, Phil Croucher & Peter Baker (2006, 117)

Distribution and logistics is largely structured around the concept of a load unitization and the choice of a unit load, which are determined by the type and size. It is vital for the effectiveness and economics of a logistics operation, because choosing the most appropriate type and size of a unit load minimizes the rate of material movement.

Moreover the right unit load allows the standard storage and handling to be used with optimum equipment utilization. It also minimizes loading and unloading times and improves product protection, security and stockaging. Alan Rushton, Phil Croucher & Peter Baker (2006, 117)

Considering the packaging that should enhance the logistical operation in any occasion on the way in the supply chain and should not be in any circumstances an obstacle to the linked operations. Metso MAC DC Europe has set clear requirements for the packages that are been launched and introduced to the suppliers. The visual guidelines, which is a report designed to emphasize the new packaging requirements to Metso MAC items, introduce the new era of the packaging in the company's history, giving a clear message of the high quality and strong brand. The boxes, which are to be launched, are designed to be as clear, clean and consistent as possible. The only graphical elements on the packages in addition to the brand elements are the handling symbols and the packaging marks for SSCC lists. Toni Helsten. Visual Guide Lines (2011).

These symbols enhance the processes in the transportation phase since they indicate how the packages should be handled in the different circumstances. The symbols are vital when the transported products require double handling, since for example in the ports the transit times are kept minimal and this might have an impact in the way the packages are handled. This requires also that the packages are strong enough to handle the rough conditions in the warehousing and transportation.

Since the supply chains have developed tremendously in the past decade and considering the transportation journey they have become really long. Metso MAC DSC Europe will have the SSCC serial number in the packages for enhancing the whole supply chain. SSCC is a shortening of Serial Shipping Container Code and it is an 18-digit number used to identify logistics units. The whole supply chain benefits from SSCC since its basic operating principle is to communicate information about the transported package to the whole chain. The idea is that the consignor produces the SSCC, which is exploit throughout the whole supply chain and it will be encoded always when it is passing over the organizational borders. This will intensify the follow up and the tracking of the shipment. ISO web site. Updated, 28.11.2011, www.iso.org

With these new designed packages new possibilities are available. The follow up of the shipments might get easier and this could intensify the tracking. With strong packages, which have clear symbols how they should be handled, could decrease the amount of mistakes in the way. Using this type of packaging might also have an impact to the throughput times during pit stops in the supply chain, which would also decrease the overall lead time. Over all these would enable to allocate the scarce resources of the company and enhance the total service level.

3.1 Impact of packaging in the Metso MAC supply chain

One of the most important factors is not yet brought up, which is the cost. What kind of an impact this kind of a packaging would have in the final cost of the product? There are several hidden costs in the supply chain and every time the packages are received and again dispatched additional costs occur. These costs require managing and like mentioned in the logistics chapter, if one element of the supply network fails, the impact might be tremendous. Like mentioned in the operative purchasing chapter the items are procured with:

PO, which stands for purchase order and is made when purchasing items that are stocked to the warehouse and also to the parts that are only purchased against customer requirements.

MTO, which stands for made to order and is purchased from a supplier that will supply parts, which are custom, made for Metso MAC crushers. Made to order is more or less the same type as a normal purchase order. These parts are not usually stocked in the warehouse and are mainly purchased against customer requirements.

STO, which stands for stock transfer order and is made in occasions where the supplier cannot supply outside the Finnish borders and the part has to be dispatched from the warehouse in Belgium. There are also occasions where the part can be transported more quickly from the own warehouse to another than the supplier. Of course this requires that there is available stock in the other warehouse.

Considering all this inbound movement of the purchased items one can clearly see that the parts are transported and stocked at least one time before they will be dispatched to

the customer. In some scenarios the part might have several pit stops before it is dispatched and every time the shipment is received and again shipped several costs occur. This brings a lot of pressure to the supply chain, since the items should be transported to the customer to most cost efficient way.

The warehousing chapter gave a picture about the basic processes that are likely to take place in every warehouse. These included receiving, inspection, stocking, picking, packaging and dispatching the items. All of these executed operations include a cost.

The outbound processes when the packages are finally dispatched the transit phase might have several variables before the package reaches the customer. If the package is to be transported for example outside the European union there are several phases to be considered. The package is usually first loaded to the truck and the transported to another location for short preservation. Usually near to the harbor or airport. Then the packages are stacked to containers, in case of ocean freight shipment, or stacked to aircraft. When the shipment has arrived to the destination harbor or airport, the packages are unloaded and again loaded to the trucks for transportation to the destination determined by the customer. As mentioned before, when there are double handling included to the operation, it requires always an additional cost.

There are also human factors to be considered on top of all these other factors named before. If, for example, the package gets lost, time consumed finding it will have an impact to the customer’s point of view and sometimes when this happens the customer requires some kind of compensation. If the customer receives the item damaged, the item has to be recovered back to Metso MAC DC Europe warehouse and a new part needs to be sent to the customer. This might also include several obstacles such as the stock situation. If the item is not stocked in the warehouse and is only ordered against the sale the through put time when it is manufactured along with the lead-time when the product will be at Metso MAC DC Europe warehouse could take considerable amount of time, which will also have an impact to the final cost.

3.2 The cost centers in the supply chain

Supply chain has several cost centers. A cost center is part of an organization that does not produce direct profit and adds to the cost of running a company. (SearchCRM 2006. Updated august, 2006. www.searchcrm.techtarget.com.). Every time an item is double handled an additional cost occurs. When goods are dispatched, received, stored and again dispatched there is an additional cost. As a principle the later in the supply chain the packaging is made, more costs occur.

As previously stated in the supply chain of linked operations every operation that adds value to the chain wants its little margin from the customer's money it invested when ordered the product. The costs centers can be divided to the inbound costs and outbound costs. Inbound costs consists of:

Pick up of the purchased items from the suppliers premises, which can be handled in several ways depending from the mode conducting business. Metso MAC has a policy where the incoterm used in the inbound transportation is FCA. Using this mode means that the supplier packages the items and places the supplied items to the named dispatch area and helps in the loading process. Nominated Metso MAC freight forwarder picks the shipment and transports it to the harbor. After this typical harbor operations take place, which are unloading the shipment from the truck, consolidating the shipment to the container and loading the container to the ocean vessel. When the items reach the destination harbor named freight forwarder will unload the container and load the shipment to the truck where the shipment is again transported to the main distribution center. There the shipment is again unloaded and placed to the receiving area. After this the shipment will be visually inspected for clear damages and then placed to the shelves in the warehouse.

Outbound costs consists of:

The items are picked from the shelves and placed to the packaging area. The items are packaged and then placed to the dispatch area, where they are picked depending from the mode conducting business. Metso MAC prefers incoterm DDU used in the outbound transportation. This means that Metso MAC handles the transportation and is fully responsible from the shipment until the customer receives and signs the proof of delivery

form. The chain can be longer though. The items are also transported to another Metso MAC location where the typical warehousing functions take place. After this the items might travel through Metso MAC sales and service organization and after that to the customer, dealer or end-user.

It is obvious now how many cost centers there are in this type of supply chain. The products are double handled in some cases so many times that the packaging becomes one of the most important things. Even if the product would be ordered to some customer in Europe and the chain would consist of supplier, distribution center and the customer. Even in this chain the product is double handled at least two times.

The companies across the industry have become aware of these cost centers which many times are really hard to distinguish. When additional handling takes place it might not add value to the product in the end users point of view. The main question here is that at which point the final packaging should take place. If the items are packed by the supplier with materials they prefer the package has to be usually changed and labeled in some point of the chain. The final packaging executed in the supplier's premises might have significant impact to the final cost of the quality.

The following chapter will introduce the total costs of packaging. It will also demonstrate the effects what happens if a product gets damaged during the transportation. The following chapter is also trying to answer to the question, what is sufficient packaging and why it is important.

4 THE ANALYSIS

The supplied items are not packaged in a standardized way in inbound shipments. The final packaging is provided in the warehouse function in Tongeren, which was mentioned in the network operations section warehouse support. This company is the third party logistical partner and provides warehousing services, which was also mentioned in the previous chapters. The warehouse uses the packaging materials proved by Metso MAC and the items travel in these packages until the end customer.

The following section represents some figures what happens when investment is added to the packaging. These packages are designed specially to the products they are preserving. This mode of packaging was mentioned in the latter chapter in the visual guidelines by Toni Hellsten.

4.1 Total quality cost calculator

The total quality cost calculator gives a comprehensive insight of the annual total material costs of packaging, annual total freight costs and finally the annual total packaging costs between the alternatives that are compared.

The demonstration focuses to the investment put to the packaging in the outbound logistics. It does not analyze the costs occurring in the inbound logistics phase. There are also costs such as research and development that were not included to the survey. The focus was drawn upon the materials used in the packages and handling costs. The main goal is to see the result if there are damages occurring during the transportation. The following section outlines the differences between the compared packaging methods.

4.2 The Old Design

The Old Deign consists from normal Plywood box, which dimensions are presented in the following figure (3). The transported item is protected with plastic and corrosion protection is also added before the item is placed to the box. The box is attached to a pallet, which facilitates the loading and unloading process.

The dimensions of the analyzed package are 385 x 385 x 388 mm and the weight of the package is 5 kg. The dimensions of the pallet are 800 x 600 x 141 mm and the weight of the pallet is 10 kg. Metso MAC. Tampere packaging material range (2011) (figure 3, 4)

ID	Type MTG	Type SAP	Discription	L	W	H	theo vol
X89	**4D28**	**Z4D028**	Plywood box ISPM-15	385	385	388	57,51
X90	**4D45**	**Z4D045**	Plywood box ISPM-15	485	485	488	114,79

Figure 3 Tampere packaging material range (2011)

ID	Type MTG	Type SAP	Discription	L	W	H	theo vol
60X	**PX1**	**ZPX001**	Pallet ISPM-15	800	600	141	67,68
61X	**PX3**	**ZPX003**	Pallet ISPM-15	1200	800	141	135,36

Figure 4 Tampere packaging material range (2011)

The solution presented in the following picture. Special handling is required to wrap the transported item to the plastic wrap (picture 3).

Picture 3 item packaged before placed to the plywood box

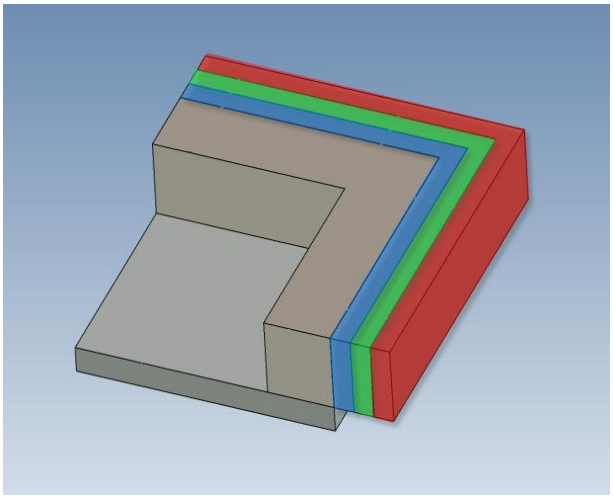
4.2 The New Design

The new design is carefully designed and developed to an individual item. There are six different boxes to choose from. The alternative that will be analyzed is the Box five. The dimensions of the package are 480 x 480 x 145 mm and the weight of the package is 6 kg. Metso MAC. Packaging instructions (2012). The following figure demonstrates the alternatives (figure3).

Box	**Int. dimensions**		**Drawing no.**	**Rev.**
Box 1	480x480x445		323042-000	C
Box 2	665x665x90		323043-000	C
Box 3	665x665x560		323044-000	C
Box 4	665x665x370		323045-000	C
Box 5	480x480x145		323046-000	C
Box 6	335x335x185	no runners	323047-000	C

Figure 5 Metso MAC. Packaging instructions (2012)

There are also three different alternatives of foams to choose from to support the preserved item. The foams are placed in the bottom of the box and on top of the box, four to each corner. Metso MAC. Packaging instructions (2012) (Picture 5).



Picture 4 Metso MAC. Packaging instructions (2012)

The next step is to choose the right box, corner fitment and fill foams. The following figure demonstrates the different boxes, which item is to be packed and matching foam

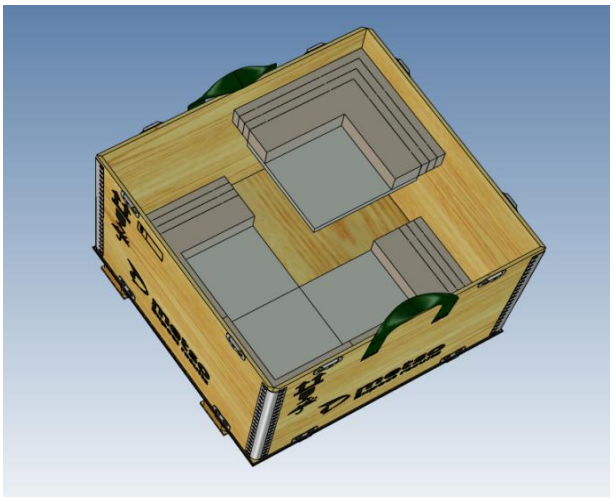
corners. The following figure demonstrates the packaging range that is designed to individual products. Metso MAC Packaging instructions (2012) (figure 6).

Part name	Drawing no.	Foam type	Tear off count	Box no	Box size length	Box size width	Box size height	Mill foam thickness
Bearing bushing E25	171455	Foam 1	1	Box 1	480	480	445	50
Bearing bushing E30	171456		1		480	480	445	50
Bearing bushing E16	171457		1		480	480	445	50
Bearing bushing E20	171551		1		480	480	445	50
Bearing bushing E16	171565		1		480	480	445	50
Eccentric bushing GP 300S	188325		2		480	480	445	0
Eccentric bushing	mm0266967		2		480	480	445	0
Ring	285063	Foam 2	2	Box 2	665	665	90	50
Support bushing	285064		1		665	665	90	50
Eccentric bushing E25	285344	Foam 1	2	Box 1	480	480	445	30
Eccentric bushing E20	285417		2		480	480	445	30
Eccentric bushing E30, G411	mm0273426		2		480	480	445	30
Eccentric bushing E25/32	582362	Foam 2	1	Box 3	665	665	560	0
Eccentric bushing GP 500S	189534		1		665	665	560	0
Eccentric bushing E32/40	582415		1		665	665	560	0
Eccentric bushing GP200S	908527	Foam 1	1	Box 1	480	480	445	10
Eccentric bushing GP200	938615		1		480	480	445	10
Eccentric bushing	938617		1		480	480	445	10
Frame bushing	942551	Foam 2	1	Box 4	665	665	370	35
Frame bearing bushing d11	mm0815148		2		665	665	370	0
Frame bushing	285063	Foam 1	3	Box 1	480	480	445	120
Frame bushing	931714	Foam 2	3	Box 4	665	665	370	20
Frame bearing bushing	582411		4	Box 3	665	665	560	135
Thrust bearing set	938375	Foam 1	2	Box 5	480	480	145	30
Thrust bearing set	941532	Foam 3	2	Box 6	335	335	185	70
Thrust bearing set	941534	Foam 1	1	Box 5	480	480	145	40
Thrust bearing set	941535		1		480	480	145	50
Thrust bearing set GP500 &GP500S	941536		3		480	480	145	25
	mail attach pic	Foam 3	0/1	Box 6	335	335	185	0

Figure 6 Metso MAC. Packaging instructions (2012)

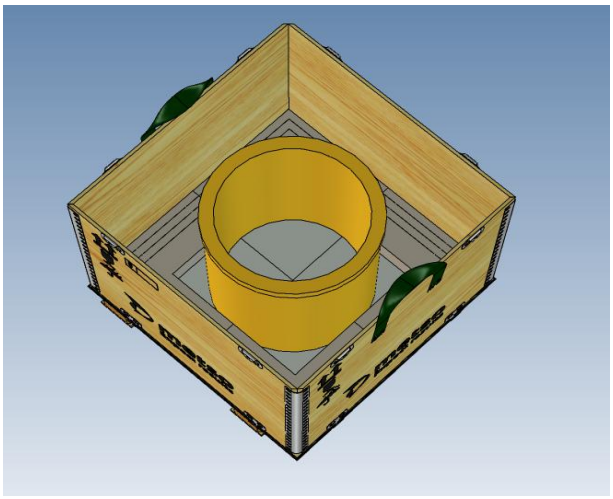
The right column indicates the material to be packed and drawing number is the item identification that Metso MAC uses to identify each product. Third column indicates the foam type to be used to support the item that is preserved in the box. The remaining data indicates the box to be used and the dimensions of the used box.

The next step is packing the product. When the right box is chosen the supportive material and foams should be mounted on bottom of the box. Corner fitments are placed on bottom, against box corners. Metso MAC. Packaging instructions (2012). The picture demonstrates the corner fitments (picture 5).



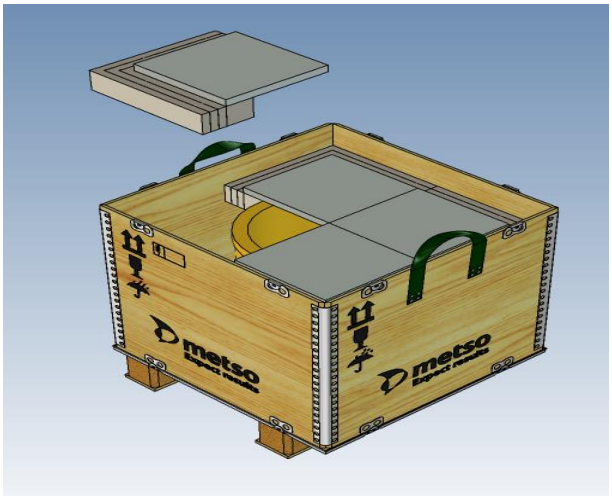
Picture 5 Metso MAC. Packaging instructions (2012)

The next step is to place the Bronze product inside so that the bottom edge lies on thin foam and foam sides are blocking product movement in sideways. Metso MAC. Packaging instructions (2012). The following picture demonstrates the product inside the alternative package (picture 6).



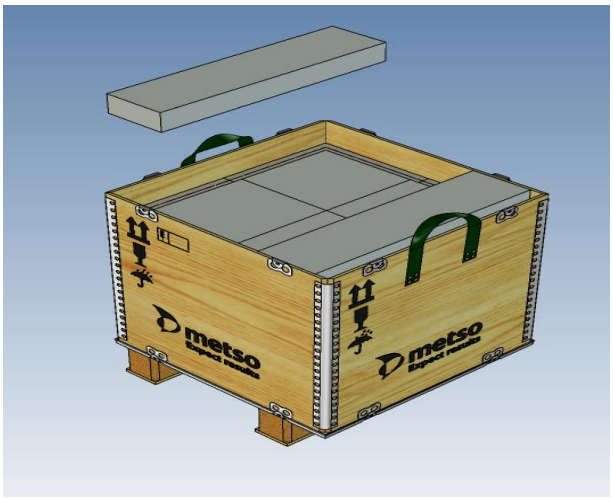
Picture 6 Metso MAC. Packaging instructions (2012)

When the item is placed to the box four fitments should be placed on top of the product. The following picture demonstrates the four corner fitments. Metso MAC. Packaging instructions (2012) (picture 7).



Picture 7 Metso MAC. Packaging instructions (2012)

In the final packaging stage fill foams are placed on top to fill empty space, which prevents the product moving during the transportation. Finally Lid is placed and the package is ready. Metso MAC. Packaging instructions (2012). The following picture demonstrates the final package, ready to be transported to the end user (picture 8).



Picture 8 Metso MAC. Packaging instructions (2012)

Using the total cost calculator first it needs information such as the basic data of the product, which consists of dimensions and weight of the analyzed product. Also annual delivery volume and the price of the product are essential information at this stage. Dimensions of the product are 360 x 360 x 100 mm and the weight of the product is 62 kg. The purchasing price of the product is 1979, 5 € (figure 7).

Basic Data of Product

Item

Item Number	1
Item Description	A
Weight [Kg]	62,00
Height [mm]	100,00
Width [mm]	360,00
Length [mm]	360,00
Volume [m3]	0,013
Annual delivery volume	25
Price per product	1 979,50 €
Cost of capital	8 %

Figure 7 Total quality cost model basic data of the product

After this the calculator requires information about the analyzed packages, which consists from dimensions, weight and units per package. The dimensions of the Old Design are 385 x 385 x 388 mm and the weight of the box is 5 kg. Compared solutions presented below (figure 8, 9).

Transport Packaging Unit Data

Unit Description	Old Design
Stackable [yes/no]	YES
Unit Height [mm]	388
Unit Width [mm]	385
Unit Length [mm]	385
Number of products per Unit	1
Weight [Kg]	5
Number of Units per year	25

Figure 8 Total quality cost model transport packaging unit data Original plywood box

Transport Packaging Unit Data	
Unit Description	New Design
Stackable [yes/no]	YES
Unit Height [mm]	145
Unit Width [mm]	480
Unit Length [mm]	480
Number of products per Unit	1
Weight [Kg]	6
Number of Units per year	25

Figure 9 Total quality cost model transport packaging unit data New Design

The packaging system itself is divided to three different categories, which are primary packaging, secondary packaging and tertiary packaging. The essentials here are the price, volume and weight of the material.

The primary packaging indicates to the materials used before the item is placed to the box. The item, which is packed to the Old Design, is protected with cardboard before placed to the plywood box (figure 10).

Packaging Material € / pcs / Kg	Price [€]	Pcs	Weight
Primary packaging			
Corrugated box			
Other	1,00 €	1	1,00
Total:	**1,00 €**		**1,00**

Figure 10 Total quality cost model primary packaging Old Design

The secondary packaging is the actual box and tertiary packaging is used if the box needs to be placed on top of a pallet. In this case the Old Design needs to be transported on top a pallet but the New Design solution can travel with out it.

Tertiary Packaging

Box / Crate / Rack			
Metal rack			
Plywood box/crate	10,00 €	1	5,00
Corrugated box/crate			
Wooden box/crate			
Total:	**10,00 €**		**5,00**
Pallet			
Wooden pallet	19,00 €	1	10,00
Wooden Pallet			
Plastic pallet			
Plywood pallet			
Corrugated pallet			
Metal pallet			
Total:	**19,00 €**		**10,00**

Figure 11 Quality cost model tertiary packaging Old Design

Secondary packaging

Corrugated box			
Plywood box	16,02 €	1	1,00
Other			
Total:	**16,02 €**		**1,00**

Figure 12 Total quality cots model secondary packaging New Design

When the packaging data is filled the next step is to fill all the require information about the accessories used in the analyzed packages to protect the items. The item, which is travelling inside the Old Design, is wrapped to a plastic cover and it is also protected with corrosion protection. Boards are needed to adjust the plywood box to the pallet (figure, 13).

Accessories

Fitments / inserts / dunnage			
corrugated board [pcs]			
layer divider [pcs]			
plastic [m^2]			
boards [pcs]	1,00 €	1	1,00
plastic pack band [m]	1,00 €	1	1,00
metal pack band [m]			
plastic stretch film [m^2]			
edge protection [pcs]			
rust protection [VCI]	2,00 €	1	1,00
Total:	**4,00 €**		**3,00**

Figure 13 Total quality cost model accessories Old Design

The item, which is travelling inside the New Design, is supported with the corner fitments and the leftover of the foam is used to fill the empty space in the box. Also this item is protected with the corrosion protection (figure, 14).

Accessories

Fitments / inserts / dunnage			
corrugated board [pcs]			
layer divider [pcs]			
plastic [m^2]			
boards [pcs]			
plastic pack band [m]			
metal pack band [m]			
plastic stretch film [m^2]			
edge protection [pcs]	5,50 €	8	1,00
rust protection [VCI]	2,00 €	1	1,00
Total:	**46,00 €**		**9,00**

Figure 14 Total quality cost model accessories New Design

All the required information about the packages is now filled. The next step is to fill all the information relating to the handling of the analyzed packages. This step analyzes how much are the total handling costs per minute. Since this survey is analyzing only the outbound costs we will leave the part unloading the shipment open (figure, 15).

Handling	Old Design
Time required for packing [min]	5,00
Other handling [min]	4,00
Unloading transport equipment [min]	
Checking condition of goods [min]	
Warehousing [min]	1,00
Internal transports [min]	2,00
Loading the transport equipment [min]	1,00
Labor cost per minute	0,67 €
Overhead cost	
Handling Cost	**6,03 €**
- per Item	**6,03 €**

Figure 15 Total quality cost model handling Old Design

Handling	New Design
Time required for packing [min]	2,00
Other handling [min]	4,00
Unloading transport equipment [min]	
Checking condition of goods [min]	
Warehousing [min]	1,00
Internal transports [min]	2,00
Loading the transport equipment [min]	1,00
Labor cost per minute	0,67 €
Overhead cost	
Handling Cost	**4,02 €**
- per Item	**4,02 €**

Figure 16 Total quality cost model handling New Design

After this section the transportation route and the transportation mode has to be chosen. There are several alternatives to analyze. We could choose the shipments, which are dispatched from Finland, or shipments that are dispatched to Finland. Also we could choose to analyze shipments that are moving in domestic routes. Since we want to know the total costs we will choose all routes. The transportation alternatives vary from freight forwarders special services such as courier air and courier road. Normal transportation alternatives consist of air, sea and road modes. As indicated before this survey analyzes the total costs, hence we will choose all transportation modes to have a comprehensive vision about the total costs.

As the figure (17) indicates the total freight costs are greater using the Old Design solution. The courier services are much more expensive than the normal transportation alternatives. The average freight cost per unit using the Old Design is 140, 9 € and using the New Design the same cost is 125,3 €. With the annual volume of 25 units the annual freight costs using the Old Design are 3 523,15 € and using the New Design the annual freight costs are 3 131,69 €.

Total Costs, Freight	Old Design	New Design
Courier Air	236,51 €	210,23 €
Courier Road	236,51 €	210,23 €
Air	204,79 €	182,03 €
Road	7,45 €	6,62 €
Ocean	19,37 €	17,22 €
Annual Delivery Volume Units	25	25
Average Freight Cost / Unit	140,93 €	125,27 €
Average Freight Cost / Item	140,93 €	125,27 €
Annual Freight Cost	3 523,15 €	3 131,69 €

Figure 17 Total quality cost model total freight costs

As we can see from the figure (18) the annual packaging material costs are higher using the New Design solution. Then again annual freight costs are less than using the Old Design. Annual total packaging costs are a bit higher using the New Design solution.

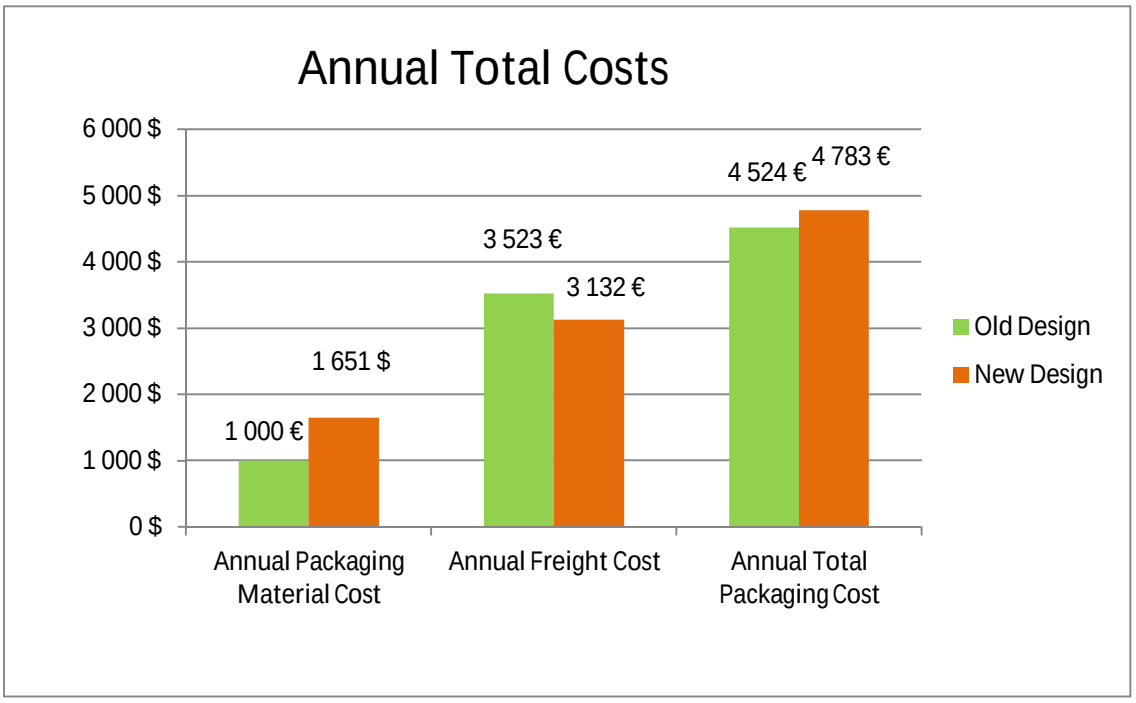


Figure 18 Annual total costs

If we look at the annual total savings, the figure (19), it clearly indicates that using the Old Design savings would be 650 €. Using the New Design solution, total annual freight costs savings are 391 €. Annual total cost savings are 259 € using the Old Design.

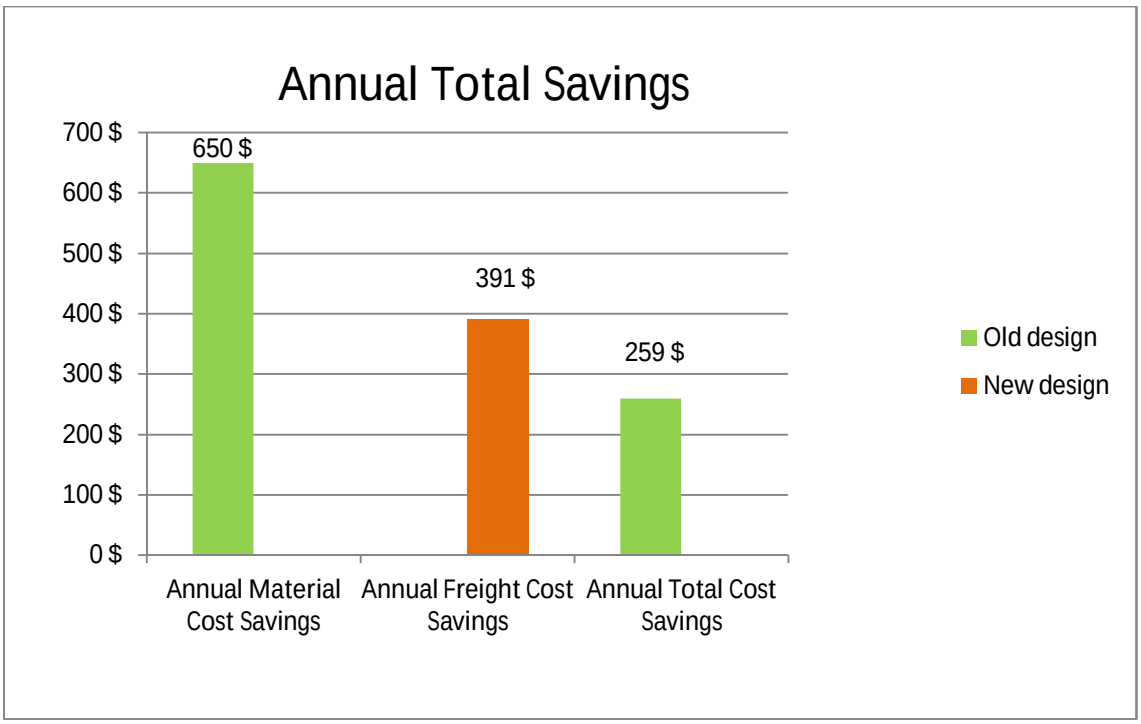


Figure 19 Annual total savings

If we take a look the total packaging costs using the Old Design in the figure (20), we can see that the total packaging costs are consisting mainly from the freight costs with 78%. After that come the material costs with 19% and last handling costs with 3%.

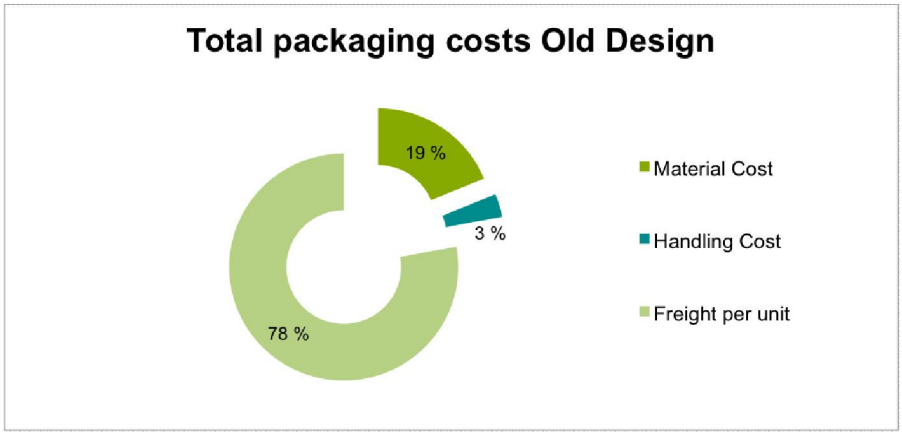


Figure 20 Total annual packaging costs Old Design

Analyzing the same costs with the New Design solution, we can see from the figure (21) that the total costs are consisting from freight costs with 66%. Material costs are higher than using the Old Design with 32%. The handling costs are 2% from the total packaging costs.

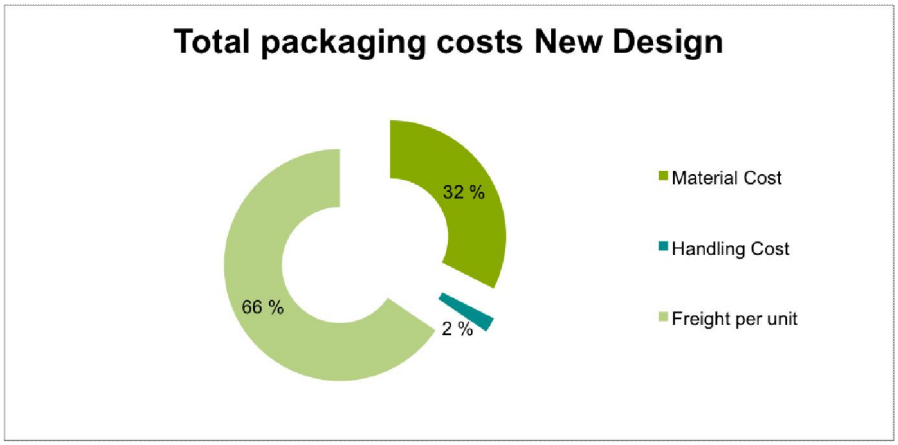


Figure 21 Total packaging costs New Design

6.1 Analyzing a scenario where a product gets damaged

Analyzing the scenario where one transported item breaks during the transportation using the Old Design. From the history we have learned that damages have occurred transporting these sensitive items with a packaging solution such as Old Design.

As the figure (22) indicates annual total packaging costs rise tremendously with Old Design. The total annual packaging costs rise up to 3 827 €. Annual freight costs stay the same, but the annual total packaging costs rise to 7 049 €.

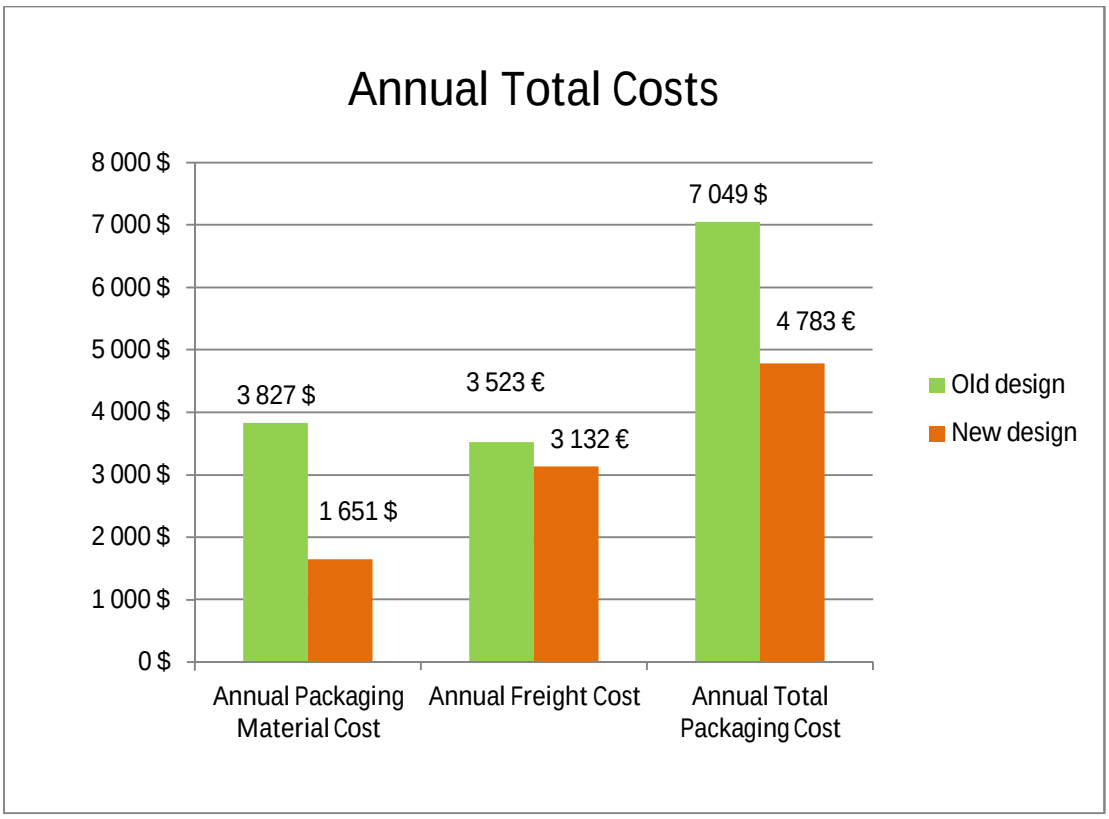


Figure 22 Annual total costs case damaged item

Annual total savings indicate that annual material cost savings would be 1 875 € using the New Design solution. Annual freight costs stay the same, but annual total cost savings rise to 2 266 € (figure, 23).

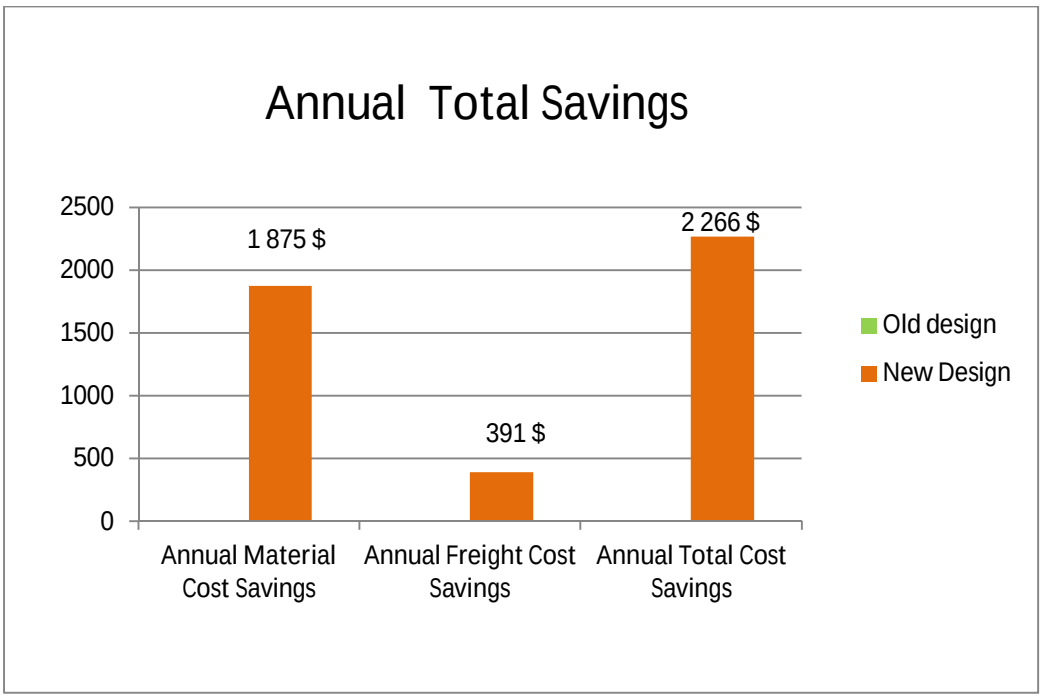


Figure 23 Annual total savings case damaged item

Analyzing the total packaging costs using the Old Design, we can conclude that the damage costs are 36% from the total packaging costs (figure, 24).

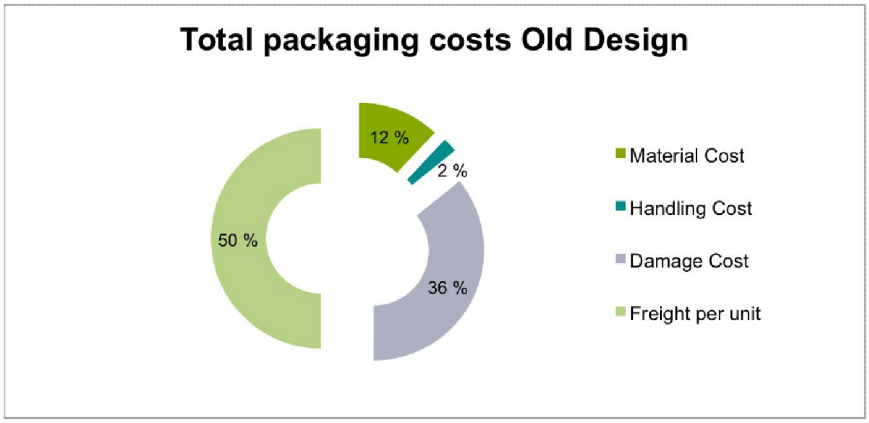


Figure 24 Total packaging costs case Old Design damaged item

7 CONCLUSIONS

Analyze consisted from two packaging modes. The preserved item was the same in both cases. Demonstrating the total packaging costs, a total cost calculator was used and the calculator was provided from Metso MAC. The data required for conducting a comprehensive calculation consisted from the packaging data that included the basic information of the item and information about materials used in the packaging solutions. The second section consisted from the handling costs that derive from the actual time required to package the items. This section considered also the time required labeling, weighting and internal transportation of the item. Finally the time required to load the package was added. The third section consisted from the freight costs. This section was divided to transportation routes and the actual transportation modes. The fourth section consisted from the total cost summary and the graphs.

In the beginning of the analyzing phase it was clear that the material costs and the total packaging costs are going to be higher using the New Design solution. Investing to the packages, which are designed to preserve a specific item, requires specific materials used in packaging. The transportation costs turned to be less using the New Design solution, but like mentioned before the total annual packaging costs were higher than with the Old Design. The reason that this comparison was conducted was because of the possible damages during the transportation. Since damages have occurred in the past using the Old Design solution a scenario where one item breaks during the transportation was created. This resulted to be a great favor to New Design packaging solution. The Annual savings were huge compared to the Old Design solution.

8 RECOMMENDATIONS

This analyze demonstrated the total packaging costs for just one item. Looking only the material costs and transportation costs the differences were significant. One can only imagine what kind of an impact this would have in the throughput times in the various transit operations, basically in any place where double handling of the package is required.

Moving to packages such as New Design in the survey would decrease the damages during the transportation and would surely facilitate all the logistics operations throughout the supply chain. Also investing to the packages with a larger scale would have a significant impact to the hidden costs in the supply chain. There are several hidden costs rising from the supply chain and investing in the very beginning of the whole chain will have a significant impact to the total quality costs.

The lead times are already kept to a minimum, since the items are usually needed urgently. The situation where the item breaks during the transportation is quite devastating from the customers' point of view. They have to wait a new item to arrive, which in some cases mean that the production has to be placed on hold. Then the item needs to be transported in a hurry with express order, which is a service provided by the freight forwarders for emergency situations and costs are higher. After this someone has to go to install the item and usually this means that a specialist is required. Using packages such as the New Design, which is designed to the particular item will definitively increase the customer satisfaction and moreover keep the customers coming back. This kind of an impact is expected, when the end customer gets the ordered items intact and in a package that reflects excellent quality and a carefully managed brand.

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APPENDIX 1

Packaging Cost Model: Summary			
Item Number:	1		
Item Description:	A		
Total costs, analysis	**Old Design**		**New design**
Material per unit			
Material Cost	34,00 €		62,02 €
Once-for-all Cost / Invest	- €		- €
- per Unit in 1st year	- €		- €
Handling Cost	6,03 €		4,02 €
Storage Cost	- €		- €
Damage Cost	- €		- €
Disposal Cost	- €		- €
Freight per unit			
Courier Air	236,51 €		210,23 €
Courier Road	236,51 €		210,23 €
Air	204,79 €		182,03 €
Road	7,45 €		6,62 €
Ocean	19,37 €		17,22 €
Average	140,93 €		125,27 €
% of Total cost per unit			
Material Cost	18,79 %		32,42 %
Once-for-all Cost	0,00 %		0,00 %
Handling Cost	3,33 %		2,10 %
Storage Cost	0,00 %		0,00 %
Damage Cost	0,00 %		0,00 %
Disposal Cost	0,00 %		0,00 %
Freight Cost	77,88 %		65,48 %
Material per item			
Material Cost	34,00 €		62,02 €
Once-for-all Cost / Invest in life cycle			
- Once-for-all Cost / Invest in 1st year			
Handling Cost	6,03 €		4,02 €
Storage Cost	- €		- €
Damage Cost			
Disposal Cost	- €		- €
Freight per item			
Courier Air	236,51 €		210,23 €
Courier Road	236,51 €		210,23 €
Air	204,79 €		182,03 €
Road	7,45 €		6,62 €
Ocean	19,37 €		17,22 €
Average	140,93 €		125,27 €

Figure 25 Total Cost Calculator Summaries

% of Total cost per item			
Material Cost	18,79 %		32,42 %
Once-for-all Cost	0,00 %		0,00 %
Handling Cost	3,33 %		2,10 %
Storage Cost	0,00 %		0,00 %
Damage Cost	0,00 %		0,00 %
Disposal Cost	0,00 %		0,00 %
Freight Cost	77,88 %		65,48 %

Figure 26 Total Cost Calculator Summaries

Total Cost, summary	Current solution	Alternative 1
Total Material Cost / Unit	40,03 €	66,04 €
Total Material Cost / Item	40,03 €	66,04 €
Total Material Cost / Unit in 1st year	40,03 €	66,04 €
Total Material Cost / Item in 1st year	40,03 €	66,04 €
Average Freight Cost / Unit	140,93 €	125,27 €
Average Freight Cost / Item	140,93 €	125,27 €
Total Packaging Cost / Unit	180,96 €	191,31 €
Total Packaging Cost / Item	180,96 €	191,31 €
Annual Packaging Material Cost	1 000,75 €	1 651,00 €
Annual Freight Cost	3 523,15 €	3 131,69 €
Annual Packaging Cost	**4 523,90 €**	**4 782,69 €**

Savings in Total Cost, summary	Current solution	Alternative 1
Total Material Cost / Unit	26,01 €	- €
Total Material Cost / Item	26,01 €	- €
Freight Cost / Unit	- €	15,66 €
Freight Cost / Item	- €	15,66 €
Annual Material Cost Savings	650 €	- €
Annual Freight Cost Savings	- €	391 €
Annual Total Cost Savings	**259 €**	**- €**

Total Summary	Current solution	Alternative 1
Basic Data		
Cost of capital [%]	8 %	8 %
Summary		
Once-for-all Cost		
Annual Packaging Material Cost	1 000,75 €	1 651,00 €
Annual Freight Cost	3 523,15 €	3 131,69 €
Annual Total Packaging Cost	**4 524 €**	**4 783 €**
Annual Total Cost Savings	**259 €**	**- €**

Figure 27 Total Cost Calculator Summaries

APPENDIX 2

Packaging Cost Model: Summary			
Item Number:	1		
Item Description:	A		
Total costs, analysis	**Old Design**		**New design**
Material per unit			
Material Cost	34,00 €		62,02 €
Once-for-all Cost / Invest	- €		- €
- per Unit in 1st year	- €		- €
Handling Cost	6,03 €		4,02 €
Storage Cost	- €		- €
Damage Cost	100,99 €		- €
Disposal Cost	- €		- €
Freight per unit			
Courier Air	236,51 €		210,23 €
Courier Road	236,51 €		210,23 €
Air	204,79 €		182,03 €
Road	7,45 €		6,62 €
Ocean	19,37 €		17,22 €
Average	140,93 €		125,27 €
% of Total cost per unit			
Material Cost	12,06 %		32,42 %
Once-for-all Cost	0,00 %		0,00 %
Handling Cost	2,14 %		2,10 %
Storage Cost	0,00 %		0,00 %
Damage Cost	35,82 %		0,00 %
Disposal Cost	0,00 %		0,00 %
Freight Cost	49,98 %		65,48 %
Material per item			
Material Cost	34,00 €		62,02 €
Once-for-all Cost / Invest in life cycle			
- Once-for-all Cost / Invest in 1st year			
Handling Cost	6,03 €		4,02 €
Storage Cost	- €		- €
Damage Cost	100,99 €		
Disposal Cost	- €		- €
Freight per item			
Courier Air	236,51 €		210,23 €
Courier Road	236,51 €		210,23 €
Air	204,79 €		182,03 €
Road	7,45 €		6,62 €
Ocean	19,37 €		17,22 €
Average	140,93 €		125,27 €

Figure 28 Total Cost Calculator Summaries

% of Total cost per item			
Material Cost	12,06 %		32,42 %
Once-for-all Cost	0,00 %		0,00 %
Handling Cost	2,14 %		2,10 %
Storage Cost	0,00 %		0,00 %
Damage Cost	35,82 %		0,00 %
Disposal Cost	0,00 %		0,00 %
Freight Cost	49,98 %		65,48 %

Figure 29 Total Cost Calculator Summaries

Total Cost, summary	Current solution	Alternative 1
Total Material Cost / Unit	141,02 €	66,04 €
Total Material Cost / Item	141,02 €	66,04 €
Total Material Cost / Unit in 1st year	141,02 €	66,04 €
Total Material Cost / Item in 1st year	141,02 €	66,04 €
Average Freight Cost / Unit	140,93 €	125,27 €
Average Freight Cost / Item	140,93 €	125,27 €
Total Packaging Cost / Unit	281,95 €	191,31 €
Total Packaging Cost / Item	281,95 €	191,31 €
Annual Packaging Material Cost	3 525,50 €	1 651,00 €
Annual Freight Cost	3 523,15 €	3 131,69 €
Annual Packaging Cost	**7 048,65 €**	**4 782,69 €**

Savings in Total Cost, summary	Current solution	Alternative 1
Total Material Cost / Unit	- €	74,98 €
Total Material Cost / Item	- €	74,98 €
Freight Cost / Unit	- €	15,66 €
Freight Cost / Item	- €	15,66 €
Annual Material Cost Savings	- €	1 875 €
Annual Freight Cost Savings	- €	391 €
Annual Total Cost Savings	**- €**	**2 266 €**

Total Summary	Current solution	Alternative 1
Basic Data		
Cost of capital [%]	8 %	8 %
Summary		
Once-for-all Cost		
Annual Packaging Material Cost	3 525,50 €	1 651,00 €
Annual Freight Cost	3 523,15 €	3 131,69 €
Annual Total Packaging Cost	**7 049 €**	**4 783 €**
Annual Total Cost Savings	**- €**	**2 266 €**

Figure 30 Total Cost Calculator Summaries