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PACKAGING SOLUTIONS AND THEIR SUITABILITY BY THE EXAMPLE OF COMPANY X

Bachelor Thesis

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AUTHOR'S DECLARATION

I have written the Bachelor's thesis independently.
All works and major viewpoints of the other authors, data from other sources of literature and elsewhere used for writing this paper have been referenced.

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ABSTRACT

The title of this Bachelor's thesis is „Packaging solutions and their suitability by the example of Company X".

The problem that lead to this thesis was a business problem from telecommunication devices producer Company X, which wished to reduce its packaging costs while making its packaging solutions more environmentally friendly. This thesis tackles this problem from the supply chain point of view and aims to give a feasible business solution to the Company X to follow.

Thesis is divided into three paragraphs. First one explains the theory of packaging by giving the basic information of the history of the packaging. Moreover, it also describes different types of packages as well as its functions. Author was using sources from a worldwide scientific literature written by American and British researchers as well as the international ISO standards from the official ISO regulations catalog.

In the second paragraph, the author focuses on a Company X which was having a problem of with their packaging solution. Therefore, author describes functions of the company and the industry it works at. Apart from that, there are information regarding the situation of packaging solutions before the improvement provided by an author of this thesis.

In the third paragraph author summarizes the expert interviews and analyses the results of those in order to come up with 3 courses of action available to Company X now and picks the course of action which at this stage is the best for the Company X.

In the end author concluded that the packaging solution used by the Company X is to effective and creates too much cost, while a less effective solution would be cheaper and more environmentally friendly as it uses less materials to produce. The author also suggests for the Company X to analyze the rest of their product portfolio and to determine if the company wide standard is too high or that it is just the case with the current products in scope.

Keywords: Packaging, packaging solutions, environmentally friendly packaging, cargo claims, company case study, Bachelor thesis.

INTRODUCTION

Author was motivated to write this thesis because package is a very important, but often overlooked part of a product. Package must ensure the safety of the product throughout the supply chain, while ensuring that the handling of the product in package is as simple and safe as possible, the package must also be informative for the handlers and in the end of the supply chain easily recyclable or reusable. Taking into account all that it is important to also note that the package itself is a cost item for the producer and therefore must be optimized to the maximum.

In this thesis the author focuses on different packaging solutions currently available and used in the supply chains, what are the advantages and disadvantages of these solutions and why they are being used in this manner. Also which different regulations shape these solutions and restrict the creation of packages. The work also includes the aspect of environmentally friendly packaging and how this is regulated within the European Union and worldwide.

The aim of this thesis is to analyze the current packaging solutions suitability in the Company X based on the data available to the author from the company as well as interviews with the key stakeholders within the Company X and its sub-contractors. Research questions based on the aim of the work are:

1. How good is the currently used packaging solution by Company X?
2. What are the main constraints related to packaging at the Company X?
3. What are the current problems related to packaging at the Company X?
4. How could Company X improve its packaging solutions?

The data and information handled in this thesis was gathered by the author during an interdisciplinary project carried out by a team from Tallinn University of Technology, comprised of professors and students from the fields of Physics, Chemistry, Mechanics and Logistics at the Company X with the aim to reduce the cost of packaging and increase the environmental sustainability of the packaging. The author was responsible for the logistical side of the project and this work consists of the information and conclusions gathered from the said project.

This thesis is 38 pages long, includes 9 Figures and 4 Tables. It consists of abstract, introduction, three chapters, summary in English and Estonian and references.

In the first chapter author describes what is packaging and why is it important within the supply chain, the important aspects of the package, the different materials used in the creation of packages, the regulations and constraints related to packaging, testing of the packaging solutions and what are cargo claims. Author used American and European literature explaining the history and basics about packaging. Moreover, for describing different ISO regulations author used an official ISO regulations catalog.

In the second chapter author describes the methods of research that were used in this thesis, the Company X and the manufacturing plant which products are in the scope of the thesis, the current situation regarding the packaging and the cargo claims the packaging is or isn't responsible of.

In the third chapter author summarizes and analyses the outcomes of the expert interviews conducted at the Company X and its sub-contractors with the aim of finding root-causes to the problem at hand, highlights 3 courses of action which the company has to move forward from this point and picks the best available course of action based on the theory and real-life situation.

The current thesis conclusion is a suggestion to the Company X on how to improve its packaging solutions in order to solve the business problem that they are currently facing.

1 THEORY

1.1 Definition of Packages

Package is a vital component for performing logistical processes. It ensures the safety and quality of the product within. Informing the user or handler about all the relevant features of the product can also be considered as one of the important parts of the package. Supply chains would not be able to function properly without the packaging of the goods.

The definition provided by European Commission Directive says that "*Packaging' shall mean all products made of any materials of any nature to be used for the containment, protection, handling, delivery and presentation of goods, from raw materials to processed goods, from the producer to the user or the consumer.*". [1]

The first use of packaging was in ancient ages, when people needed containers which would enable to carry meat, grasses or water. "Clay pots met this need and archaeological evidence dating to 8000 BC shows large wide-mouthed jars being used for grains, salt, olives, oils, etc." [2]. This proves that the first function of packaging was transportation of goods.

Packages became essential in XIX, when there was an industrial revolution in the world. There was a bigger production of goods which needed to be transported for longer distances. This being an important reason for producers to think of materials, which could enable the possibility of transportation of goods between countries and continents. [3]

In 1895, the producer of whiskey, Jack Daniels noticed that a bottle which is a package of his product can be used for receiving more benefits. The bottle was used to differentiate Jack Daniels whiskey from the other ones by making it look more attractive for the customers. This step was meaningful for the history of packages, because since then other producers started using packages also for a product differentiation. This happened during Industrial Revolution, it was a time when the massive production was very meaningful and goods started also to be transported to different parts of Europe or even other continents.

During XX century the meaning of the packages significantly increased. Producers started designing more and higher quality packages. Moreover, recycling became a very important trend in the world of logistics. Packages were designed in a way that it allowed the producers and customers to reuse the packages many times or recycle them for other purposes. [4].

1.2 Functions of packaging in logistics

There are five categories of functions of the packaging categories: Protection, Transportation, Marketing, Information and Recycling. Each of these categories represents a dilemma for the producer of the product the package is supposed to protect: How to ensure that these categories are sufficiently fulfilled while finding a good balanced in the cost of the package. [2]

1.2.1 Protection

Packaging protects a product from mechanical damage, climate, biotic damage (microorganisms, pests) and defects. Protection is a very important function which is crucial especially for a process of transportation of the goods. While transporting the goods many different damages can happen so a product might lose its quality. The packing should be made out of strong and high quality materials which can ensure the stability of a product put inside. [2]

1.2.2 Transportation

Transportation is a process which leads to a movement of a product or a person from point A to the point B. In case of packaging it always relates to goods. Goods can be loaded to different means of transportation including trucks, ships or planes where they are loaded also into containers or on pallets. Containers as well as pallets are the most popular form of transporting products in a safe and standardized way all over the word. Transportation in containers and on pallets is meant to be safe and comfortable not only during the journey but also for loading and unloading the goods. However, it has always risks of causing a damage. If the package is damaged during the transportation it has a chance to later increase the potential for the product being damaged. [2]

Figure 1. Cargo Container [5]

Container is a metallic box with special construction and specific dimensions which is designated for the carriage of goods. The products are still packed into another packaging including cardboard packaging, parcels and boxes or placed on EURO pallets. [6]

Table 1. Standard Cargo Container external and internal dimensions [6]

Standard External Container Dimensions					
	(8ft)	**(10ft)**	**(20ft)**	**(30ft)**	**(40ft)**
Container Length	2.42m	3.05m	6.06m	9.12m	12.19m
Container Width	2.17m	2.44m	2.44m	2.44m	2.44m
Container Height:	2.26m	2.59m	2.59m	2.59m	2.59m
Standard Internal Container Dimensions					
Internal Length	2.28m	2.80m	5.87m	8.93m	12.00m
Internal Width	2.10m	2.33m	2.33m	2.33m	2.33m
Internal Height:	2.04m	2.35m	2.35m	2.35m	2.35m
End Door Aperture Width:	1.94m	-	2.26m	2.26m	2.26m
Floor area	4.78 m2	6.69 m2	13.93 m2	21.09 m2	28.33 m2
Cubic capacity:	9.28 m3	15.89 m3	32.85 m3	49.84 m3	66.83 m3
Weight	1.02 tons	1.52 tons	2.44 tons	3.25 tons	4.06 tons

The unification of containers enables faster handling operations and specialized equipment. The container protects the goods within from outside conditions as well as physical damage. [6]

ISO 6346 is a regulation which helps to identify a container regarding to its country, origin, destination and a special coding. Thanks to this, any container will not be lost during the vogue. Moreover, it helps different stakeholders involved in a supply chain to handle the transportation of goods to the next company or an institution with no need to seeing an inside of a container. [6]

Figure 2. EURO pallet [7]

Pallet is a platform which is used for transporting goods in any means of transportation and also inside of building on forklifts. Because of the pallets standardized dimensions in accordance to ISO standard 6780 it is easier and more comfortable to load and unload the products on it as well as transport the pallet within the warehouse. [8]

Table 2. Standard EURO pallet dimensions [8]

Standard pallet dimensions				
Name	Length	Width	Height	Safe working load
EUR, EUR1 (ISO 1)	800 mm	1200 mm	144 mm	1500 kg
EUR 2 (ISO 2)	1200 mm	1000 mm	162 mm	1250 kg
EUR 3	1000 mm	1200 mm	144 mm	1500 kg
EUR 6 (ISO 0)	800 mm	600 mm	144 mm	1000 kg

The most common pallet used for handling the goods is the so-called EURO pallet (EUR, EUR1) with following dimensions: 800mm x 1200mm. [8]

1.2.3 Marketing

Marketing is a function which means that packaging has a role of facilitation of sales volume and it provides an explanation of how the products should be used properly. The manufacturer/seller must use the packaging, usually seen before the product, as the means of attracting the would-be purchaser. This is done by a combination of a color, graphics, shape and size of the pack, which must combine to provide novelty, or a familiar chord of recognition, usually backed up by advertising depicting the pack and portraying the desired product image. The attractiveness of packing might even lead to a bigger volume of sales since this is usually the first thing which a hypothetical purchaser sees. [9]

1.2.4 Information

Packaging provides the valuable information to anyone engaged in handling the product, including the final consumer. It can provide information how to use the product, if it is possible to be recycled or also about any dangerous features. Moreover, it possesses information about expiration dates if it belongs to FMCG category of goods. Without packaging information about the product it would be not accessible in that comfortable way for a manufacturer as well as for a consumer. [2]

1.2.5 Recycling

A very important trend in 21st century is a possibility to design a packaging which is possible to be recycled. The main goal of recycling is to avoid an overuse of materials, thus, it means optimization of consumption of an energy used for manufacturing. Recycling protects the environment from the negative effects caused by extensive manufacturing. Moreover, it ensures the sustainability on the Earth for future generations as well as more effective usage of recent materials. [2]

1.3 Types of packages used in logistics

There are different types of packaging in logistics made of materials which determine what kind of goods can be put inside.

Table 3. Different materials used for packaging [2]

Material	Description	Advantages	Disadvantages
Paper	Paper has many applications as it can be soft and rigid. Soft packaging's for: refined wrapped paper and plastics or metal coated. Rigid packaging: cardboard, cardboard, multilayer cardboard plywood.	Good mechanical properties Low weight Low odor Ease of processing Ease of printing on it Low production cost Eco-friendly	Weak towards any sort of damage
Glass	It is generally used for packaging food products. It can be shaped into: bottles, jars, balloons, ampoules. They can be produced by colorless or colored glass.	Smoothness, Non-absorbability Chemical resistance Transparency Hygienic Easy to reuse	Needs to be used together with other types of packaging in the supply chain
Plastic	Plastic packaging is available in various forms: foil sheets, bags, thick-walled containers (canisters). Plastic makes up for other traditional packaging, such as caps, stoppers. Plastic packages can be given different shapes and form.	High physical and chemical strength Resistance to wrinkling, Transparent, Cheap, Light, Resistant to gas and water	Non-organic Not eco-friendly
Aluminum	Aluminum is a silvery white metal belonging to the boron group of chemical elements and has an atomic number of 13. Aluminum is used widely in foil form for packaging at thicknesses of just over 6 to around 150 microns (a micron is one millionth of a meter). It can be made into cans or other smaller containers.	Easy to shape Easy to process Keeps the original shape	Weak in high temperatures
Steel	Steel often appears in the packaging market together with tin, in the form of tinplate, which is a low carbon steel sheet coated with a skin of tin. Other forms of steel include tin-free steel (ECCS) and black plates.	Strong Easy to recycle and reuse	Chemical goods might affect the packaging

The variety of materials which can be used for production of packaging is diverse. Every material has its advantages and disadvantages. The decision about which materials should be used for a product depends on the product type as well as the predicted transportation process.

The type of the goods determines which package will need basing on its sizes and shapes. Moreover, there are special ISO regulations which explain which materials should be designed for which products. [2]

Green packaging is a special form of packaging. The main goal of creation of a green package is to reduce the negative impact of the packaging on the environment as well as ensure its production from environmentally friendly materials. Therefore, it can allow for a longer lifetime of the package or enabling easy recycling of the package. [10]

Green packaging should be focused on a minimal use of materials by smaller package or fewer layers. What is more, the life cycle of the packaging should be prolonged so a green packaging can be used more times than one by a consumer. Another very important feature is production of such packaging which should be manufactured by using a renewable energy, which can be created from the sun, wind or geothermal heat. Apart from that, green packaging should be able to be recycled so after a consumption of a packaging, the materials can be used again for another purposes. [10]

1.4 ISO regulations relevant for packaging

1.4.1 General ISO regulations for green packaging

Green packaging has its legislation in order to understand the way how to use this packaging properly as well what improper using can cause to the user or the environment, which was created by ISO. Through years International Organisation for Standardisation has come out with important regulations so the manufacturers of packaging, companies, consumers and other stakeholders can use the packaging in an internationally acceptable manner. Therefore, for packaging matters, ISO has regulations which help to go through the steps how to use and utilize packaging in the supply chain.

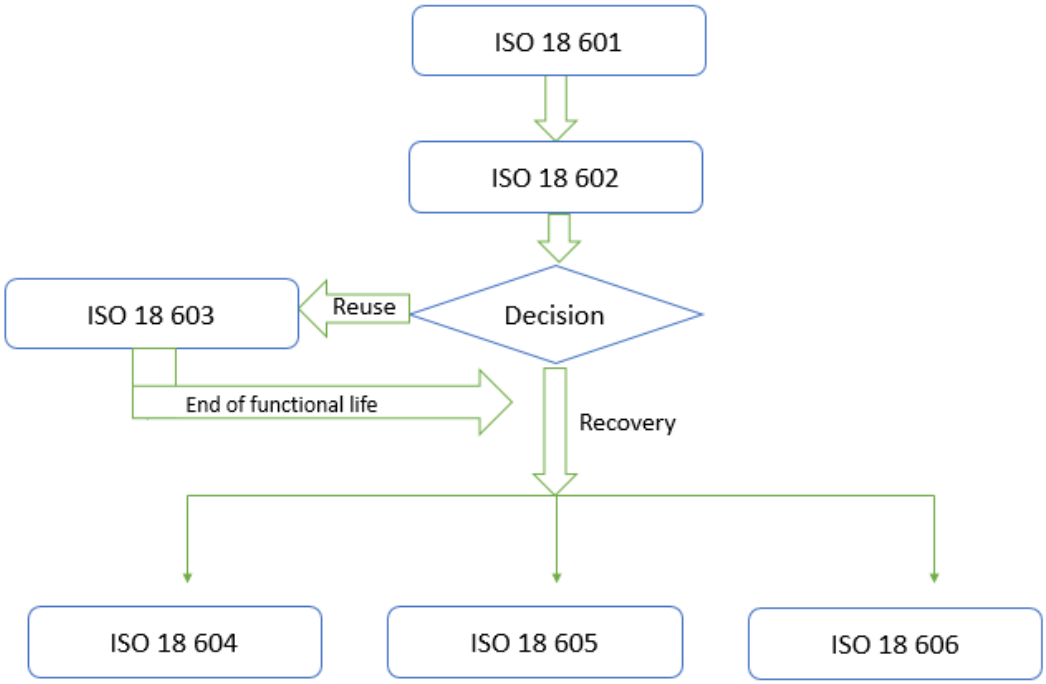

Figure 3. Relations between packaging related ISOs. [11]

ISO 18601 focuses on relations within the scope of ISO standards related to the environmental impact of packaging for the whole life cycle. Therefore, ISO standards can define whether the selected packaging is used efficiently and whether the packaging needs to be changed in order to be recycled. These requirements for ISO standards can be performed by manufacturer or supplier or a user. In fact anyone can announce claims about a certain packaging in terms of the occurrence which is not approvable by these regulations. [12]

ISO 18602 is responsible for definition of weight of particular ingredients which are allowed to be used for production of a packaging. It determines the minimum ingredients made of harmful materials in the packaging so it does not create negative impact on the environment. It also stresses on the usage of heavy metals including lead, cadmium or mercury. [13]

ISO 18603 defines different features which enable a packaging to be reused so a manufacturer can see this materials as a recognizable for repeated production and then for packing another goods. [14]

ISO 18604 is responsible for defining packages which can be reused and recycled. Therefore, such packaging can be classified to another usage and create new values for next purchasers in a supply chain. [15]

ISO 18605 says about classifying the packaging which can reuse energy and be recycled. This is a very important regulation because knowing that, the packaging do not go for waste but create a new value. [16]

ISO 18606 is a standard which enables to reuse a packaging in an organic recycling. It focuses on everything that was used for designing of a package. With this regulations, it is possible to say that the packaging can be separated and particular layers or materials can be reused in another packaging or purposes. [17].

1.4.2 Standards for the testing of packaging

International Organisation for Standardisation has established a set of standardized test to be carried out in order to determine the strength and potency of the packages in protecting the product inside.

ISO 2248:1985 regulates the testing of packaging through vertical drop tests, where a fully assembled package is dropped from a high of 100 cm to a flat surface in order to determine the damage caused by the drop to the package and the product within. To conduct a drop impact test, the package is allowed to free-fall onto corners, edges, and flat surfaces. In the case the packaging is damaged the damage will be evaluated with the aim to determine whether or not a consecutive fall to the damaged area could cause damage to the product inside. In the case that the product in the package is damaged during the test the packaging is classified as not adequate and fails the testing. [18]

Figure 4. AccuDrop™ 500 Drop Tester [19]

ISO 1856:2001 regulates the testing of packaging fitments, which are created from cellular plastics or rubbers, through compression test. The fitment is put under pressure by a standardized tool to determine the force that is necessary to damage the fitment irreversibly. The irreversible damage has been reached once the fitment doesn't regain at least 90% of the width. [20]

ISO 2247:2000 regulates the testing of filled transport packages through vibration. Product surrounded by the fully assembled package is placed on the testing tool in order to determine if the package is able to protect the product from sustaining permanent. [21]

Figure 5. VibraTest™ Series Mechanical Shaker [22]

1.5 Cargo Claims theory

Cargo Claims, also known as Freight Claims, are incidents, where the goods get irreversibly damaged during the transportation process and need to be sent back to the producer. [23]

There can be different problems with a product or with the packaging which might occur during its transportation. First of all, the packaging might be damaged due to bad quality of its manufacturing. Therefore, ISO regulations described above determine the ingredients and its amount in order to produce the quality packaging. Secondly, a very common issue is that during transportation different problems might happen, for example: road accidents, damages caused by loading and unloading the goods. Apart from that, the problem might occur also while storing the goods in a warehouse. They might be accidentally damaged there or lose their quality

with time. The worst case is that the transported goods are stolen and all costs involved in the manufacturing and delivering the products are lost. [24]

During transportation, a package is a subject to vibration and shock, which are generally generated from the acceleration and speed of the vehicle it is in. Shock is a sudden force applied to the package while vibration is mostly constant, both of which are in correlation with the speed the truck is moving and can create damage to the stacked packages if their properties are not proper. [25]

2 METHODOLOGY

2.1 Research strategy

This Bachelor thesis is a case study based on an interdisciplinary project carried out by the professors and students of Tallinn University of Technology at a telecommunication equipment producer Company X. Work of the author should be considered as a part of the project focused on the logistical and supply chain constraints on the packaging.

Strategy followed in this thesis involves qualitative and quantitative methods in order to solve the business problem posed by the Company X.

Quantitative information gathered by the author from the Company X was analyzed in the form of a Case Study to identify the potential improvement points and later put into real life context to check their relevance and credibility. [26]

Qualitative information was gathered by the author by the means of expert interviews at the Company X and its relevant sub-contractors in order to further explain why the quantitative data as it is and what causes the incidents the case involves. The questions aimed at the experts were aimed to be leading in order to reach the root cause of the said problems and to be able to suggest feasible business solutions as a result. [27]

2.2 Company X

2.2.1 Worldwide

Company X is a renowned telecommunications equipment producer, which telecommunication and multimedia solutions are being used all around the globe by various commercial and private users. The company focuses also on development of new and improvement of the currently used solutions in their field. Its activity encompasses the entire communication spectrum and is one of the leaders in the data transmission over their devices. It has many specialized and generalized factories all across the world with strong standards and expectations for its supply chain.

2.2.2 Estonia

Company X has been operating in Estonia since the late 1990s with the addition of a manufacturing facility being established in the 2000s and recently starting to test the new products and develop solutions for their industrializing. The manufacturing plant in Estonia is one of the main intragroup producers of testing systems as well as managing their world-wide supply chain. It also develops and produces different radio and digital products for the entire market.

The plant itself is one of the largest production plants in Estonia which aside from the production of different products and systems also serves as an international logistics center.

The working environment at the manufacturing plant is very multicultural with more than 35 nationalities represented in the workforce. Working language therefore is either Estonian, English or Russian. The most important values there are workplace health and safety, workers self-development and workplace happiness as well as continuous management techniques development.

2.3 Project on improving the packaging solution in Company X

The problem this Company X faced was comprised of 2 variables: cost of the package and that the packaging solutions used were not recyclable or green. The cost of the packaging had been steadily increasing and starting to have a large impact on the profit margin, while the Company X had taken an executive decision to move towards more green and sustainable solutions in all of their activities. Therefore the Company X started a research project to come up with a business solution focused on improving those 2 fields as well as the supply chain processes and standards which influence the final packaging solutions.

The products in scope of the project were telecommunication devices, which weight varied from 25kg to 40kg and functionality was similar.

2.3.1 Cost of the packages

Manufacturing plant was creating considerable cost due to packaging of the products in scope. The cost was estimated to rise with the increased demand of these products.

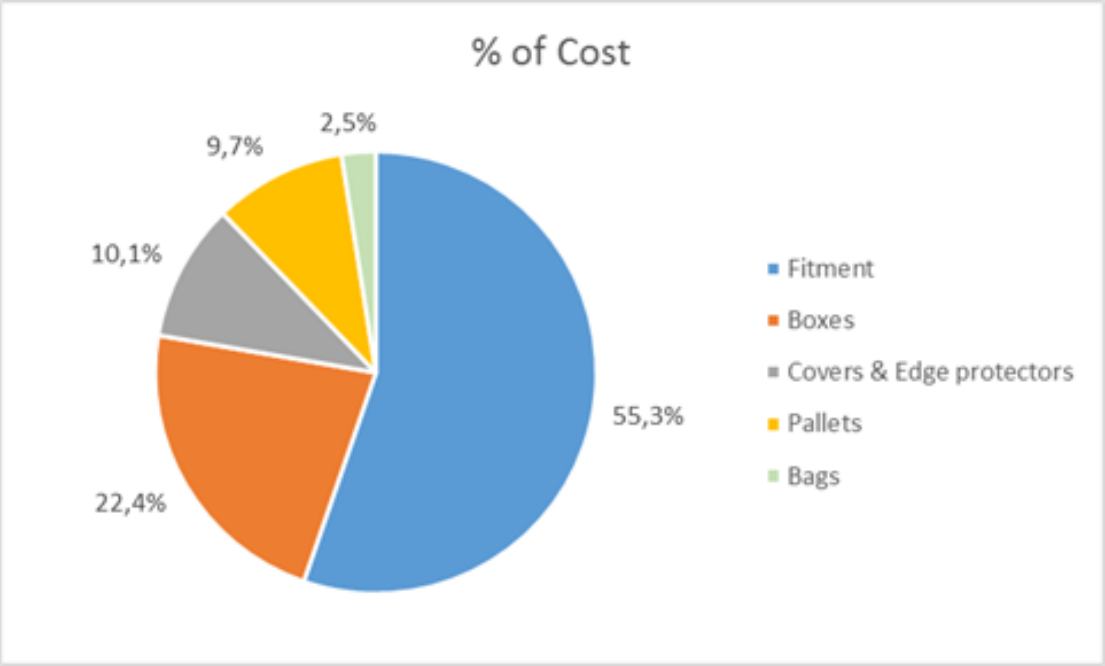

Figure 6. Cost distribution for packages of products in the scope of the project

As seen from the Figure 6. fitments generate more than 55% of the entire packaging cost, making them the largest cost article in the package.

2.3.2 Environmental friendliness of the packages

The packaging solutions in the scope of the projects were comprised of 4 components: Fitments, boxes, bags and edge & cover protectors.

Fitments in the scope of the project were from Expanded Polypropylene (EPP) or Expanded Polyethylene (EPE) plastics, neither of which are considered as green materials or possible to be easily reused without the process of returning them to the producing factory or recycling the material.

Bags were made from common Polyethylene (PE) plastic, which is also not considered as a green material as the only way of reusing them is through complicated recycling process and they are not biodegradable.

Boxes themselves were from corrugated fiberboard, which makes them environmentally friendly and can be considered as green packaging. They are biodegradable and could also be easily reused at the end of the supply chain by the end-customers.

Edge & cover protectors will not be in the scope of the project as their impact is too marginal compared to the rest of the packaging.

2.3.3 Aims to achieve during the project

The process of packaging a product should not have a large cost impact on the product, due to the work hours put into it. The packaging solution, which was used in the beginning of the project had only a marginal impact on the overall cost due to the packaging process of the product and the company wished that it remained so.

The size of the package has a large impact on the transport costs, therefore the solution is encouraged to decrease the dimensions of the packaging or the method of storing them on the pallets.

The packaging must ensure that the product inside the packaging remains safe and intact throughout the Supply Chain and doesn't damage other products that are potentially being transported with it. This was ensured by the following company standards which the packaging must endure:

- Impact drop test, where the package with the product inside is dropped from the height of 100 cm [18].
- Compression test, where only the fitment is compressed until irreversible damage [20].
- Vibration test, where the package with product inside is subjected to constant vibration for set amount of time [21].

2.4 Cargo claims

Company X has produced over 10 000 products, which are in the scope of the project over the past 2 years, which have had to be shipped over land or sea to their distribution centers or secondary storages. The products were placed in their final packaging in the manufacturing plant before being shipped therefore during all the risen cargo claims the products were protected by the packaging. The packaging was designed to endure the tests carried out by the company standards.

Table 4. Cargo Claims for 2 years for the products in scope

Cargo Claims for 2 years		
Product	No. of Claim	% of Claims
Product 1	613	46%
Product 2	273	20%

Product 3	108	8%
Product 4	125	9%
Product 5	72	5%
Product 6	52	4%
Product 7	18	1%
Product 8	18	1%
Product 9	13	1%
Product 10	10	1%
Product 11	10	1%
Product 12	9	1%
Product 13	8	1%
Product 14	6	0%
Total	1335	100%

As seen in Table 4. over the past 2 years the Company X products had suffered 1335 Cargo Claims related to the products in the scope of the project. Amounting to around 13% of all the produced products being subject to a cargo claim.

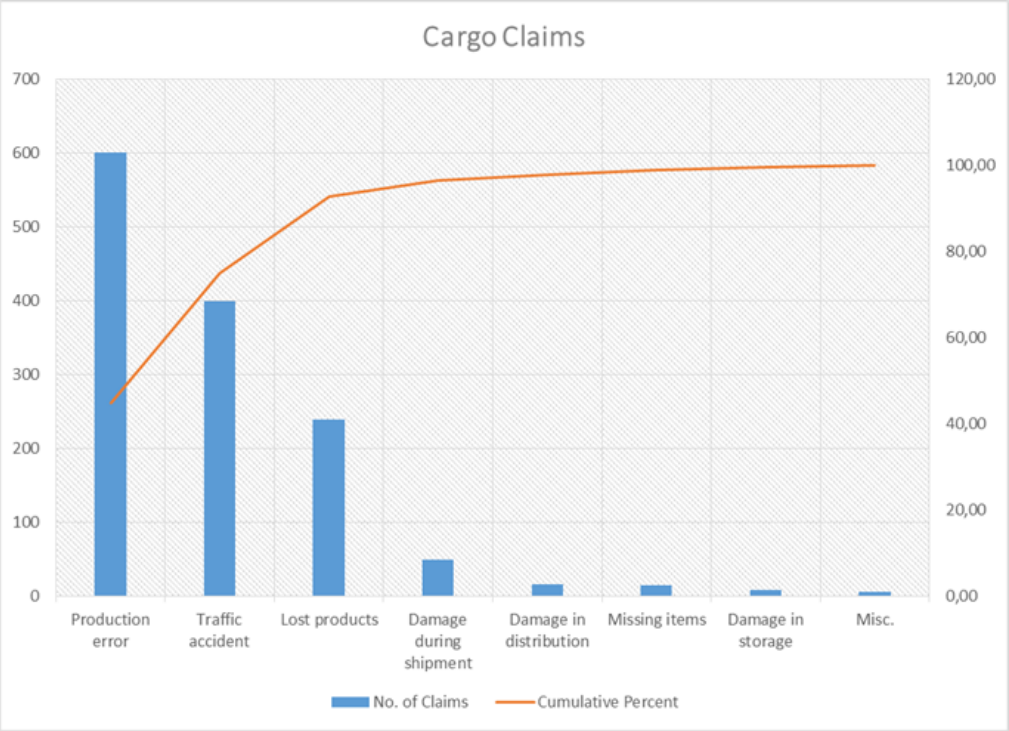

Figure 7. Causes for cargo claims in cumulative percentage

Majority of those Cargo Claims shown on Figure 7. were not due to the packaging itself, but rather due to the mistakes made in production or transit and are therefore the responsibility of the sub-contractor responsible for transporting them. 45% of the claims were due to production error, 30% of the claims were due to a traffic accident, 18% of the claims were due to the products simply being lost in the supply chain, 1% of the claims were due to inadequate packing methods, leaving only 6% of the claims due to avoidable physical damage.

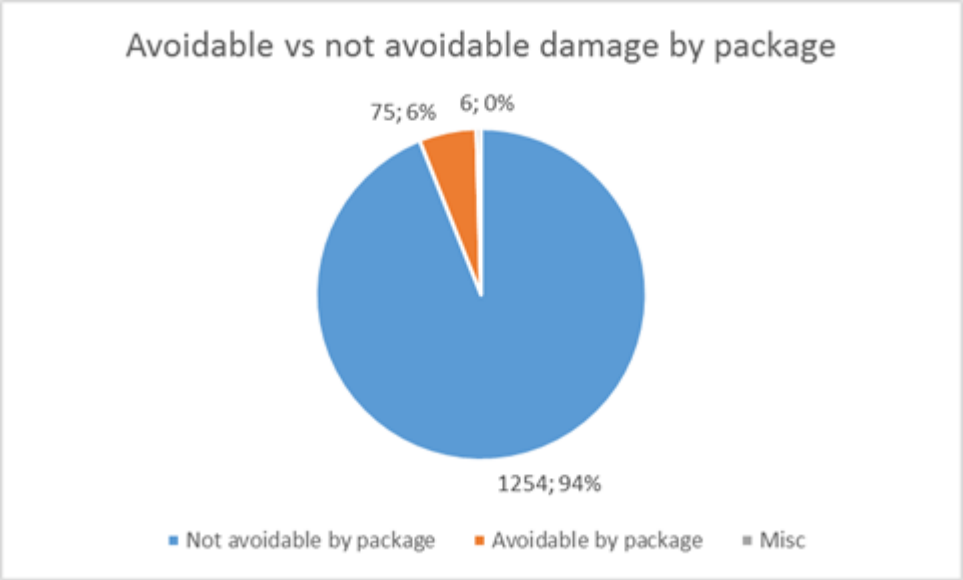

Figure 8. Avoidable versus not avoidable damage by package

Figure 8. shows that only 75 Cargo Claims out of the 1335 total claims made over the 2 years were due to the damage, which could have been avoidable by a more adequate and stronger packaging, making that just 0,8% of the total products produced being damaged in transit. This doesn't mean that these claims were entirely the responsibility of the producer, rather just that these damages could have been avoided if the package was good enough.

This data creates precedence to think that the packaging solutions used by the Company X are too good for the products in scope and therefore should be further investigated.

3 ANALYSIS

3.1 Analysis of the current condition of the Supply Chain

Based on the data about the Cargo Claims author of the thesis conducted interviews with the experts responsible for logistics and supply chain in the Company X and its sub-contractors. The aim of these interviews was to not only confirm the data available, but also understand the "Why?" aspect of the claims. The experts were asked the following leading questions:

- What is the most common damage sustained by the product during the supply chain and why it happens?
- How often does it happen that the product is dropped during the supply chain?
- Why is the product dropped in the cases it is?
- What are the most common complaints by the workers regarding the packaging?
- What is the most important thing the package must have during supply chain?

The following details were conclusions from the interviews and based on the data available about the cargo claims.

Figure 9. Three categories of the transportation chain

As was revealed during the interviews the Company X divides their supply chain activities in 3 categories: transit, storage and distribution. Each one of those categories has different threats and risks as well as the importance of different parts of the package is different among those categories. Author interviewed at least 2 experts from each category and they were asked the same questions in order to ensure that all the critical fields and questions are covered

in each category and to check if the answers are not conflicting between different experts in the same area.

3.1.1 Transit

During transit the packages have to able to be stacked. The containers, as described in ISO 668, are 245 cm tall and can normally fit up to 21 EURO pallets with the dimensions described in ISO 3394, on the floor of the container, therefore the higher it is possible to stack the products the more it reduces the overall transportation cost per product. The biggest limitation in this is the strength of the corrugated fiberboard box that is currently in use, which is supposed to carry the full load of the stacked packages on top of itself (e.g. if the products are 25kg and the stack is 12 products high then the box is supposed to be able to carry at least 300kg).

The products are shipped in full containers from the manufacturing plant by the sub-contractor, who delivers the container filled with products to the secondary storage facility. The Company X pays the sub-contractor by the container shipped, therefore it's in the interest of the Company X to fit as many products into the container as possible. This is limited by the dimensions of the container as well as the potency of the boxes. In case the size of the package could be reduced, it would be possible to fit more products into the containers reducing the logistics costs per product (e.g. If the number of products in the container rises from 400 to 500, resulting in the increase of 25%, the logistics costs per product would lower 20%).

The role of the fitment in transit is to fill the corrugated fiberboard box up to minimum of 85% of its entire volume in order for the box not to lose its integrity during the duration of the transport. The integrity of the corrugated fiberboard box can decrease due to the vibration and bumps while in the container on the road, on the sea or in the air. If the corrugated fiberboard box is filled less than 75% of its entire volume then there is a high chance that the corrugated fiberboard box will fold upon itself while stacking products and cause the entire stack of products to collapse, especially if the force is applied from different directions and is the largest threat to the packaging in this part of the supply chain. [27]

Fitments role during transportation is to not only fill up the corrugated fiberboard box, but also reduce the vibrational effect on the product and protect the product in the case of strong G-forces (e.g. when the truck takes a sharp turn or runs through a large hole in the road). But

overall the role of a fitment is not that important in the stage of transit as the roads transportation devices don’t generate so high G-forces to the cargo.

3.1.2 Storage

During storage the pallets stacked with products are take out from the containers they were transported in and placed in the warehouse. In the warehouse there are around 6 times the forklift interacts with the pallet per warehouse the product goes through – 3 times when it lifts it up to move it to another place and 3 times when it puts it down to the intended location. This happens when the forklift takes the pallet off the container and moves it to storage, when it moves the pallet from storage to loading area and when it loads the pallet to the next container. At this stage the most important part of the package is again the box, which has to keep its integrity during those lifts and drops to keep it from falling over. If the box loses its integrity at this point then the whole stack of packages will fall from mostly higher than 1m and the fitment created by the ISO standard 2248 will not save the product from damage in this case.

Fitments role in this stage is to again fill the box to increase its integrity and to save the product from the described lifts and drops. Those lifts and drops are from height up to 15 cm, therefore the G-forces involved are not high enough to damage the product.

The products in the scope will almost never be handled by hand in the storage phase, limiting the possibility of the product being dropped from 1m to very low. If an accident happens then it involves a larger number of products and results in high damage regardless of fitments surrounding it (e.g. top pallet out of 3 stacked pallets falls from 2 meters).

The most common accident is caused by the package being damaged when the pallets are loaded or unloaded into the containers, where the edges of other pallets might damage the boxes or plastic wrapping holding the stacks on pallets together. This kind of damage occurs due to the mistake of the forklift operator who has either not placed the pallet close enough to the walls of the container leaving the next pallet too little room to fit in the container or by accident hits products on previously placed pallet with the pallet it is transporting. These accidents make up around 90% of the transportation related claims.

3.1.3 Distribution

At this point the products will be taken apart from the larger stacked pallets and placed into smaller vehicles for transportation to the client. Making this the most viable place for a worker to drop the said product, but 100 cm drop standardized is still not possible because of

how an average human carries and reacts to a heavy product dropping. It is feasible that the product drops maximum of 50 cm in free-fall when being lifted from the stack to a smaller pallet because of the worker's negligence, but this isn't a high chance and should not be the defining factor in designing the package the experts say.

Alternatively sometimes due to the packaging being too large and uncomfortable to be transported the worker tasked with transporting the product to the client will simply remove the packaging before leaving the distribution center. This leaves the product without any extra protection and any drop can damage it without the extra protection offered by the fitment. This is clearly a sign that the packaging is designed in a way that hinders the transportation of the goods and should be made easier to be handled by for example reducing the packaging and fitment size.

In this stage the most important is for the packaging to be easy to handle in order for the worker to not drop the product or remove the packaging around it. Fitment is important in this stage, but only if it is practical.

3.1.4 Summary of Supply Chain expert interviews

Answers from the experts within their responsibilities were not conflicting. Though in few cases their answers about the areas not under their responsibility were conflictive with the answers that were given by the experts of the respective areas, if that happened the author put more weight on the answer given by the responsible of the field.

For transit the most important part of the package is the box, which takes the most punishment and results in the most accidents if not designed in a proper way.

Accidents that happen during storage are generally related to the forklift operator's competences and not to the packaging itself, even though not properly filled box that folds in on itself and causes an accident is the responsibility of the producer. In the case that an accident happens the products fall from higher than 100 cm so the results of standardized drop-tests carried out are not applicable.

The most dangerous point in the transportation chain for the product is during the distribution when products are separated from the stacks, but even then the chance of an accident happening is low.

Fitments role is mostly to protect the product from vibration and constant G-forces applied during the transportation chain. On the same time it fills out the box to make sure it's integrity doesn't fall during interactions.

In the case that the packaging size could be reduced it would also reduce the logistic costs, because Company X pays the sub-contractor per container shipped and in the case the producer could fit more products in a container the cost per product would decrease.

3.2 Analysis of the engineering and management constraints

After carrying out the interviews with the Supply Chain experts author interviewed the packaging engineers and the Company X manufacturing plant management in order to understand what are the constraints, suggestions and wishes from their side.

3.2.1 Packaging engineers interviews

During the interviews with the packaging engineers the author focused on the following questions:

1. How the packages are designed and what are are the biggest constraints in designing a package for these products?
2. What are the work-processes involved in designing a package?
3. Which ISO standards are being followed in the creation of the package?

The packaging is designed by a sub-contractor of Company X, to whom the Company X sends the dimensions of the product and any special specifications necessary for the design and production of the package. Currently none of the ISO 1860X standards are requested from the sub-contractor. The same sub-contractor is also responsible for the production of the said packaging.

Once the package has been designed the packaging engineer at the Company X has to confirm that this design fits the needs and specification set to the sub-contractor. After the packaging design is approved the sub-contractor sends a sample of the packaging to the Company X for physical testing based on the company testing standards that are in line with the ISO 2247, ISO 2248 and ISO 1856 mentioned above in this thesis.

If the packaging passes the testing then sub-contractor starts providing these packaging's to the manufacturing plant.

3.2.2 Company X manufacturing plant management interviews

During the interviews with the Company X manufacturing plant management author focused on what are the roots of the project and what are the feasible options for improvement and change.

The management wished to keep the quality standards their company is known for and not increase the number of cargo claims which happen due to the packaging. On the same time they agreed that the packaging potency might be too high as the cargo claims data suggests, they were unsure if this is due to the company wide standards being too high or the packaging solutions provided by the sub-contractor being simply too high quality. The first would be very difficult to change as this would require a large-scale change throughout the Company X and the business opportunity for this kind of a change would need to be very formidable. The sub-contractor would be easier to change if there were any grounds for it, but as of then the manufacturing plant management didn't wish to take up the whole packaging design process responsibility, which would be necessary to ensure that the packaging is just effective enough and there wouldn't be any waste. It's also in the interest of the sub-contractor to offer the cheapest possible solution, because if the packaging cost becomes too high for the Company X, then there would be a possibility for the discontinuation of the contract between Company X and the current sub-contractor. Therefore, the management believes the solution offered to them is as close to the optimal solutions as could be currently.

3.3 Conclusion

As the data of Cargo Claims shows, the packaging of the products in the scope of the project is very formidable, but as the business problem is the high cost of the packaging, then the current solution is not the most optimal business solution with only 0,8% products of the entire production being in one way or the other damaged.

55,3% of the total packaging cost comes from the fitment and expert interviews reveal that the impact of the fitment in supply chain is not that important compared to the box surrounding it and is less likely to save the product from becoming defected. Company X is not entirely in the control of the packaging solutions created for them by their sub-contractors, but

it’s also in the best interest of the sub-contractor to create a package that is closest to the standard strength as possible.

Taking that into account the Company X could take the following routes to resolve their business problem based on the business strategy they wish to follow:

- Reduce the fitment of the package while increasing the strength of the box - This option would reduce the cost of the package while increasing the safety of the product in the more problematic stages of the supply chain, while also reducing the volume of the product and decreasing the overall logistics cost per product.
- Implement a greener packaging solution, which follows the ISO standards 18601 to 18606, which is the equivalent cost of the current packaging solutions, but has slightly less defensive potency towards the product.
- Implement a green packaging solution which has even less defensive potency than the 2nd option, but decreases the cost of the packaging while fulfilling solving the secondary problem of the package being too environmentally unfriendly.

Either of the 3 options would be feasible in the real-world according to the information gathered for this thesis. The third option would be the more risky option, while the first two don’t fully solve the initial problems.

Author suggests based on the information and data gathered during this research for the company to select the first option, which would also fulfill at least partly the ISO standards 18601 and 18602. This option would not fulfill the ISO standards 18603 to 18606, but in the current situation with these products a fully green packaging solution wouldn’t have enough potency to protect the products to even minimal extent necessary.

In the longer term author suggests the company to run a similar analysis for all the manufacturing plants Company X has, in order to determine if the company wide packaging standards are optimal or it is only the case with the products that were in the scope of the project that were sub-optimal. In case the analysis bring similar results the author suggest to follow a similar course of action as with the current products in scope.

SUMMARY

Packaging is crucial for getting the product from the producer to the consumer. The type of packaging used depends highly on the product and the dimensions of the product within. There are numerous regulations by the European Parliament and International Standard Organization to regulate the packaging and the testing of the packaging to ensure that the products within the packaging are not damaged in transport or that the packaging is environmentally friendly. Keeping the packages environmentally friendly and ensuring the safe arrival of the product to the destination while not creating excessive costs for the producer is a difficult task that all the production companies are tackling.

Company X is faced by just such a problem - their packaging costs are rising and the policy of the company is to decrease their negative impact on the environment, which put together called for an external research team to solve.

Analyzing the Cargo Claims of the Company X resulted in the understanding that even though there is quite a large number of claims related to the products in the scope, most of those were incidents that couldn't have been avoided with a more effective packaging.

Using the Cargo Claims analysis as a baseline author conducted interviews with Company X supply chain experts, packaging engineers and management. Interviews confirmed the hypothesis that came from the analysis of the Cargo Claims data: The packaging solutions standards are too high. Also that lowering the standards could result in a serious reduction of the package cost and therefore allow to also make it more environmentally friendly.

The conclusion from this thesis is that the author suggests for the Company X to reduce the fitments for the products in scope in order to lower the price and reduce the negative environmental impact the packaging has. Author also suggests for the Company X to run a companywide analysis to determine if the situation is similar across the company as was with the products in the scope of this work.

From authors research we can see that packaging is important in fact for the whole supply chain. Therefore designing and then choosing a proper packaging solution for certain products is a very important at the first stage of a supply chain. A wrong decision might affect next stages of the supply chain, leading to increased costs and their not efficient usage.

As the aim of this thesis was to analyze the packaging solutions used at the Company X, find the constraints faced in the supply chain towards the packaging and based on those suggest a course of action for the Company X to follow in the future to reduce the cost of the packaging and make it more environmentally friendly, then this thesis was a success.

KOKKUVÕTE

Töö pealkiri : „Pakendamislahendused ning nende sobivus Ettevõtte X näitel“

Autor: Taavi Valgerist

Pakend on väga oluline osa toote jõudmiseks tootjalt tarbijani. Pakendi tüübi ning materjali määrab toode ning selle suurus. Euroopa Parlament ning Internation Standard Organisation (ISO), on loonud mitmeid regulatsioone ning korraldanud teste, et kindlustada toote algse kuju ja kvaliteedi säilimine transpordi käigus ning pakendi loodussõbralikkus. Pakendi hoidmine loodussõbralikuna ning toote tervena jõudmise kindlustamine tarbijani on juba keeruline ülesanne, aga kui see ühendada ka sooviga minimaliseerida pakendi maksumust, muutub see veelgi raskemaks. Just selle probleemiga seisavadki paljud ettevõtted silmitsi.

Ettevõte X üritabki leida lahendust sellele probleemile - tema pakendikulud tõusevad, üle-ettevõtteline strateegia näeb ette loodussõbralikemate lahenduste kasutusele võttu. Sellepärast kutsuski ettevõte endale uurimisrühma appi seda probleemi lahendama.

Analüüsides vigastusi, mida on saanud Ettevõtte X projektis olevad tooted, oli näha, et kuigi kogu vigastuste number on üsnagi suur, siis enamused neist vigastustest on tekkinud põhjustel, mida pakend poleks suutnud ära hoida.

Võttes informatsiooni toodete vigastuste kohta aluseks, viis töö autor läbi intervjuud Ettevõtte X tarneahela ekspertide, pakendiinseneridega ning juhtkonnaga. Intervjuud kinnitasid hüpoteesi, mis tulenes vigastuste informatsioonist: pakendamislahenduse standardid on liiga kõrged. Nende standardite langetamine tooks kaasa kogu pakendi hinna languse võimaldades muuta pakendit loodussõbralikumaks.

Selle bakalaureuse töö tulemusena, soovitab töö autor Ettevõttel X vähendada projektis olevatel toodetel pakendis *fitment*'i, eesmärgiga langetada kogu pakendi hinda ning tõsta pakendi loodussõbralikkust. Autor soovitab ka Ettevõttel X, analüüsida oma ülejäänud toodete portfelli sarnasel kombel ning juhul kui see analüüs näitab sarnaseid tulemusi selle tööga, viia läbi suuremad muudatused üle-ettevõttelistes standardites.

Autori uurimustööst tuleb välja, et läbi tarneahela on pakendil väga oluline tähtsus. Sobiva pakendi loomine ning valimine, on tarneahelas esimese sammuna väga tähtis samm. Vale otsus selles staadiumis võib viia liigsete kuludeni ning kogu tarneahela ebaefektiivse toimimiseni.

Selle töö eesmärgiks oli analüüsida projektis olevate toodete pakendilahendusi, leida tarneahela kitsaskohad seoses pakendiga ning vastavalt sellele anda soovitus edasisteks sammudeks. Kuna need eesmärgid said täidetud, võib selle töö lugeda õnnestunuks.

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