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Fibre-based takeaway packages as an alternative to plastic packages

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TIIVISTELMÄ

Lappeenrannan-Lahden teknillinen yliopisto
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Kuitupohjaiset take away -pakkaukset vaihtoehtona muovisille pakkauksille

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Työn tarkoituksena oli selvittää, voidaanko nykyisiä muovisia take away -pakkauksia korvata kuitupohjaisella vaihtoehdolla. Viime aikoina muovipakkaukset ovat olleet negatiivisessa valossa esillä julkisessa keskustelussa. Julkisen keskustelun lisäksi vaihtoehtoisille pakkauksille on nähty tarvetta ympäristösyistä ja muuttuneen lainsäädännön myötä.

Kirjallisuuskatsauksessa käydään läpi pakkauksen perusominaisuuksia ja materiaaleja, jotka ovat tällä hetkellä yleisesti käytössä take away -pakkauksissa. Kartongin valmistusprosessiin perehdytään tarkemmalla tasolla kuin muovin valmistukseen. Lisäksi kirjallisuuskatsauksessa käydään läpi elintarvikepakkauksia koskevaa lainsäädäntöä ja pakkausten kierrätystä.

Työn kokeellisessa osiossa myymälän palvelutorilla testattiin kahta erilaista kartonkipohjaista rasiaa. Palautetta testatuista rasioista kerättiin myymälän henkilökunnalta ja asiakkailta. Lisäksi erillisellä kyselyllä kerättiin lisätietoa ja kuluttajien mielipiteitä palvelutorilla käytetyistä take away -pakkauksista yleisemmällä tasolla.

Tulosten perusteella pystytään toteamaan, että kuluttajat ovat halukkaita korvaamaan nykyiset muoviset pakkaukset kartonkipohjaisilla pakkauksilla. Pakkauksen ominaisuuksien osalta ei kuitenkaan olla valmiita joustamaan, vaan kartonkipohjaisen pakkauksen on suojattava tuotetta yhtä hyvin kuin nykyinen muovirasia suojaa. Pakkauksen tiiviys niin, etteivät nesteet valu, nähdään pakkauksen tärkeimpänä ominaisuutena. Kartonkinen pakkaus ei kuitenkaan ollut yhtä tiivis kuin muovinen pakkaus.

ABSTRACT

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Fibre-based takeaway packages as an alternative to plastic packages

Master's thesis

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67 pages, 32 figures, 4 tables and 3 appendices

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Keywords: takeaway package, plastic free paperboard package, recycling

The objective of the thesis was to find out if it is possible to replace current plastic takeaway packages with fibre-based packages. In recent times, negative features of plastic packages have been a frequent topic of public discussion. In addition to the public pressure, the demand for alternative packages has risen due to legislative and environmental reasons.

In the literature review, I will discuss the general features of packages and packaging materials and review the principle manufacturing steps of paperboard. Otherwise the focus will be on both plastic and paperboard packages and materials. I will also look at the legislation concerning food packages and recycling of packages.

In the empirical part two fibre-based takeaway packages were tested at the takeaway counters of grocery stores. Packages were used for cold food, especially for cold salads. Both employees and customers had a possibility to give feedback on the tested packages. Additionally, background information and opinions on takeaway packages were surveyed by a separate questionnaire.

Based on the survey customers are eager to replace current plastic takeaway packages with paperboard packages. However, they are not willing to make compromises on the basic features of packages. The leak-tightness is considered the most important feature of the package and fibre-based packages should protect the goods at the same level as current plastic packages which was not clearly achieved.

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At first, I would like to thank my employer SOK for giving me the opportunity to work on the thesis. Thanks to the whole SOK's project group and especially to Senja Forsman for steering the work. Practical tests had not been possible without third parts and the stores that were involved, so my deepest thanks for the cooperation. I would also like to thank Professors Juha Varis and Ville Leminen for their guidance, and not to forget my family, relatives and friends, who encouraged and helped me to finalize the thesis.

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LIST OF SYMBOLS AND ABBREVIATIONS

ABS	acrylonitrile-butadiene-styrene
CTMP	chemi-thermomechanical pulp
EFSA	European Food Safety Authority
EPR	Extended Producers Responsibility
EU	European Union
FCM	food contact material
ISO	International Organization for Standardization
LCA	Life Cycle Assessment
Luke	Natural Resources Institute Finland
PE	polyethylene
PET	polyethylene terephthalate
PLA	polylactic acid
PP	polypropylene
PS	polystyrene
PVC	polyvinylchloride
RPET	recycled polyethylene terephthalate
SBB	solid bleached board
SBS	solid bleached sulphate
SUP	Single-Use Plastics Directive
WBBC	water-based barrier coating

1 INTRODUCTION

The subject of the thesis was brought about through the S Group's initiative to find a fibre-based takeaway package, which could replace or act as an alternative to plastic takeaway packages. The tested packages had to fulfil the following requirements: they have been tested at least in laboratory scale, they are suitable for food and they meet the requirements of the legislation. Additionally, the wish was to find that kind of fibre-based takeaway package that is not widely in use in takeaway places yet.

1.1 S Group and research background

The S Group is a Finnish cooperative organization, which is operating in the retail and service sectors. S Group consists of twenty regional cooperatives and the SOK Corporation (later SOK) along with its regional and national subsidiaries. Customers, also called co-op members, own the cooperatives and SOK is owned by the cooperatives. SOK provides procurement, expert and support services for cooperatives. (S Group 2019.)

The supermarket trade chain consists of Prisma hypermarkets, Food Market Herkku, S-market, Sale and Alepa stores. There are also ABC-Market stores in some ABC service stations. There are totally 900 outlets all around Finland, and additionally outlets in Estonia and Russia. (S Group 2019.)

Takeaway food counters are available in the Prisma hypermarkets, the Food Market Herkku stores and some of the S-market stores. Different kinds of takeaway containers are used. Regional cooperatives are able to choose takeaway containers sourced by the SOK or source them locally. Locally sourced takeaway containers are not recorded by the SOK. As all takeaway containers are not recorded, the exact percentage of plastic takeaway containers cannot be stated. However, plastic containers are still the most used ones.

There are different kinds of plastic takeaway containers available, and the features and shapes of containers vary. Some of the containers are suitable for both warm and cold food, others for cold food only. Some of the containers are suitable for microwave ovens and some

are not. There are containers with a hinged lid and a separate lid, and containers made of virgin and recycled materials. Along with the plastic containers, some fibre-based containers are already available nowadays, for example fibre-based containers with a plastic lid are used in the self-service salad bars of the stores. (SOK 2019.)

1.2 Research question

S Group's responsibility program Best Place to Live, consists of four main themes (S Group 2019):

1) For the good of society
2) Climate change and the circular economy
3) Ethical operating culture and human rights
4) Health and well-being.

There are acts related to the use of plastic under the circular economy theme. All business operators of S Group are involved in the plastic strategy. The objective is not only to decrease the amount of plastic or to replace plastic items, but also to increase the amount of recyclable plastic. S Group has also decided to add recycling instructions to the packaging of the private label products to make it easier for customers to recycle the packages. (S Group 2019.)

Based on the responsibility program SOK also decided to look for new options for takeaway packages used at the takeaway counters of the grocery stores. The research question is, if it is possible to find a fibre-based takeaway package that could replace or be an alternative to plastic takeaway packages.

1.3 Goals and delimitations

The aim of the research is to find a workable fibre-based takeaway salad package, which has been tested in practice at the takeaway counters of grocery stores. Furthermore, the aim is to provide background information and support for the future decision making regarding the takeaway packages.

It was decided to delimit the research to takeaway packages for cold salads, which means that the package should be suitable for food sold at refrigerator and/or at room temperature.

It was chosen two different kinds of fibre-based packages, so that the results could be compared with each other. Even though the aim is to find a package, which is not widely in use yet, it was decided that the other option could be a package, which is already in use in some places, as there is no reported test data available. In this study, the fibre-based packages are limited to packages, which are made of paperboard. As packages were needed in early 2019 or in the spring 2019 at the latest, that delimited the number of packages available.

Due to confidential material some results concerning the company or third parts are presented in a limited level. Due to confidential material some results concerning the company or third parts are presented in a limited level. Because most of the answers were received in Finnish, they are translated only to the level seen necessary.

1.4 Structure of report

In the literature review of the thesis, it will be given an overview on packages, current takeaway containers and main parts of the manufacturing process of the materials. In addition, it will be introduced the legislation of food packages and recycling.

In the empirical part, objective was to test the chosen packages and collect feedback from customers and employees of the selected stores. Furthermore, it was collected information on attitudes and opinions in relation to the takeaway packages.

1.5 Current state analysis

Before the study started, it was reviewed the current takeaway containers sourced by the SOK. As it was possible to test only one size of package, it was also surveyed the required size of the containers interviewing the persons responsible for packaging materials at the stores. It was also contacted the producers of packaging materials and the converters of packages to find out, which kind of options they were able to provide and within what timeframe.

2 LITERATURE REVIEW

There is a wide diversity of chilled food available such as chilled desserts, ready meals, dairy products, meat, seafood, fruit and vegetables. In the literature review, it will be focused on the packages of chilled food, especially on the packages of cold salads available at the takeaway counters. However, it is taken a more comprehensive look at some general features of packages. Takeaway food is not typically pre-packed, but packed directly to the customer during the shopping. It will be looked at some general features of the packed products, but focused on items and packages that are not packed beforehand.

It will be discussed the manufacturing process of paperboard at more profoundly than the manufacturing process of plastic as the experimental study focuses on testing the fibre-based packages. Nevertheless, both fibre-based and plastic packages are included in the literature review. The need for fibre-based packages is closely related to the recycling and reduction of plastic and for example to the recently published Single-Use Plastics Directive. That is also the reason why it is taken a closer look at the recycling of plastic and the actions regarding the reduction of plastic waste, even though the practical test focuses on fibre-based packages.

2.1 General features of packages

Directive 94/62/EC defines packaging as a product, which is used for the containment, protection, handling, delivery and presentation of goods from the producer to the user or the customer. Packaging can be made of any materials of any nature. Goods can be raw materials or processed goods or something in between. (94/62/EC.)

Primary packaging or sales packaging is the sales unit available for purchase (94/62/EC). It is in direct contact with the goods inside it (Robertson 2012a, p. 2). Secondary packaging is defined as grouped packaging i.e. it consists of sales units, which can be removed. Tertiary packaging means transport packaging. (94/62/EC.) In the following text, it will be used the term package for the physical entity containing goods as defined by Robertson (2012a, p. 2).

There are four primary functions of a package. A package contains goods but also protects them. A package should be convenient and inform about the goods inside it. Protection is often regarded as the primary function of a package as it protects the contents from environmental influences such as water, water vapor, gases, odors, microorganisms, dust, shocks, vibrations and compressive forces. These influences come from outside the package. (Robertson 2012a, p. 2–3.) A protective food package also prevents food waste (The Ministry of the Environment 2018, p. 7). In addition to protection and thereby improved shelf life of food, the prevention of food waste can also be achieved with different package sizes (Silvennoinen et al. 2012 p. 40–43). The prevention of food waste is important as the environmental effect of food waste is significant, but the environmental effect of food package is usually relatively low, if we look at the whole life cycle of the food (The Ministry of the Environment 2018, p. 7; Silvennoinen et al. 2012, p. 40–43).

There are different factors affecting the selection of packaging material such as light, temperature, moisture, gases, grease resistance and mechanical strength. Some foods are susceptible to deterioration caused by light, but sometimes a light transmission is wanted to show the content of the package. If the food is heated in the package, packaging material must be able to withstand the processing conditions without damages and interaction with the food. Moisture loss or uptake affects very often the shelf life of food. A poor grease resistance can lead to leakage of oils spoiling the appearance of the package. Some foods require a higher level of protection from the package in other words the package should withstand crushing in higher levels. (Fellows 2009a, p. 716–723.)

The food products that should be stored at cold temperatures (+ 0 °C − + 8 °C) have specific requirements for the package. Some of these requirements are typical for all food products, the package should be able to protect for example from microbiological defects, foreign smells and tastes, impurities, mechanical defects, light and moisture. (Järvi-Kääriäinen & Ollila 2007, p. 51–58.)

As the interaction between the packaging material and food may have toxicological effects on the customer or it may reduce the shelf life or the sensory quality of the food, there should not be any interaction between these two (Fellows 2009a, p. 724). That means the packaging

material must always be non-toxic food grade and comply with the migration limits on harmful substances as it is stated in the packaging legislation. Additionally, packaging must be cost-effective in relation to the containing food. (Day 2008, p. 159).

2.2 Plastic takeaway packages on the market

In the following chapter, it will be reviewed the plastic takeaway packages that are currently on the market. The target is not to go through all of them but to provide some insight into the selection available. Besides, it will be discussed the general features of plastic packages and plastic as a material.

2.2.1 Plastic in general and plastic packages

Oil refining is usually the base for plastic manufacturing, which means that most of the plastics are fossil-based (McKeen 2013, p. 12; Robertson 2012b, p. 49–50). A basic component of plastic is polymer made from monomer i.e. plastic is defined as polymeric material. Additives and other substances may be added to plastic. (McKeen 2013, p. 1.; 06/1907/EC.) If the polymer is made by addition polymerization and monomer contains a carbon-carbon double bond it is called polyolefin like polyethylene (PE) and polypropylene (PP). Polyesters like polyethylene terephthalate (PET) are made from ethylene glycol and terephthalic acid by polymerization. (McKeen 2013, p. 1–5.) PE and PP are the most often used plastic materials in the packaging industry in general. Totally 47.8 million tonnes of plastic was used in Europe in 2014 from which the share of PE was 29 % and the share of PP was 19 %. The share of PET was 7 % but most of it is used for food packages like bottles. (Järvinen 2016, p. 88–91.) The packaging industry is one of the biggest industries that uses plastics in Europe including Finland (Eskelinen et al. 2016, p. 8–9; Järvinen 2016, p. 88; figure 1).

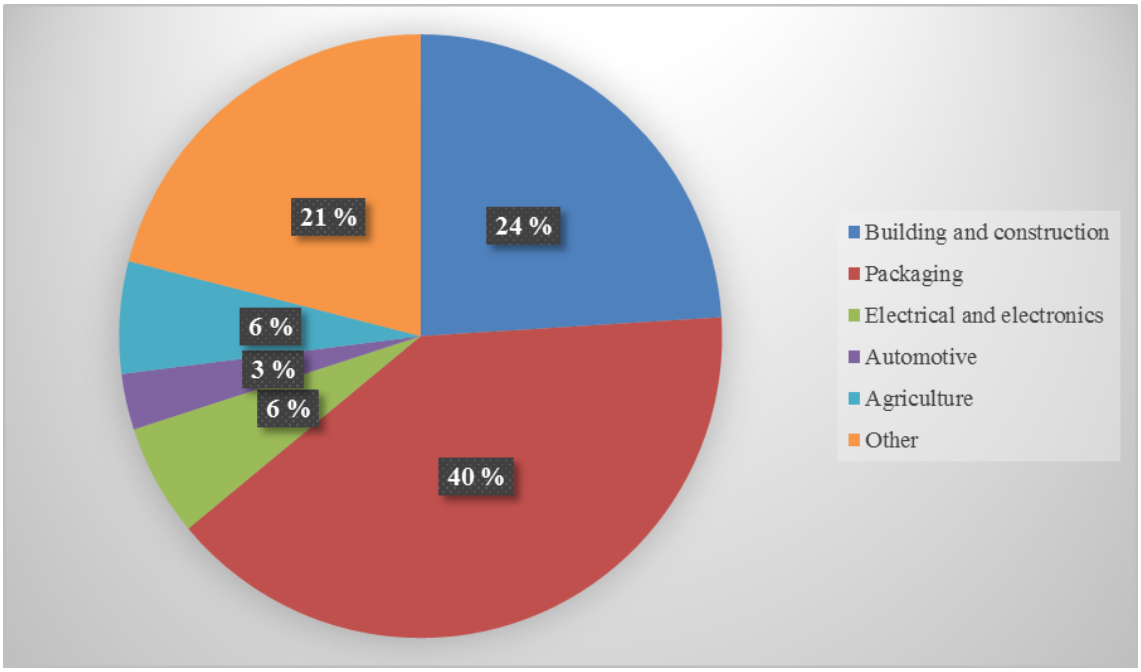


Figure 1. Plastic use in Finland in the year 2015 (modified from Eskelinen et al. 2016, p. 9).

Most of the chilled foods like ready meals are packed in plastic. It is the cheapest form of barrier packaging. Commonly used materials for semi-rigid plastic containers are PE, PP, PS (polystyrene), PVC (polyvinylchloride), PET and ABS (acrylonitrile-butadiene-styrene). There are different shapes of containers available like pots and trays. Moreover, different techniques are used like thermoforming, injection moulding and blow moulding. (Day 2018, p. 162.)

Along with fossil-based plastic, there is bio-based plastic available. The use of bio-based plastic has increased and the production of bio-based applications is expected to increase to 6.1 million tonnes by 2021 whereas it was around 4.2 million tonnes in 2016 (Plastic Europe 2019). Bio-based plastic means that the used polymers are derived from plant resources like maize and sugar cane. If synthetic bio-based polymers are used, polymers are derived from renewable resources but the plastic is not biodegradable. That is, bio-based plastic can be biodegradable but it is not always biodegradable. On the other hand, fossil-based plastic can be also biodegradable. (Emblem 2012a, p. 306–308.) Bio-based PE, PET and PVC are technically identical to oil-based plastics and can be mechanically recycled in existing recycling streams (European bioplastics 2019). Some new materials like polylactic acid

(PLA) are bio-based, and have biodegradability and compostability. Even so, composting can be done only in industrial facilities, because, in comparison to the home composting, a higher temperature and humidity is needed. (European bioplastics 2019; Emblem 2012a, p. 306–308.) There are takeaway packages made of bio-based PE, also called green PE. However, bio-based PET is the mostly used biopolymer on the market for the time being. (Emblem 2012a, p. 306–308; European bioplastics 2019; Stora Enso 2019.)

Packages are also made from recycled plastic. In addition to packages, recycled plastic is often used in agriculture, buildings and construction. While the amount of plastic waste keeps increasing, also the amount of reused plastic keeps rising. It is possible that there are foreign odours in recycled plastic. For that reason, recycled plastic is more suitable for such environment products like sewage pipes than for food packages, as odour or colour can be a problem in contact with food. Because of the strict legislation and the strict quality demands for food packages it is estimated that the use of recycled plastic will not highly increase in food packaging solutions, even though recycled plastic can be used in packages generally. (Eskelinen et al. 2016, p. 31–36.) An exception is the PET, which is used in plastic bottles. PET can be recycled and used in food packages after recycling thanks to the closed deposit system. (Finnish Plastics Recycling Ltd 2018, p. 20; Järvinen 2016, p. 41–43.) In addition to bottles, recycled PET (rPET) is also used in other solutions like takeaway packages made by Huhtamäki Plc (Huhtamäki Plc 2019; Järvinen 2016, p. 34–35). An example of a takeaway package made of rPET is shown in the figure 2. The amount of rPET is usually 50 % to 80 %. However, it cannot be 100 % because transparency and other typical features of package would suffer. The use of recycled plastic increases material effectivity. Alternatively, material effectivity can be increased by lowering the amount of plastic in the packages for example with thinner walls. (Järvinen 2016, p. 35.)

Figure 2. Plastic takeaway package made of rPET (Huhtamäki Plc 2019).

2.3 Fibre-based packages

Paperboard packages like paperboard trays are commonly in use for chilled food (Day 2018, p. 160). In the following part it will be viewed paperboard as a material and its manufacturing process. Ii will be focused on the materials and packages available in takeaway places. The term *paperboard* can be used for boxboard, chipboard and corrugated or solid fibreboards (Fellows 2017a, p. 987).

2.3.1 Paperboard and manufacturing process of paperboard

Paperboard also known as cartonboard and board is a felted sheet, which is made from pulp. Pulp is usually obtained from plant fiber in the other words paperboard is made from renewable resources. (Riley 2012a, p. 178–179; Robertson 2012c, p. 167.) Paperboard has an excellent stiffness and deadfold. Other main properties of paperboard packages are printing surface, absorbency, burst strength, tensile strength, tear resistance, compression strength and grease resistance. However, these properties depend on the grade and specification used. (Riley 2012a, p. 180–184.) Paperboard can be glued, cut, creased and shaped (Coles 2013, p. 188).

There are three main steps in the manufacturing process of paper and paperboard. At the first stage a dilute water suspension is prepared with fibres and additives. The dilute suspension is then formed into a sheet of intertwined fibres and lastly the remaining water is removed. Water can be removed via drainage, pressure, vacuum and evaporation, until a suitable substrate is achieved. The manufacturing processes may vary, however, there is always a wet end and a dry end. At first, a sheet is formed and water is removed by mechanical means in the wet end. The required moisture content of the substrate is achieved by heating. In

addition, a number of surface treatments are carried out in the dry end. (Riley 2012a, p. 200–204.) A typical example of a paper and paperboard making process, the wire or the Fourdrinier method is shown in the figure 3.

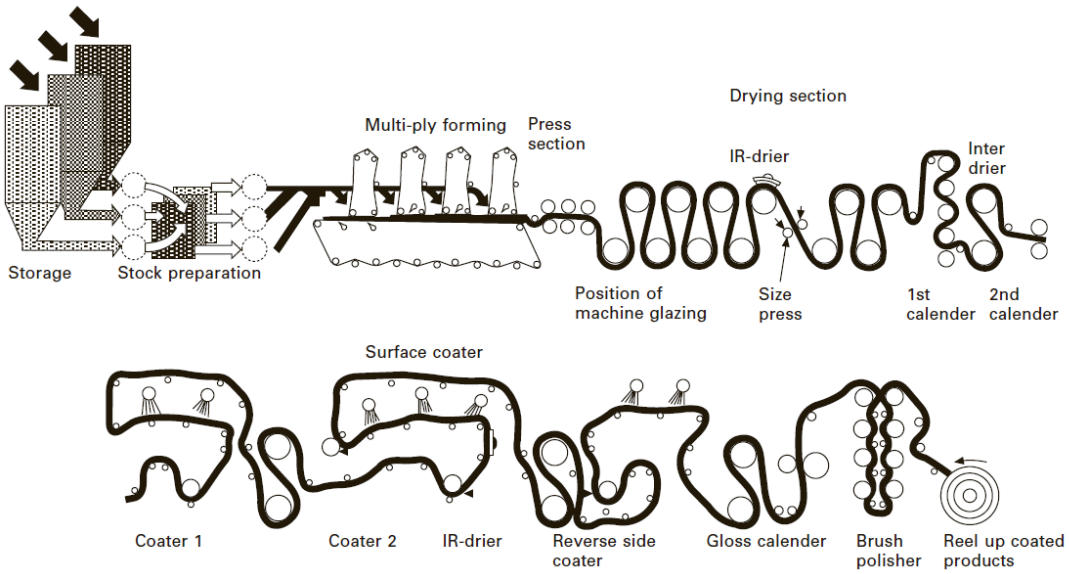


Figure 3. Fourdrinier papermaking process (Riley 2012a, p. 201).

Solid bleached board (SBB) or solid bleached sulphate (SBS) is one of the most widely used paperboard types (Robertson 2012c, p. 183). A basic structure of SBB is shown in the figure 4. SBB or SBS is usually made from pure bleached chemical pulp. Besides of that there are typically two or three layers of coating on the top and one layer on the back side. (Riley 2012a, p. 184; Robertson 2012c, p. 183–185.) White board is suitable for food contact. If recycled paper is used, paperboard is not suitable for a direct contact with food but it can be used for example as an outer carton for a package of breakfast cereals. A board with two layers, duplex board, can be used for example for biscuits. The outer layer is made of unbleached pulp and the liner is produced from bleached pulp in a duplex board. (Fellows 2017a, p. 988.)

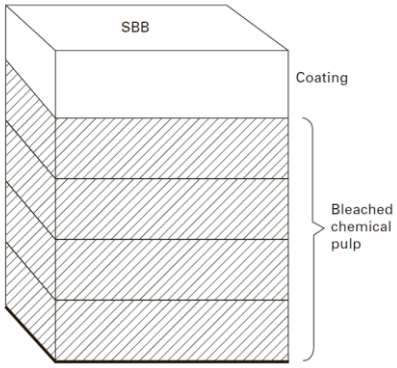


Figure 4. Solid bleached board (SBB) (Riley 2012a, p. 184).

Paperboard can be laminated or extrusion coated with PE or other polymer films, if there is a wish for specific barrier properties. Lamination or coating changes the properties of paperboard significantly as it is then permeable to gases, moisture, oils and fats. Paperboard with polymer film has a better water and product resistance, and it also provides better heat sealing properties compared to the paperboard without polymer film. (Coles 2013, p. 188; Riley 2012a, p. 189; Robertson 2012c, p. 184–185.) PE coating is widely used for food packages such as milk cartons and coffee cups when water resistance is needed (Zhua, Bousfielda & Gramlicha 2019, p. 201). If a paperboard package is coated with PET it can resist temperatures up to 220 °C. This is typical of the ready meals that are heated up for example in the microwave oven. (Day 2018, p. 160.)

Some of the surface treatments are done in-line but the coating processes can be carried out also separately. Polymer coating with plastic films can be applied by using extrusion coating or alternatively, it can be laminated on to the paper by using the adhesion process. (Riley 2012a, p. 204–205.) The simplest laminate is paperboard, which is polymer coated on one or both sides by using the extrusion process (Riley 2012b, p. 328). The extrusion coating process is shown in the figure 5. Extrusion is a continuous conversion process where granules of polymers like PE, PP or PET are melted and subsequently transformed to paperboard (Riley 2012b, p. 328–331).

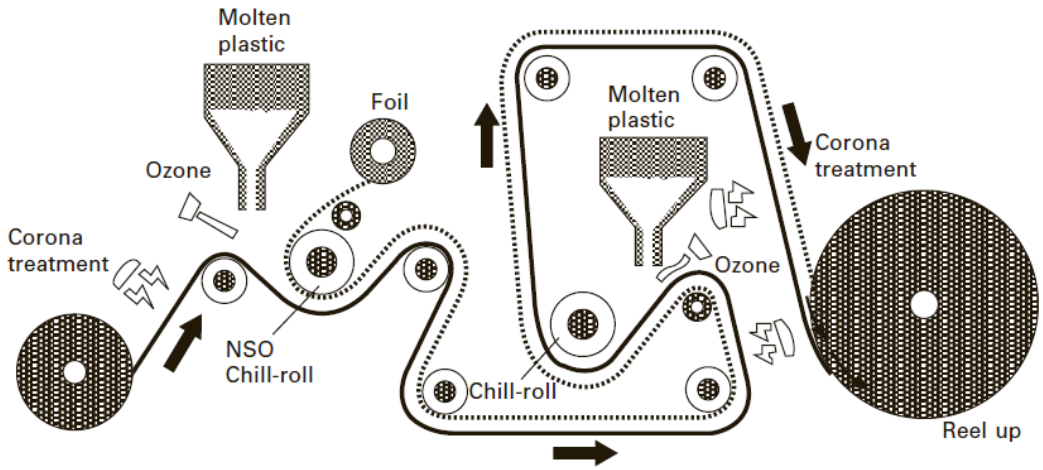


Figure 5. Extrusion coating and lamination (Riley 2012a, p. 205).

Trayforma™ PE by Stora Enso is one of the used materials in takeaway packages. For example pressed and folded non-oven trays are produced from that material. (Stora Enso Plc 2017.) Trayforma™ PE is made of solid bleached sulphate with chemo-thermomechanical pulp (CTMP) in the middle layer and a PE coating on the back side (figure 6). Chemical pulp is generally made by sulphate process. Heat and chemicals separate the cellulose fibres from the lignin and other impurities. Bleaching can be carried out at this stage if white fibres are required. Compared to other pulping processes like the mechanical pulping process, the chemical pulping process is the most expensive method to produce fibres. This is because a lower yield is achieved than in the mechanical pulping process. Additionally, the required heat energy and chemicals increase the costs. However, the strongest and whitest substrates are achieved by using the chemical pulping process with bleaching. If CTMP is used both the properties can be improved and the costs of the fibre production can be reduced as the process uses less chemicals, heat and time compared to the chemical process. (Riley 2012a, p. 191–194.)

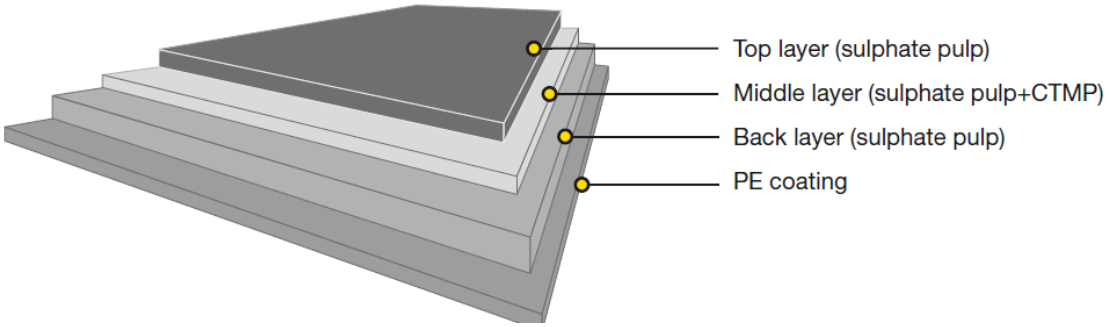


Figure 6. Trayforma™ PE by Stora Enso (Stora Enso Plc 2017).

As stated before, the properties of the paperboard are improved when combined with other materials like the PE barrier coating. However, this also means that the waste is more difficult to handle because components need to be separated at first i.e. polymer film has to be removed at or before the hydrapulper. (Riley 2012a, p. 188–205.)

Paperboard with a water-based barrier coating is claimed to be fully repulpable, which means that there is no need to separate the coating from the fibre material. Paperboard with a water-based barrier coating can be recycled the same way as the uncoated paperboard as the coated substrate does not leave any undesirable residues. (Riley 2012a, p. 188–205; Zhua, Bousfielda & Gramlicha 2019, p. 201.) Paperboard with water-based barrier coating should also break down in the environment if littered (Zhua, Bousfielda & Gramlicha 2019, p. 201). A water-based barrier coating in other words polymeric dispersion is applied on the surface of the paperboard to form a solid and non-porous film after drying. Water barrier, water vapour barrier and grease barrier are achieved with the water-based barrier coating. It is an option to the polymer film as it can provide similar protection to polymer films. (Riley 2012a, p. 188–205; Smithers Pira 2019.) Compared to the extrusion coating the water-based dispersion coatings can be applied at higher speeds (Zhua, Bousfielda & Gramlicha 2019, p. 201). Coatings are generally applied with a blade or a roll coater but also a multi-layer slot and a slide curtain coating equipment could be potentially used (Zhua, Bousfielda & Gramlicha 2019, p. 201; Smithers Pira 2019).

If the curtain coating technology is used, the coating thickness is even and the coverage is good but the surface is rougher compared to the smooth surface, which is achieved with the

blade coating technology (figure 7). There are two types of curtain coaters, a slot die and a slide die (Linnonmaa & Trefz 2009, p. 529–530). The curtain coating provides a possibility of simultaneous application of multiple coating layers (Andersson 2008, p. 25–26).

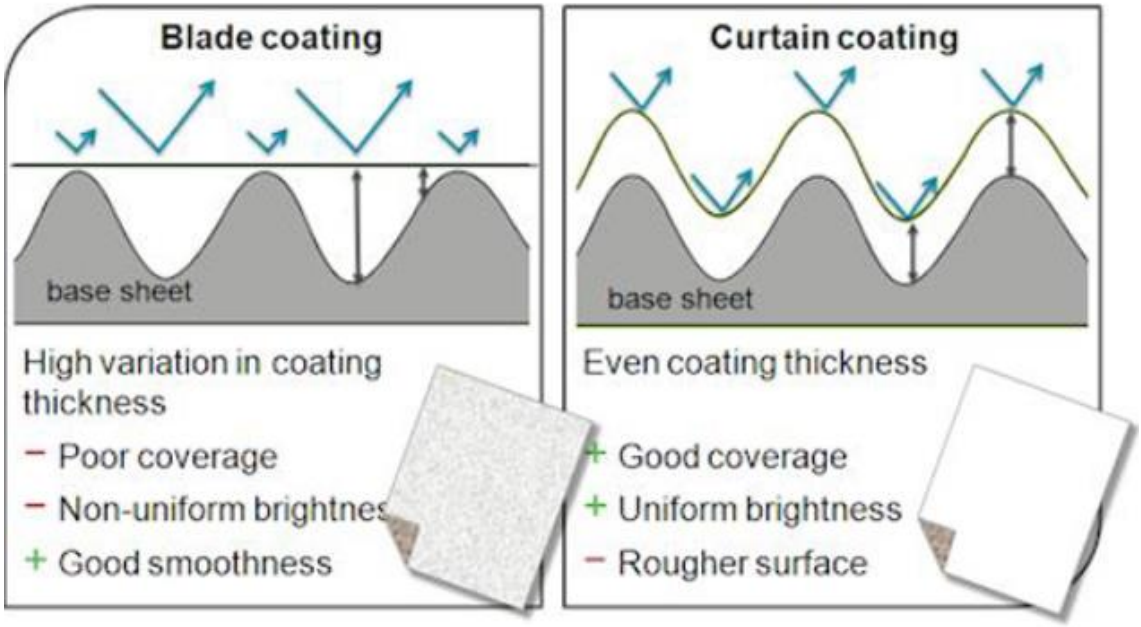


Figure 7. Blade and curtain coating layers (Valmet 2019).

For example Kotkamills Ltd is producing paperboard with water-based barrier coating by using a new curtain coating technology where water-based dispersion is applied on the paperboard. The packaging material is thereby plastic-free but also suitable for food products. With the curtain coating process multiple and homogenous coating layers can be applied. The multilayer structure is needed to achieve the required barrier properties. The thickness of coating layers can vary from thin to thick. (Kotkamills 2019.)

In addition to the curtain coating also spray coating is a commercially available non-impact coating technology for paperboard (Andersson 2008, p. 25–26). The non-impact or non-contact coating technology means that the application is contact-free and doctoring (metering) is not used. The contact-free coater reduces the risk that the web breaks, which improves the runnability. For example for this reason it is expected that the significance of the non-impact coating technologies will increase. (Kogler & Auhorn 2006 p. 377–378.)

2.4 Legislation of food contact materials

Packaging materials are called food contact materials (FCMs) if the food comes into contact with the package directly or indirectly. FCMs are regulated by the EU law (04/1935/EC). In addition to the EU regulations, packaging materials are regulated by the national legislation if there is no common EU regulation (European Commission 2019a.)

FCMs have to be safe in other words the packaging material should not affect the customer health nor have influence on the quality of the food. Business operators placing the packaging materials on the market are responsible that the materials comply with the legislation. The European Food Safety Authority (EFSA) is evaluating the safety of FCMs. (European Commission 2019a.) Both plastic and paperboard materials are defined as FCMs in the EU regulation (04/1935/EC). However, only plastic has a harmonized EU regulation from those two: the Commission Regulation (EU) No 10/2011 on plastic materials and articles intended to come into contact with food and the Commission Regulation (EC) No 282/2008 on recycled plastic materials and articles intended to come into contact with foods and the amending Regulation (EC) No 2023/2006.

In the Commission Regulation (EC) No 282/2008 specific migration limits are set out (11/10/EC). When recycled plastic is used, it is important to ensure the safety of plastic as the substances originating from the previous use may have contaminated the plastic waste. In the recycling process, the reproducible quality of recycled plastic should be guaranteed. The safety of some FCMs like the recycled PET can be achieved with closed deposit systems. It is also possible that recycled plastic is not suitable for contact with all types of food in every condition and that is the reason why a safety assessment is always needed. (08/282/EC.)

2.5 Packaging waste and recycling

The social, demographic and economic trends have led to an increasing consumption of packaging in general. For example single-packed goods are more common in the food sector nowadays. Also the use of plastic and the portion of plastic in the community waste has increased. (Eskelinen et al. 2016 p. 4–11.) Globally the plastic production has grown from

335 to 348 million tonnes between 2016 and 2017, and in Europe from 60 to 64.4 million tonnes (Plastics Europe 2018).

The waste hierarchy is the base for waste management expressed in the waste framework directive (08/98/EC). The main target is to prevent waste as shown in the figure 8. If it is not possible to prevent waste, the hierarchy order is as follows: prepare for re-use, recycling, energy recovery and disposal in other words the target of the EU is that plastic is re-used as a material or as an energy source so that it would not end up in the landfills, nature nor the oceans. (08/98/EC.)

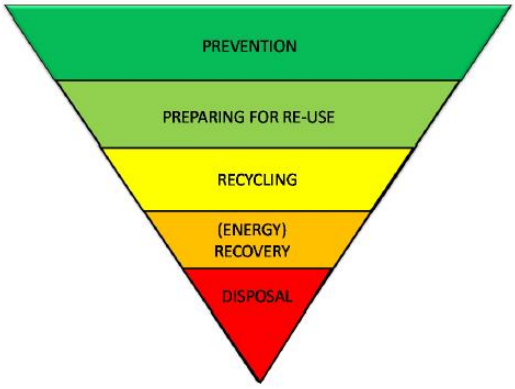


Figure 8. Waste hierarchy (08/98/EC).

Packaging has been at the central stage in the political and customer campaigns addressing environmental issues. Especially during 2018 there was a lot of discussion of marine litter in the news but also in the European Commission. (European Commission 2018; Kauppalehti 2018.) Public pressure concerning plastic waste has speeded up actions to decrease and replace plastic products. For example, many companies have published their policy regarding plastic use in the future and many packaging producers have launched new alternative solutions to plastic. (The Ministry of the Environment 2018, p. 4; Kauppalehti 2018.) Surveys show that customers are keen to recycle packages. They would also like to understand how recycling really works and prefer having plastic-free options, whenever they are the most sustainable choice available. (Milton 2019.)

According to the measurements of beach litter in the European Union (EU), 80 to 85 % of the marine litter consists of plastic. Half of the total litter amount consists of single-use plastic items. Single-use plastic products include a diverse range of common consumer products, which are typically used only once or for a short period before they are disposed. For example cotton bud sticks, straws, cutlery, plates, fast-food containers, wrap and salad boxes, beverage containers and bottles are classified as single-use plastic products. (19/904/EC; European Commission 2019b.)

To tackle the marine litter the Council of the EU adopted the measures proposed by the Commission in May 2019. For the proposal it was determined which single-use plastic products are often found on the European beaches. Based on this, ten single-use plastic products were included in the proposal as well as abandoned fishing gear and oxo-degradable plastics. The directive that aims to reduce the impact of certain plastic products on the environment, the Single-Use Plastics Directive (SUP), was published in June 2019. The Member States will have two years to implement these measures. (19/904/EC.)

Certain products are totally banned, such as plastic cotton bud sticks, cutlery, plates and straws, as well as all products made of oxo-plastic and cups and food containers made of expanded polystyrene. For plastic coffee cups and takeaway food containers, the target is to reduce the consumption. The quantity of those items will be compared in 2022 and 2026. The starting level is set in 2022. There are also other measures concerning for example the product design requirements and the extended producers' responsibility (EPR). The directive covers all plastics made from fossil, synthetic or bio-based substances. (19/904/EC.)

The SUP directive is a part of the Circular Economy Action Plan and the whole EU Plastics Strategy. The Commission presented the Circular Economy Action Plan in 2015. In addition to the strategy regarding plastics, key actions included waste reduction. The aim was also to simplify and improve definitions and harmonize calculation methods for recycling rates throughout the EU. In total there were 54 actions listed in the plan. (European Commission 2015.) In the beginning of the year 2019 the Commission reported that it had delivered or implemented all actions launched in 2015 (European Commission 2019c).

The recycling targets of packaging waste by material are shown in the table 1. There is a common EU target to reduce landfill so that it would be maximum 10 % of the municipal waste by 2035. In general, the targets are considered ambitious even though for example Finland has already reached the binding landfill target. (Euroopan parlamentti 2018.) In Finland, the recycling rate of fibre-based packages was 116 % and plastic packages 27 % in 2017 (Rinki Ltd 2019).

Table 1. Recycling targets of packaging waste by material (Euroopan parlamentti 2018).

	by the year 2025	by the year 2030
All packaging waste	65%	70%
Plastic	50%	55%
Wood	25%	30%
Iron	70%	80%
Aluminium	50%	60%
Glass	70%	75%
Paper and paperboard	75%	85%

The Finnish companies packing products or importing packaged products are obliged to recycle packages, if they have a turnover of at least one million euros. The practice is called producer responsibility. Companies can sign a contract with Rinki Ltd so that the legal obligation concerning packaging is then transferred to the producer organisation. The Finnish industry and retail trade own Rinki Ltd. (Rinki Ltd 2019.)

In the beginning of year 2016 Rinki opened eco take-back points to collect household packaging waste. The business and industry are together responsible for the collection points. Citizens can bring glass, paperboard and metal packages to the collection points. More collection points are arising and they accept plastic packages too. Based on the information available on the Rinki webpage there are over 500 take-back points for plastic packages for now. (Rinki Ltd 2019.)

Plastic waste handling and its change in Finland is visible in the figure 9. The amount of landfill waste has decreased (-63 %) during the years while the use of plastic as an energy source has increased 55 % from 2006 to 2014, for example due to new waste-to-energy

plants. Besides, Ekokem has built a Circular Economy Village in Riihimäki where Finland's first Plastic Refinery and Bio Refinery is located. (Järvinen 2016, p. 25–55.)

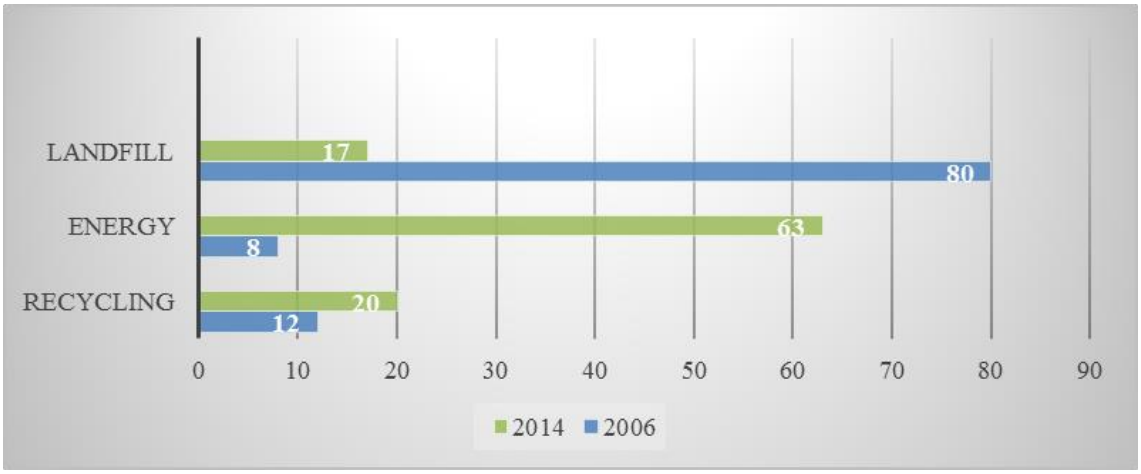


Figure 9. Handling of the plastic waste (%) in the year 2006 and 2014 in Finland (Järvinen 2016, p. 25).

The Circular Economy Village treats about 100,000 tonnes of municipal waste each year. Different waste streams are separated from the municipal waste; the amount of plastic is 4 %. In addition to the plastic derived from the municipal waste, the Circular Economy Village also treats plastic packages collected from the households and plastic originating from companies, retail businesses and agriculture. Plastic is separated, crushed, washed and granulated in the refinery as shown in the figure 10. The granules are used in the plastic industry as a raw material and it can replace virgin raw material. The energy needed for the recycled raw material is about 15 % from the energy required for the virgin plastic. (Ekokem 2017.)

To enhance the use of recycled plastic, mono-materials should be preferred in the production of plastic packages. Furthermore, the use of additives is to be considered. (Eskelinen et al. 2016, p. 4–40.) To get more information which kind of packages can be recycled, the Finnish Plastics Recycling Ltd (2018) has made a guidebook with the topic how to develop recyclable plastic packages. If the quality of the recycled plastic is good enough, the raw material of the recycled plastic is pure and homogeneous, its use can be increased. This also means that it can be used instead of virgin plastic. (Eskelinen et al. 2016, p. 4–40.) However,

Eskelinen et al. (2016, p. 4–40) estimated that the use of recycled plastic will not highly increase in food package solutions as mentioned earlier in the literature review.

Figure 10. Circular Economy Village (Ekokem 2017).

In Finland, the waste legislation is mainly based on the EU legislation. However, Finland has some stricter standards and limits than those applied in the EU. In addition, some voluntary actions have been made to support the circular economy. One example is the Plastics Roadmap, which was published in 2018. The Plastics Roadmap points out the steps towards sustainable plastic economy: reduce and refuse, recycle and replace. It has 10 key actions and several measures including actions whose target is to replace plastic with alternative solutions, to advice customers about the waste management and to introduce recycling solutions for recovered plastic. (The Ministry of the Environment 2018.) All 10 key actions are shown in the figure 11. The implementation has already started but some measures require a longer time to be realized (The Ministry of the Environment 2018).

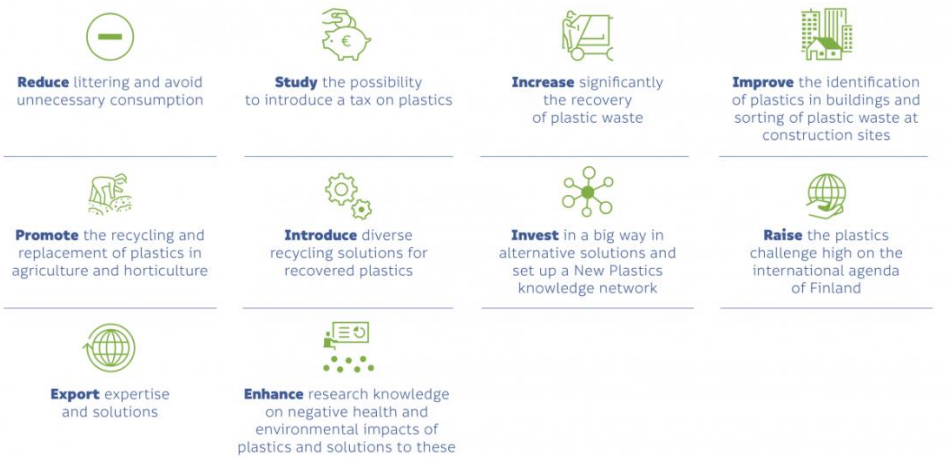


Figure 11. Measurements of the Plastics Roadmap (The Ministry of the Environment 2018).

The food industry, trade, the packaging sector and three ministries made Finland's first materials efficiency commitment in early 2019. The three ministries involved are the Ministry of Economic Affairs and Employment, the Ministry of Agriculture and Forestry and the Ministry of Environment. The aim of the commitment is to reduce the environmental impacts of food production, distribution and consumption in 2019–2021. Environmental impacts can be reduced by avoiding food loss, promoting more environmentally friendly packaging and increasing the recycling of food waste and materials. (Materiaalitehokkuuden sitoumus 2018.)

3 RESEARCH METHODS

In this chapter the research methods used in this thesis are presented. Chosen and tested takeaway packages are also introduced.

3.1 Used research methods

Different questionnaires were used to collect the data. Questionnaires contained structured, open and mixed questions. The main target was to find out what customers and employees think about chosen takeaway packages. The second target was to get information about customers' opinions regarding takeaway packages in general. Questionnaires were made within the thesis and practical test was arranged in the stores. Questions are presented with the results in the chapter four.

3.2 Ässäraati (S-Group panel)

Ässäraati (S-Gourp panel) consist of co-op members and/or their family members. Participation to S-Group panel is working on voluntary basis. However, volunteers have ability to affect to S-Group' decisions by participating in panels. Panel members are using S-Group services more than average customers.

Totally 8000 members were chosen by random from those S-Group panel members who had told that they are interested in Prisma and/or S-market stores. This limitation was made because takeaway counters are located in Prisma and S-market stores. All chosen members were of legal age (18 years old) and their native language was Finnish. Delimit term for the questionnaire was that person is using takeaway counters at least few times per year. Web questionnaire was sent by email and data was collected during April 2019.

Results are expressed by power point graphics and cross tabulation. Most of the answers of open questions are listed. Besides of tested packages, questionnaire included questions about current packages, some general questions related to takeaway packages and use of takeaway counters. S-Group panel members were not able to test the packages, they only saw the pictures.

3.3 Practical test and measurement arrangements

Two different fibre-based takeaway packages were tested at takeaway counters at grocery stores. Test package 1 was tested in four grocery stores and test package 2 was tested in three grocery stores. All stores were S-markets. 2000 containers, 1000 of each, were delivered to the stores in the beginning of April 2019. The test period lasted four weeks. Approximately the same amount of both containers was used during the testing period. Some of the stores used both packages side by side and some started with one package and moved then to the other package. Besides of test packages, customers had possibility to choose plastic package which was currently in use at the store, the customers were asked if they would like to try the test package. Some examples of plastic packages in use are shown in figure 12. Plastic packages which were in use at the stores may vary store by store because stores are able to decide themselves which kind of package they use. Test packages were mostly used for cold salads, but it was possible to use package for any food sold cold or at room temperature. Besides salads, for example minced meat steaks or mashed potatoes were packed into test packages.

Figure 12. Examples of plastic takeaway packages which were currently in use at the stores.

Test package 1 was folded fibre-based takeaway package with water-based dispersion barrier (figure 13). Because water-based dispersion barrier was used, package was considered as non-plastic. Packaging material was produced by Kotkamills Ltd and converted by Pyroll Group Ltd. Volume of package 1 was 750 ml. Package was suitable only for cold food that is food which was at fridge temperature or food which was served at room temperature. Package was not suitable for microwave oven. Test package 1 is called *folded test package* onwards.

Figure 13. Test package 1 (folded test package).

Test package 2 was round fibre-based takeaway container with plastic lid (figure 14). There was also thin PE-plastic barrier layer on the container. Packaging material of container was produced by Stora Enso Plc and converted by Huhtamäki Plc. Container with two different printing was used because of availability of the containers. Black colored printing was used in Ässäraati questionnaire (figure 13a). Salad printing was used in practical test (figure 13b). In theory, PE layer could have been made from non-oil alternatives(green-PE). However, green-PE coating was not used in tested containers. Volume of test package 2 was 775 ml. Package was suitable for cold food or food which was served at room temperature. Container could have been used also for warm food (+60 – +120 °C), but it was not suitable for microwave oven. Test package 2 is called *round test package* onwards.

Figure 14. Test package 2 with two different printing. Printing a was used in Ässäraati and printing b was used in practical test.

There would have been a possibility to use PEFC™ or FSC® certified wood as raw material of tested packages, if it had been agreed beforehand. Certified wood is not automatically used in the packages in general.

Before practical test, it was also investigated if it would have been possible to test fibre-based container with fibre-based lid. Microwavable and oven-baked pots like showed in figure 15 are used for ice cream and noodles, as plastic barrier is capable to withstand temperatures from –40 °C to + 200 °C. Because it was not possible to get this kind of package for practical reasons, package was not tested in the stores.

Figure 15. Microwaveable and oven-baked pot by SP Containers (SP Containers 2019).

3.3.1 Customer and store questionnaires

There were QR-code on the tested packages so that customers were able to give feedback about test packages. QR code and questionnaire was created by Microsoft forms software in Finnish. Base of the questionnaire was questionnaire used in Ässäraati as it was created first. Respondents had possibility to win S Group's gift card. Questionnaire data was analysed in excel. Besides of that employees in the stores collected open comments from the customers on to the paper during test period. Date of the comment, number of the test package (1 or 2) and the comments were documented.

Questionnaire was used also for data collection from the employees of the stores. Like customer questionnaire also questionnaire for the stores was created by Microsoft forms software in Finnish. Link for web questionnaire was sent to the stores by email.

3.4 Other measurement arrangements

Recycling fees and cost of test packages were compared to rPET package. Compared to other plastic packages rPET package is seen little bit more sustainable solution as recycled plastic is used instead of virgin plastic. Both waste hierarchy and SUP directive drive to re-using material even though the main target is to prevent the waste (08/98/EC; 19/904/EC).

Weight of the containers were measured with scales available in the food stores. Same kind of scales are used for takeaway food, fruit and vegetables. Accuracy of the scale was 0,001 kg.

4 RESULTS

In this chapter the results of Ässäraati and practical test are expressed. Besides of that recycling fees and cost of the test packages are presented. Most of the figures and tables are in Finnish as also questionnaires were in Finnish but translated in necessary level.

4.1 Results of Ässäraati (S-Group panel) questionnaire

Total response rate of Ässäraati was 47 % (N=3742). There were 1723 respondents (46 % from all the respondents) who use takeaway counters at least few times per month and buy food which is sold cold at least few times per year. Questions regarding the takeaway packages were asked from those 1723 respondents (N=1723).

4.1.1 General features of package and use of takeaway packages

The first part of the questionnaire surveyed the customers' insight of the importance of different features of the packages. Results are shown in figure 16. Based on the results, the most important feature of a package was tightness of package. Four main features of package were:

1) tight package (very important 82 %, quite important 16 %)
2) package is easy to take with (very important 50 %, quite important 44 %)
3) package is easy to open (very important 50 %, quite important 41 %)
4) package is free of charge (very important 57 %, quite important 32 %)

48 % of the respondents thought it is very important that package is environmentally friendly and 37 % thought it is quite important. 25 % of the respondents thought it is very important to see inside the packaging after food is packed and 41 % thought it is quite important. Only 19 % of the respondents thought it is important or quite important that package looks good/stylish while 38 % thought it is not important.

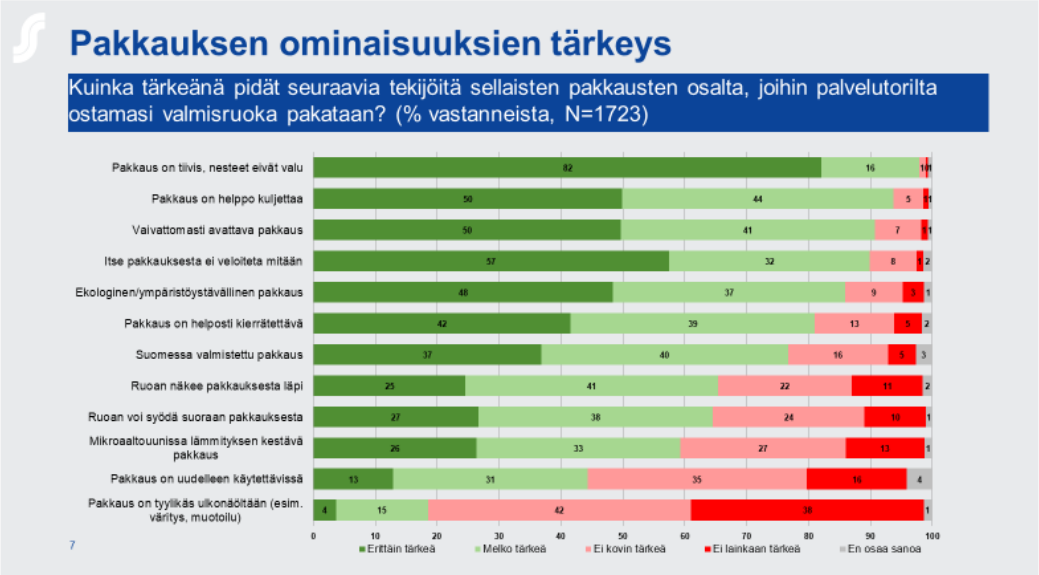


Figure 16. Importance of features of package (x % of the respondents, N=1723, from left to right: green = very important, light green = quite important, pink = not so important, red = not important, grey = I don't know).

More than half (57 %) of the respondents often keep the takeaway food in the takeaway package in the refrigerator before they eat it. Almost half (47 %) mainly/often eat the takeaway food from the plate when 22 % from respondents eat it directly from the takeaway package. (Figure 17.)

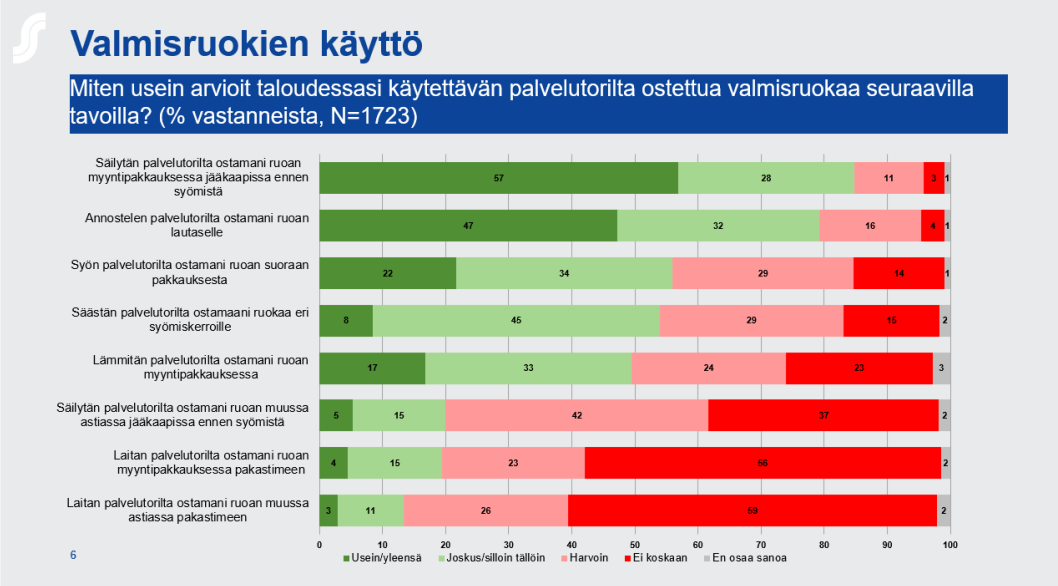


Figure 17. Use of takeaway food (x % of the respondents, N=1723, from left to right: green = often/mainly, light green = sometimes, pink = rarely, red = never, grey = I don't know).

For 62 % of the respondents it would be positive change and for 11 % it would be negative change if paperboard packages replaced plastic packages. Rest of the respondents do not see it positive nor negative change. (Figure 18.)

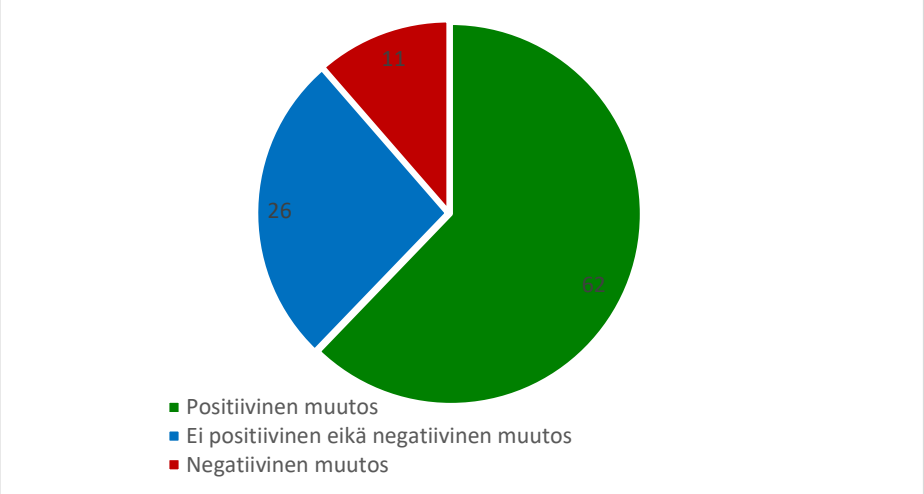


Figure 18. If paperboard packages replace plastic packages, will it be positive or negative change? (N=1723, top to bottom: green = positive [62 %], blue = nor positive nor negative [26%], red = negative [11 %]).

If the price of plastic package and paperboard package was the same, 62 % of the respondents would choose paperboard package. If the plastic package was cheaper, 63 % would choose it. If the paperboard package was cheaper, 77 % of the respondents would choose it. (Figure 19.)

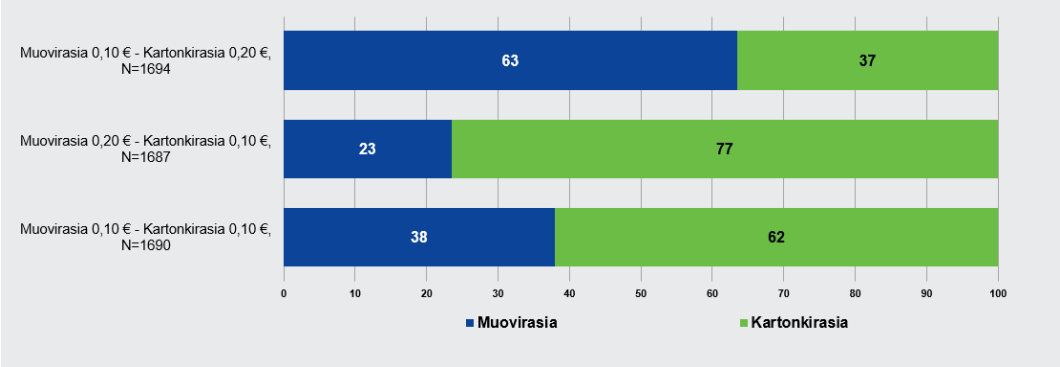


Figure 19. Would you choose plastic package or paperboard package if the plastic package was cheaper (first column from the above), if the paperboard package was cheaper (second

column from the above), if the price was same (third column from the above). (N=1723, from left to right: blue = plastic package, green = paperboard package.)

4.1.2 Features of packages

The second part of the questionnaire consisted of evaluating questions about package features. The respondents were also asked to choose one of the packages they would like to use in the future. Results are shown below.

Three main features of folded test package were easy to recycle (64 %), ecological (60 %) and easy to open (60%) according respondents. Below 10 % thought that food remained good in the package (9 %), package was tight (4 %) or the package was reusable (4 %). (Figure 20.)

Figure 20. Features of folded test package (x % of the respondents, N=1722).

Three main features of folded test package without printing (plain white) were easy to recycle (66 %), ecological (64 %) and easy to open (57 %) according respondents. Below 10 % thought that package was long-lasting/strong enough (8 %), food remained good in the package (7 %), package looked stylish (6 %), quality of package was good (5 %), the package was reusable (4 %) and it was tight (4 %). (Figure 21.)

Figure 21. Features of folded test package without printing (x % of the respondents, N=1722).

The main feature of round test package was easy to open (69 %). Other main features were suitable for takeaway food (43 %), practical (39 %), easy to carry with (37 %) and easy to recycle (36 %). 17 % of the respondents thought that round test package was ecological. (Figure 22.)

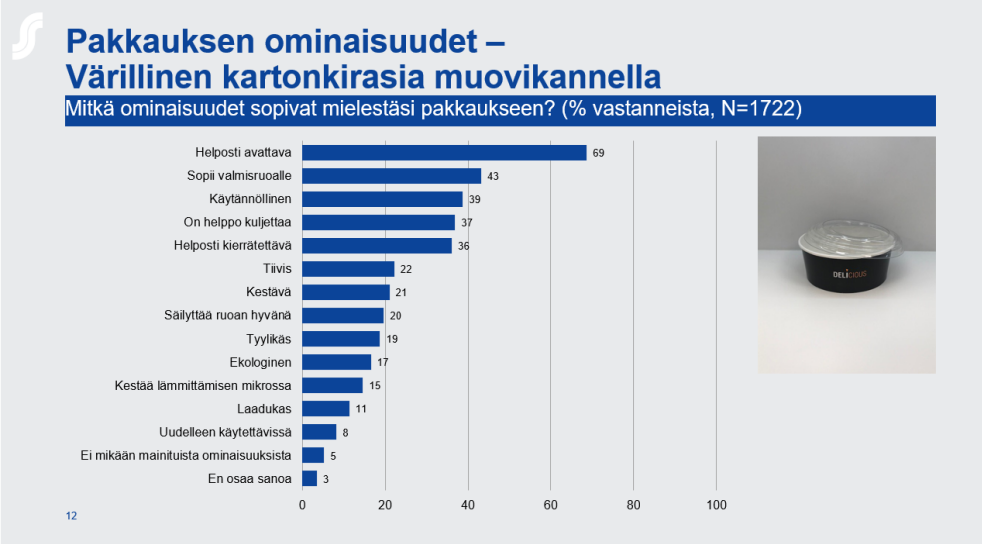


Figure 22. Features of round test package (x % of the respondents, N=1722).

The main feature of plastic package used in the stores was easy to open (55 %). Next three main features were suitable for takeaway food (45 %), easy to carry with (43 %) and tight

(37 %). Below 10 % thought that quality of package was good (8 %), package looked stylish (5 %) and it was ecological (5 %). (Figure 23.)

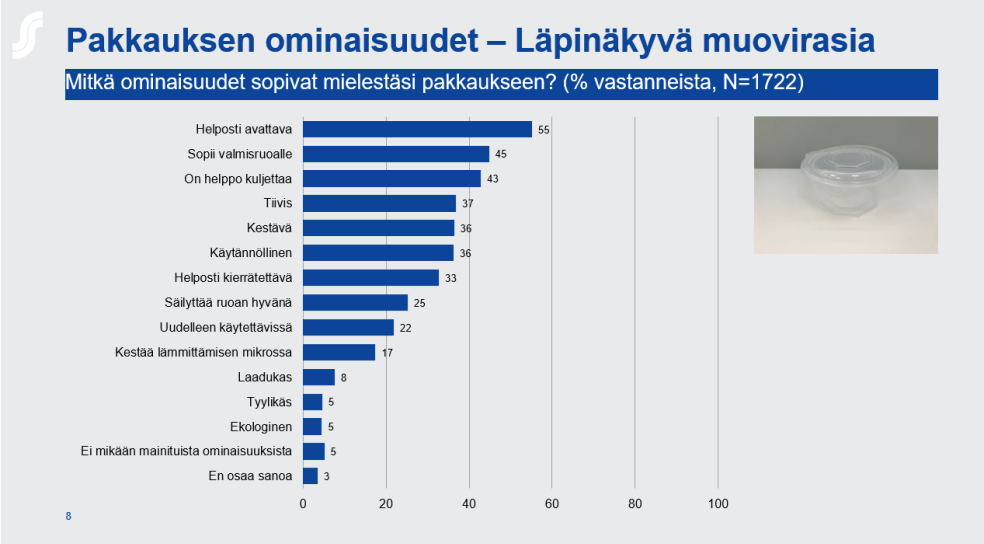


Figure 23. Features of plastic package which was currently in use (x % of the respondents, N=1722).

Two main features of brown paperboard package were ecological (77 %) and easy to recycle (69 %). Below 10 % thought that package looked stylish (8 %), food remained good in the package (8 %), quality of package was good (7 %), the package was reusable (7 %) and it was tight (5 %). (Figure 24.)

Figure 24. Features of brown paperboard package (x % of the respondents, N=1722).

Three main features of black plastic package were long-lasting/strong (54 %), suitable for takeaway food (51 %) and microwavable (49 %). Below 10 % thought that quality of package was good (8 %), it was ecological (4 %) and it looked stylish (3 %). (Figure 25.)

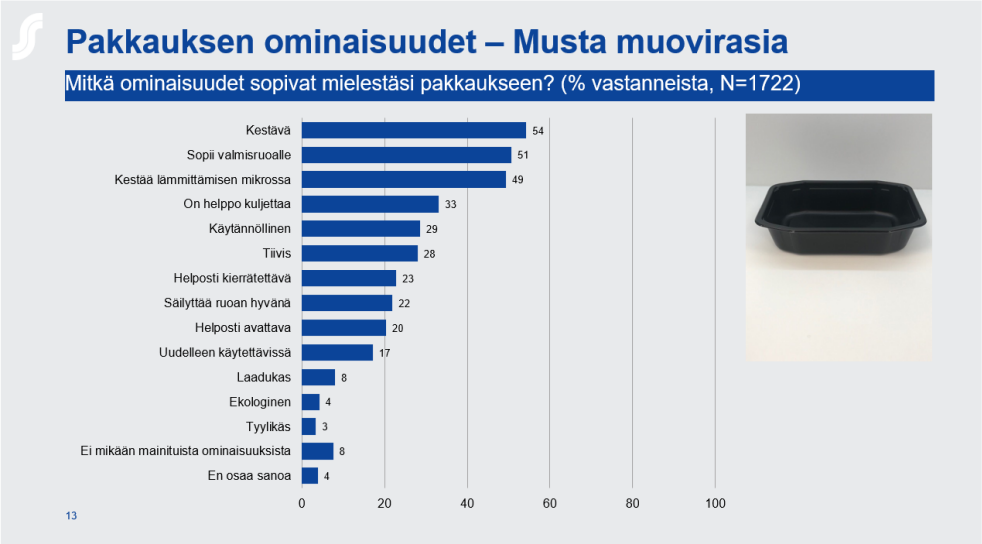
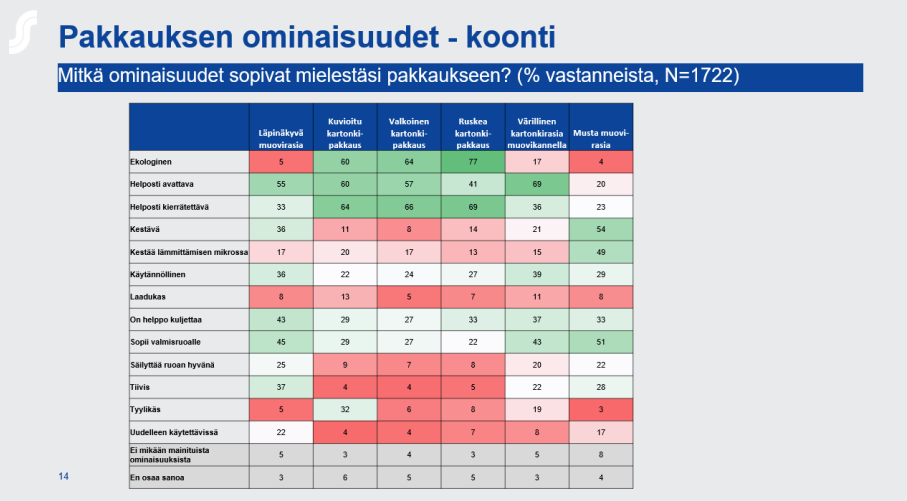


Figure 25. Features of black plastic package (x % of the respondents, N=1722).

All packages and features were collected to the same table. The higher the percentage was the more respondents thought that feature fits to the package. Color indication of cell is light green if the percentage is over 30 % and dark green if the percentage is over 70 %. Red color meant that 20 % or below 20 % of respondents thought that feature fits to the package. Printed paperboard package (folded test package), unprinted (white) paperboard package and brown paperboard package had quite similar color indication in the table 2. However, it was possible to see that respondents thought that printed paperboard package (folded test package) looked good (stylish), which was not seen with unprinted (white) paperboard package nor brown paperboard package (Table 2). There was quite similar color indication also with plastic package and printed paperboard package with plastic lid (round test package) in the table 2.

Table 2. Summary of features of the packages. (x % of the respondents, N=1722; from left to right: plastic package, printed paperboard package (folded test package), un-printed (white) paperboard package, brown paperboard package, printed paperboard package with plastic lid (round test package), black plastic package; from up to down: ecological, easy to open, easy to recycle, long-lasting/strong, microwavable, practical, quality of package is good, easy to carry with, suitable for takeaway food, food will remain good in the package, tight, looks good/stylish, able to use again).



Pakkauksen ominaisuudet - koonti

Mitkä ominaisuudet sopivat mielestäsi pakkaukseen? (% vastanneista, N=1722)

	Läpinäkyvä muovirasia	Kuvioitu kartonki-pakkaus	Valkoinen kartonki-pakkaus	Ruskea kartonki-pakkaus	Värillinen kartonkirasia muovikannella	Musta muovi-rasia
Ekologinen	5	60	64	77	17	4
Helposti avattava	55	60	57	41	69	20
Helposti kierrätettävä	33	64	66	69	36	23
Kestävä	36	11	8	14	21	54
Kestää lämmittämisen mikrossa	17	20	17	13	15	49
Käytännöllinen	36	22	24	27	39	29
Laadukas	8	13	5	7	11	8
On helppo kuljettaa	43	29	27	33	37	33
Sopii valmisruoalle	45	29	27	22	43	51
Säilyttää ruoan hyvänä	25	9	7	8	20	22
Tiivis	37	4	4	5	22	28
Tyylikäs	5	32	6	8	19	3
Uudelleen käytettävissä	22	4	4	7	8	17
Ei mikään mainituista ominaisuuksista	5	3	4	3	5	8
En osaa sanoa	3	6	5	5	3	4

14

The respondents were asked which one of the packages they would choose from the evaluated packages. 25 % of the respondents chose printed paperboard package with plastic lid (round test package), 23 % chose plastic package, 16 % chose brown paperboard package, 14 % chose black plastic package, 13 % chose printed paperboard package (folded test package) and 9 % chose unprinted (white) paperboard package which was folded test package without printing. (Figure 26).

Figure 26. Selection of preferred package (x % of the respondents, N=1722).

4.1.3 Ecological packages

The third part of the questionnaire surveyed the customers' insight of the ecological packages. Most of the respondents totally or mainly agreed that ecological package was easy to open, the quality of food remained same as in the plastic package and it was possible to carry ecological package in the bag without damages. 7 % of the respondents totally agreed that ecological paperboard package kept the liquids inside the package in other words package was tight. 5 % of the respondents totally agreed and 14 % mainly agreed that it was possible that ecological paperboard package caused off-flavors to food. (Figure 27.)

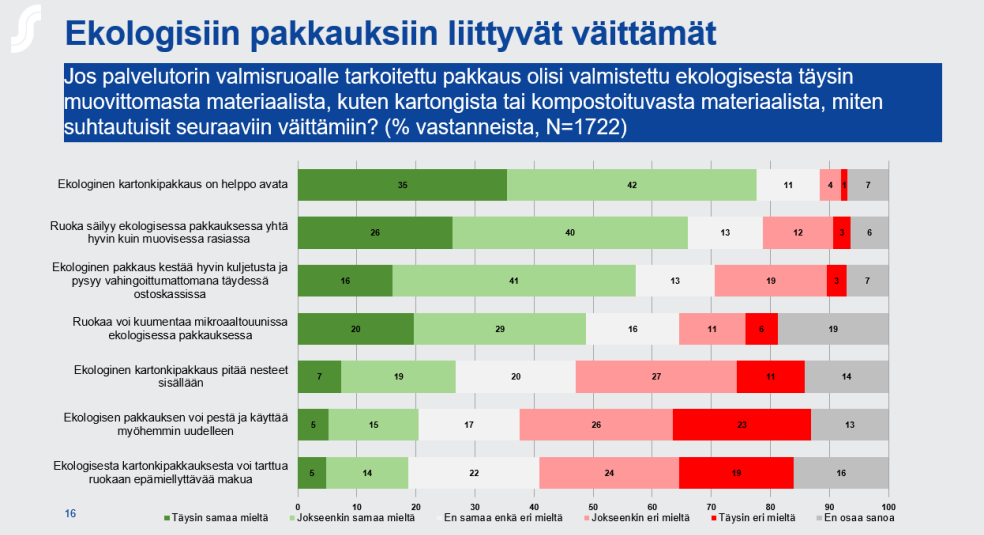


Figure 27. Opinion about claims which regarded to ecological packages (x % of the respondents, N=1722, from left to right: green = totally agree, light green = mainly agree, white = not agree/not disagree, pink = rather disagree, red = totally disagree, grey = I don't know).

4.1.4 Open comments of Ässäraati

There were given totally 494 open comments in Finnish (results not showed). Based on the open comments, 26 % of the open comments concerned tightness of the package; respondent doubted tightness of the paperboard package or highlighted that tightness of the package was very important. 21 % of the respondents commented that it would good if it was possible to use own package or if it was possible to have deposit-based return system for salad containers.

4.2 Tested packages from the viewpoint of customers

Totally eight answers were given from test packages via QR-code. QR-code was on the test package which customers got from the store when they bought takeaway food. Two answers were given from folded test package and six answers were given from round test package. Half or more than half of the respondents thought that very important features of takeaway packages are following ones: tight package, easy to carry with, ecological and/or environmentally friendly and easy to recycle. (Figure 28.)

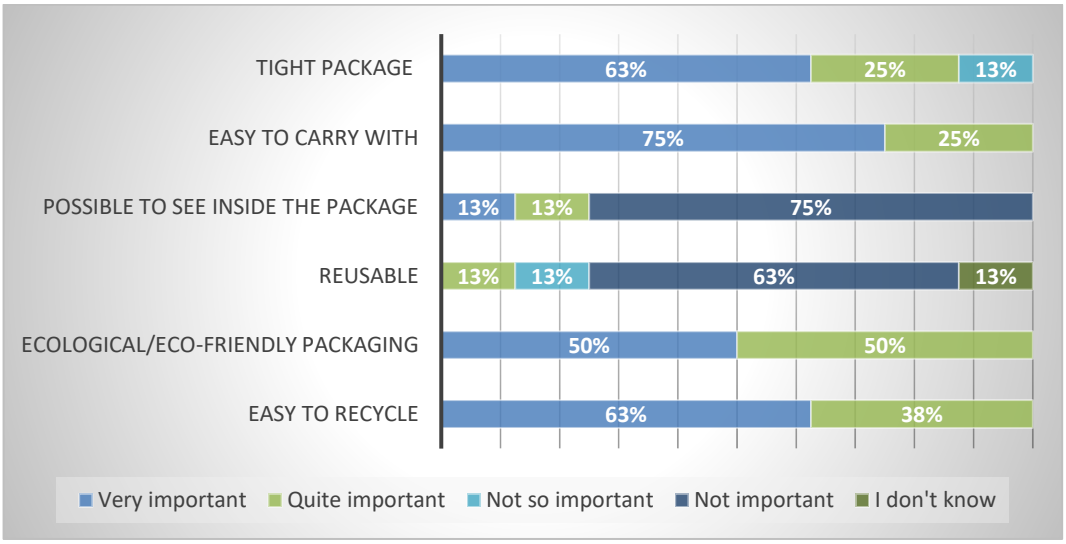


Figure 28. Importance of features of packages (x % of the respondents, N=8).

The respondents were asked how many points from 1 to 5 they would give to tested packages. Average of the results for folded and round test packages are shown in the table 3. The higher the points were the better the package was considered to be. Besides of average points, arguments are shown in the same table 3. All the respondents (N=8) would use tested packages also in the future.

Table 3. Average points (minimum 1, maximum 5) which were given to test package 1 (folded test package) and 2 (round test package). The higher the points were the better the package was considered to be (N=8)

Test package	Average points	Open comments
1 (folded)	4,5	It was able to recycle as it was paperboard packaging
2 (round)	5	Good that container is made of paperboard however plastic lid could be made also paperboard; There is risk that lid is not tight enough; Shape of the container is nice however square/rectangle form would be more practical in the bag; Good package

Open comments given by customers are showed in the appendix I and II. Besides of comment, it was marked if comment was positive or negative. Totally 16 comments were given from folded test package by customers (appendix I). Half of the comments were

positive and half were negative. Negative comments were related for example to the tightness of package and possible leakage of package. Positive comments were related for example to outlook of package and possibility to have paperboard package instead of plastic package. Totally 15 comments were given from round test package by customers (appendix II). 67 % of the comments were positive and 33 % were negative. Negative feedback was given because it was seen that wholly plastic package is better than round test package because plastic package was seen for example tighter than round test package. Positive comments were related for example to outlook and form of package and possibility to have paperboard package instead of plastic package.

4.3 Tested packages from the viewpoint of stores

Totally 11 answers were given by four stores where packages were tested. Three main features of the packages were easy handling of package, easy to dose the food in the package and easy closing of package from the viewpoint of stores (figure 29).

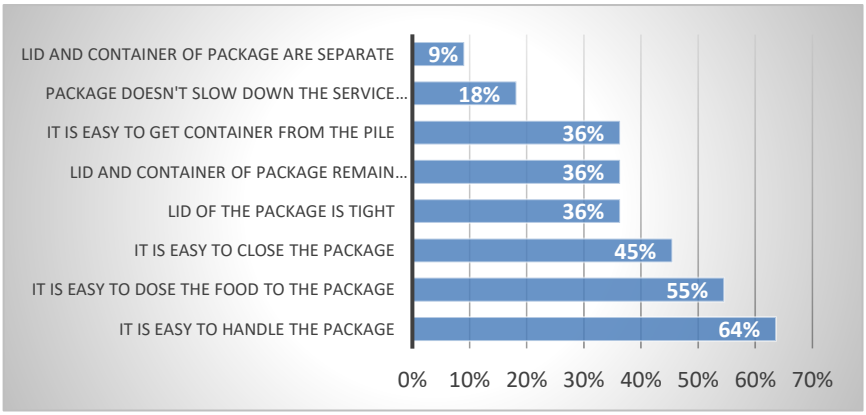


Figure 29. The most important features of the packages from the viewpoint of stores (x % of the respondents, N = 11).

Employees were asked which features are suitable for folded and round test package. Results are shown in figure 30. Respondents had possibility to choose one or more opinions. Round test package was more practical and more suitable for takeaway food sold cold compared to folded test package. It was easier to handle the round test package and dose the food to the round container than to the folded test package. Employees saw more often that folded test package did not slow down service time compared to round test package. Folded test package

was little bit easier to get from the pile, easier to close and tighter than round test package. Based on the open comments (results not shown) tightness referred to closing system, more attention was needed to check that plastic lid is properly closed.

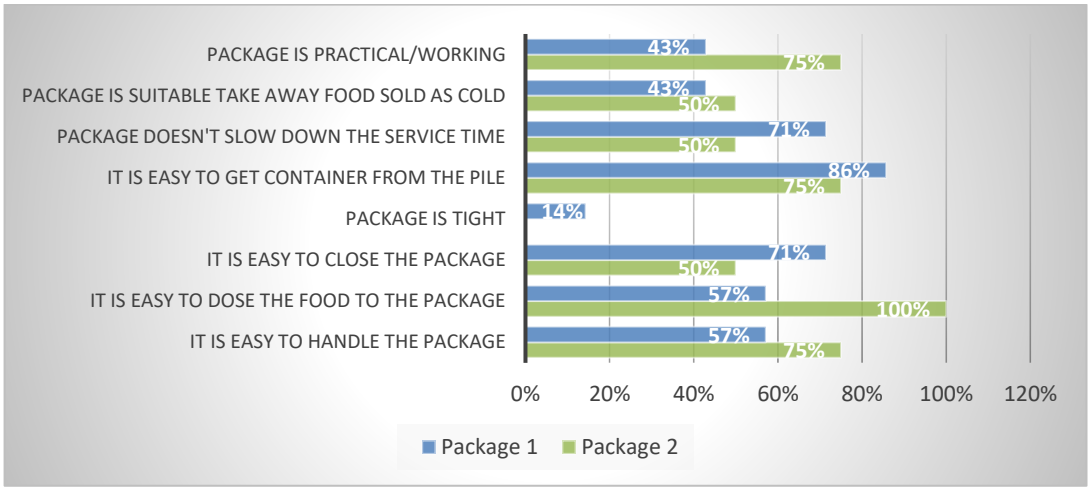


Figure 30. Which features are suitable for test package 1 (folded) and 2 (round) (x % of the respondents who thought that feature was suitable for package, N = 11).

According results 71 % of the respondents would gladly use folded test package also in the future. All of the respondents (100 %) would gladly use round test package also in the future.

There were asked positive and negative features of the test packages. Results are shown in figure 32 and 33. Positive features of folded test package were material and outlook. Material meant it was recyclable and made of paperboard. Outlook, size and form of the package were positive features of round test package. (Figure 32.)

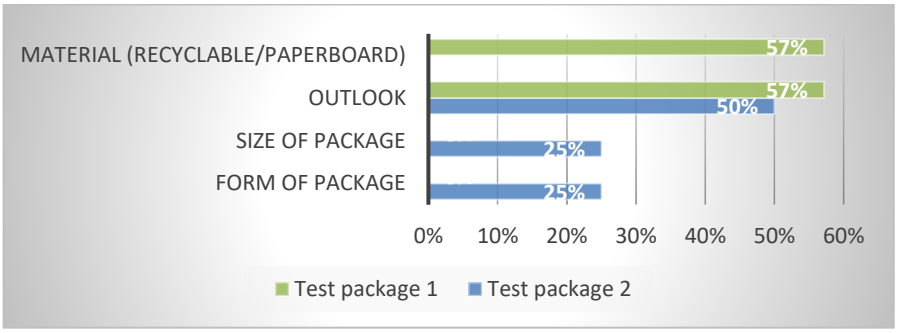


Figure 31. Positive features of test package 1 (folded) and 2 (round) (x % of the respondents who thought that feature was positive, N = 11).

Over 50 % of the respondents (totally 71 %) thought that lid of the package was not tight enough in the folded test package. Half of the respondents thought that plastic lid and difficultness to use lid was negative feature of the round test package. (Figure 33.)

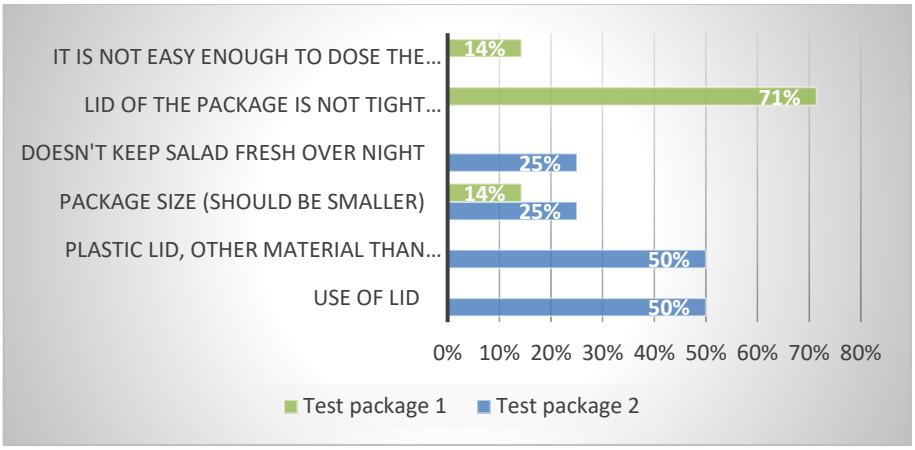


Figure 32. Negative features of test package 1 (folded) and 2 (round) (x % of the respondents who thought that feature was negative, N = 11).

4.4 Recycling fees and cost of containers

Recycling fees (€/ton) for different packaging materials in 2019 are shown in the appendix III. Fees are determined by producer organization in the packaging sector. (Rinki Ltd 2019.)

Equation used to calculate recycling fee for one container is shown below:

$$\frac{\left(recycling\ fee\left(\frac{€}{1000}kg\right)*m\ (kg)\right)}{1000} = recycling\ fee\ (€)\ per\ container \qquad (1)$$

In equation 1, m is mass of container including lid if separate lid is used. Mass of container is shown in table 4. Recycling fee was calculated for the tested packages and current rPET takeaway package which was shown in figure 2. Calculated recycling fees in euros per container are shown in table 4.

Table 4. Mass, volume and recycling fee of test packages and rPET package.

Package	Mass (m)	Recycling fee (€) per container
Test package 1, folded (750 ml)	0,022 kg	0,001034
Test package 2, round (775 ml)	0,026 kg	0,001222
rPET package (750 ml)	0,038 kg	0,00114

Sourcing cost of rPET package, folded test package and round test package were proportioned to 100 %. Share of rPET package was about 18 %, folded test package 50 % and round test package 36 %. This meant that cost of folded test package was almost three times higher than rPET package and cost of round test package was two times higher compared to rPET package which means that sourcing cost of folded test package was higher than cost of round test package. However, it should be noticed that these were only directional costs as there are always variables which will affect the sourcing cost. In addition of showed costs (recycling fee and cost of package) there are other costs like delivery cost, which will affect the final costs. The final costs of packages were not calculated because of uncertainties.

5 DISCUSSION AND ANALYSIS

This chapter presents key findings from the results and other observations noticed during the test. In addition reliability and validity as well as topics and observations for future research are discussed shortly.

5.1 Key findings of the results and other observations

It was noticed that there were available only few potential options which could be considered as plastic free and fibre-based option. There was plastic lid or at least plastic coating on the many fibre-based package. Target for SUP directive is to decrease the amount of single use plastics like takeaway packages (19/904/EC). Before national interpretation of SUP directive is ready it is likely that paperboard package with plastic barrier could be an alternative and fulfill the target of SUP directive because the main raw material of package is paperboard. However, there is still demand to find plastic free options as global packaging trends drives to find those solutions (Mistel 2019). It is also willingness from the viewpoint of company's strategy.

According to the results customers see the replacement of plastic package into paperboard as positive change (figure 18). Totally 63 % of the respondents chose fibre-based package when six options were showed (figure 26). This is almost same amount as showed in figure 19: 62 % of the respondents chose fibre-based package if plastic and fibre-based packages were available in same price. As there has been lot of discussion of negative sides of plastic packages, presumption was that customers like to have options to plastic packages. However, respondents were not willing to pay extra from fibre-based package or more ecological options. Assumable customers expect that package is already calculated the final cost of product. Percentage of respondents who would have chosen plastic package if they had been possibility to choose between plastic and paperboard package is still remarkable as almost 40 % would have chosen plastic package (figure 19).

When the respondents were asked which one of the packages they would choose from the six evaluated packages, they chose round test package most often (25 % of the respondents).

However almost same quantity of respondents (23 %) chose plastic package. (Figure 26.) It is also good to notice that customers were able to choose printed or non-printed folded test package. This means that totally 22 % of the respondents chose folded test package if portions of printed and non-printed packages are summarized. Summed portion is close to portion of round test package and plastic package. Generally, it is not possible to say if the portion would have been as high if there had been only one folded option. Percentage of printed version alone was 13 % and non-printed version only 9 %. All in all, it is little bit unsure to say clear top choice of respondents as differences were so small. Results probably reflect attitudes of respondents, they see fibre-based package as an interesting option but still plastic package is more familiar and practical, and for this reason they chose it more often than fibre-based package. Almost half of the respondents thought that plastic package suits well for takeaway food when below third of respondents (about 30 %) thought that folded test package suits well for takeaway food (figure 20 and 23).

Even though there were not clear top choice, the reason why round test package or plastic package was chosen rather than brown fibre-based package or folded test package may be tightness of package besides of familiarity. Tightness was clearly seen the most important feature of the package (figure 16). Lack of the good tightness properties were mentioned also in other results, for example in open comments given by customers (appendix I and II). Respondents mentioned lack of the good tightness properties more often with folded test package than with round test package (appendix I and II). Closing system of folded test package and brown fibre-based package was totally different compared to round test package or plastic package. It is true that closing system of folded fibre-based package is not as tight as it is in plastic packages or if separate lid is used. Assumable the tightness of package refers to closing system. As the protection is often regarded as the primary function of the package in the literature it is not surprise that respondents saw tightness the most important feature of the package, even though this study regarded takeaway packages not packages of pre-packed food. Generally takeaway packages are not as tight as packages of pre-packed food which need to withstand conditions of storage and transport. Robertson (2012a, p. 2–3) says that package should protect its contents from environmental influences. Thereby package should protect also the other way around. Because respondents mentioned in the open comments that package may leakage in the shopping bag or backpack if package does not

remain straightforward, it strengthen the assumption that tightness of package referred to closing system not to leakage of the seams of the package. At least it is likely that customers and stores would have reported if seams had been leaked. Besides of that, producer has tested the package which means that package should be workable and seams should be strong enough. However, seams of the folded packages can be weak parts of the package as folding usually leads to decreased barrier performance of the coating. Besides of that barrier properties of dispersion coated packages after folding has not been well reported in the literature. Therefore it is unsure how coating method affects barrier properties after folding. (Zhua, Bousfielda & Gramlicha 2019, p. 201–202.)

Although 38 % of the respondents thought it is not important that package looks stylish, outlook of package is not indifferent. Customers chose printed paperboard package (folded test package) more often than non-printed white paperboard package (figure 26). They also saw that quality of printed package was better compared to blank package (figure 20 and 21). Besides folded test package got positive feedback because of nice outlook which means that customers mind the outlook of package (figure 20 and appendix I).

Communication is one of the main features of the package and package is kept as a silent seller. With the package it is also possible to stand out from other products. (Robertson 2012a, p. 4; Vila-López & Küster-Boluda 2019, p. 166). Vila-López & Küster-Boluda (2019, p. 172–173) showed also that packages' outlook, different colors and different messages will lead to different physiological and cognitive responses. This will affect the customer's willingness to try the packed food product. According to the study, color affected more than text on the label when those parameters were studied. Therefore it is advised to prioritize visual attributes like colors instead of text on the label design. Even though respondents thought that outlook of package is not important it may affect image about features of package. Hence outlook of package can be seen important feature. Paperboard as a material offer more printing possibilities compared to plastic package which is often transparent. Customer also noticed it, they specially mentioned nice outlook of folded test package in open comments (appendix I and II).

Based on the results of Ässäraati, 25 % of the respondents thought it is very important to see inside the package and more than half of the respondents (66 %) thought it is very important or quite important to see inside the package although customers choose the goods before packing. Like mentioned, folded test package got positive feedback because of nice outlook but negative feedback was not noticed even though it was not possible to see inside the package. Based on this it is unsure to say if transparency or lack of it really affects customers' choice. It is also impossible to say which will have the biggest effect, printing, shape or possibility to see inside the package. Package should tell about the content of the package and communication is one of the main features of package like mentioned before but it would need further analysis how much package should tell about the content of takeaway food when the food is bought directly from the counter. It is also good to remember that it is always possible that customers make other choice than they are saying. This problematic has reported in many studies like in the study of Vila-López & Küster-Boluda (2019, p. 172–173).

Hypothesis was that brown paperboard is seen more ecological than white paperboard. For that reason, it was chosen both white and brown paperboard packages into S Group panel questionnaire. Respondents saw that brown fibre-based package was primarily ecological and then easy to recycle. Other two folded fibre-based packages were primarily easy to recycle and then ecological (figure 20, 21 and 24). It was also seen that customers chose brown fibre-based package more often than white fibre-based package (figure 26). Color of paperboard is white if bleached pulp is used and brown if unbleached pulp is used (Fellows 2017a, p. 986–988). Paperboard can be also printed to brown. According to Finnish Packaging Association (2018) there is not anymore need to print white paper to brown to have impression of ecological packaging, material can be as it is nowadays. Both customers' and companies' attitudes have changed. This means for example that sustainability is important part of the companies' strategy and it is important to make real actions if company wants to be trustworthy. Besides, color does not tell directly which one is more ecological as it depends on the whole process. Still according, in this study it was seen that customers have image that brown paperboard is more ecological than white paperboard.

And then, what is ecological and sustainable package? This question was thought before and during the thesis a lot. It is not possible to find exact answer to question as there is not enough comparable studies taking into account the whole manufacturing process which affect on it. Life cycle assessment (LCA) is a tool which can be used to evaluate environmental impacts of package over the whole life cycle. International standards ISO 14040 series gives framework to conduction of LCA but there is not single method. LCA can be good assistance tool and it can be used for assessing waste management options. If different packaging materials are compared to each other it is important to know what assumptions has been made and which data has been used in LCA. LCA still has some limitations, for example own LCA study is needed in every case as it has not been possible to create universal generalizations. Besides of that, it does not take into account economic factors even though cost of the package has important role in packaging industry. (Robertson 2012d, p. 660–663.)

LCA calculation was not possible within this study. However, it should be considered if there is need to calculate it later. Generally it would be helpful if some generalizations could be done as there is going to be need to compare different materials also in the future. Currently this kind of data is not available. It is also probable that there is need to compare ecological effects of different packages which are made of same kind of material.

Although ecological package would have been defined, it is good to notice that customers may misunderstood meaning of ecological. For example word *bio* may sound ecological from the viewpoint of customers. According Emblem (2012a, p. 306–308) bio-polymer or bio-plastic is often understood synonymous with biodegradable by general public which is misleading. Boesen, Bey & Niero (2019, p. 1204–1205) noticed in their study that material type and possibility to dispose the package affected Danish customers' assessment of the sustainability of liquid food packaging. Customers did not consider impacts related to packaging production and transport according to the study. Bio-based packaging types and glass packaging was seen the most sustainable options and plastic packaging the least sustainable option. Some of the customers saw laminated paperboard sustainable option and some not in other words there were lot of variation in the customers' opinions. They also noticed that customers assumptions were not in line with studied LCAs. Based on the LCAs

found from the literature, plastic and laminated paperboard were seen the most sustainable solutions. It is also seen that there might be misunderstandings in public discussion also in Finland. Discussion does not always base on reliable data. Like Boesen, Bey & Niero (2019, p. 1204–1205) also says, actions from all parts, producers, retailers and policy makers are required so that customers could get objective information so that they are able to make informed choices. Besides of that, green claims like *environmentally friendly* and *recyclable* should be use carefully and only if claim is truthful, accurate, and able to be substantiated like Emblem (2012b, p. 79–80) writes.

Recycling rate of fibre-based packages is currently high, over 100 % like mentioned in literature review. Customers also saw fibre-based packages easier to recycle compared to plastic packages. Although legislation but also company's strategy drives to find alternative solutions to plastic, plastic will be important packaging material also in the future. According to the study customers seemed to think that plastic is good packaging material and suitable for takeaway food. Besides of that it is good to keep in mind that plastic really have good features, for example quality of fibre-based packages can be significantly increased when coated with plastic (Day 2008, p. 160). Plastic is often seen to have good protection features by improving storage life and preventing food loss and waste. Therefore it is also beneficial for the environment. (The Ministry of the Environment 2018, p. 7.) In addition plastic packages are seen practical in the stores because plastic packages can be used for different food items. Currently it is not possible to use own package for every food item at the takeaway counter, mainly because of limited space of takeaway counters. Hence it is also good to pay attention to plastic packages and recycling of plastic in addition to looking for new solutions and packaging materials.

According to Hottlea, Bilecb & Landisc (2017, p. 304–305) recycling will have significant effect to the whole life cycle impacts of plastics when comparing LCA studies for biopolymers and fossil-based plastics. Recycled plastic would have major benefits to environmental impacts if it could be used instead of virgin plastic. That is reason why sustainability point of view it is also remarkable if biopolymers can be recycled or not.

Recycling rate of plastic should be almost two times higher by the year 2025 than it is now (Rinki Ltd 2019; Euroopan parlamentti 2018). Recycling symbol is one way to help and advice customers to recycle plastic packages. Even though symbol and instructions are added it is unsure if customers have possibility or interest to sort takeaway packages. By saying this it is important that plastic packages can be sorted out from general waste stream. This should be already possible like it was mentioned in the literature review (Ekokem 2017). Even though plastic can be sorted out from the waste stream it is still unsure if takeaway packages are clean enough for reuse. If customers eat takeaway food under way, they might not have possibility to clean the package. However, it was not defined what is clean enough in literature but the way the package is used is good to keep in mind.

If plastics are recycled and reused there should be also enough solutions where recycled plastic can be used. Recycled plastic could become desirable raw material in the future like the situation is with the recycled fibre material. There is lot of solutions where recycled fibre material can be used and it is desirable raw material (Suomen Kuitukierrätys 2019). So that supply and demand manage to coincide it should be clearly instructed which plastic materials can be used after recycling in other words which materials have markets. Like mentioned before, Finnish Plastics Recycling Ltd (2018) already made a guidebook regarding development recyclable plastic packages. This is right direction because then it would be clear for all operators which materials should be preferred even though it is not always possible to replace one material to another. It would be also good if same guidance could be followed in different countries as packages are developed and marketed globally.

Cost of the packages will also affect to the decisions which will be taken in the future. Based on the results, plastic package is cheaper than paperboard package. If use of paperboard packages will increase it should also lower the cost of final packages, eventually this may affect further demand of packages. Albeit there is willingness to move to ecological and new options, cost should be reasonable. In general packaging must be cost-effective (Robertson 2012a, p. 159). It is possible that form of takeaway package does not affect remarkable on the other cost like delivery cost. This is because takeaway packages are mainly piled packages. However form of package may have clear effect on delivery cost in general. A good example is case of mashed tomato, where the change of tin into tetra pack decreased

delivery costs (SOK 2019). Besides of that recycling fee for fibre-based tetra pack is cheaper compared to tinplate package (appendix III). Regarding recycling fee it is good to notice that recycling fee is same for all fibre-based packages despite plastic lid, for example it is same for folded test package and round test package. It is interesting to see if principles of recycling fee will change in the future. Even though recycling fee per package is not high and it is only one part of cost it will affect when it is sourced thousands of packages. However price of package (sourcing cost) will have the biggest effect on final cost but it would be advisable to have total cost analysis before final decision is made.

One question is also how to communicate to customers that ecological options are available and how it will affect the image of package like it was discussed before. Kotkamills' material can be seen plastic free as water-based barriers are dispersions which do not form polymeric structure like defined in point 5 of Article 3 of Regulation (EC) No 1907/2006. When it was offered plastic free paperboard package (folded test package), it was possible that words plastic free created image of package which is sensitive to leakages. Even though it is plastic free in the legislation point of view there is still barrier coating. Water-based barrier coating provides for example water and grease barrier (Riley 2012a, p. 188–205). How is this information communicated to the customer in easy way? One possibility could be to add information on the label. However more probable option is that knowledge about new possibilities will increase among operators and customers when use of plastic free options increases. It is important that reliable information is offered for example in the newspapers as the customer will make the final decision which kind of package will be used in the future. This is because customers will have to finally accept use of new package. It is also good to remember that sales may drop and customers are displeased if package does not work. That is reason why decisions need to be considered carefully. It is also good if it is possible to test all the alternatives before decision. All in all, companies have developed new creative options to plastic which can be seen positive development, and it is interesting to see which kind of options are available after few years. Public discussion about plastic, global packaging trends and legislation like SUP directive are the divers for development. Still it is good to keep in mind some points, packaging waste would not be environmental problem if it is not littered and food waste will have bigger environmental impact than package itself which why package is seen necessary. Therefore plastic package may be sometimes better

option than some other package if it protects the food inside the package and then food loss can be avoided.

5.2 Reliability and validity

Because practical test was used instead of laboratory test, optimization was difficult and results are seen directional. Besides of that only few stores were involved in the test and that is reason why limited feedback was got from the employees. It is still normal that some pilot stores are used when new procedures are tested as it is not possible to test new options in all stores. But it is true the more stores are included the more reliable results is got. Panel of Ässäraati was big enough to get reliable results and it is reason why it was focused on the results of Ässäraati even though respondents did not test the packages. The number of respondents who tested the packages was very limited which why one answer has very big effect on the results. This is reason why it was viewed those results with the reservations even though it seemed that results are in line with results of Ässäraati.

It was seen that QR code is not good way to collect feedback from the customers, only few answers were given even though there was possibility to win S Group's gift card. If same kind of test is made in the future feedback from the customers should be collected some other way. Analyzing of results is easier if questionnaire is used instead of open comments while open questions may tell more about opinions of customers. It was still noticed that internet-based questionnaire can be good way to collect feedback from the stores also in the future. It is still good to notice that there might be need to define more carefully terms like tightness of package.

5.3 Topics for future research

It should be considered if there is need to carry out LCA for different takeaway packages so that reliable data about different packages and their ecological level could be get. Besides of tested packages LCA should be carried out currently used packages to get better understanding which is the best option in the sustainability point of view. For example Natural Resources Institute Finland (Luke) is one the companies in Finland who is offering and developing LCA calculating tools (Luke 2019). Final cost of packages and other features of packages should be also considered. One feature which could be good to notice is use of

package which means here for how many products it could be used at takeaway counters as it is not possible to use own package for every product.

Additionally, it would be good to test how folded test package works in self-service salad places because there is need to reduce number of takeaway packages which are made of plastic. It is likely that salad is more often bought for lunch and carried in hand. If it is so it might be easier to accept looser closing system because there is not need to put package in the shopping bag. If test is carried out, it should be carefully considered how reliable feedback can be collected from the customers so that sampling would be big enough. In the open comments it was also disclosed the use of own package or new kind of deposit system. This solution is also good to keep in mind and investigate different possibilities how these could be implemented. One question is how it is guaranteed hygienic quality of food and packages.

Hopefully producers and converters will continue development of tighter closing systems so that plastic free paperboard packages could be used for different kinds of takeaway products. Besides of that it is hoped that producers would innovate new plastic free materials which would be suitable for wide range of takeaway products, for cold and warm products.

6 CONCLUSION

The aim of this thesis was to study the possibility of replacing current plastic takeaway packages with fibre-based packages. It was shown that both test packages, round fibre-based container with plastic lid and folded plastic-free paperboard package can be used for cold salads with some limitations. According to the results for example required tightness was not achieved with folded paperboard package and package did not fulfill its main features like expected level of protection. Therefore, it should be considered carefully if it is possible to replace the current plastic takeaway packages.

According to the results, the round test package got a little bit more positive feedback than the folded test package. For example customers who tested the packages gave more positive feedback to it, all employees were willing to use round test package also in the future and respondents of Ässäraati chose the round test package from all of the packages most often. Still the differences between the packages were not significant enough to say for sure. Before any final decisions the costs of the packages need to be calculated and estimated in detail. Furthermore, it would be useful to make further tests if customers would be willing to accept the folded test package at the self-service salad bar. Although customers are willing to replace plastic packages with fibre-based packages they are not willing to make compromises with the basic features of the packages nor willing to pay extra. It is still clearly seen that legislation and public pressure drives to look for alternative options to current takeaway packages. This is also in-line with the company's strategy.

Hopefully this kind of co-operation can be used also in the future. It is important to test new packages in the real environment so that both workers and customers are possible to give feedback. Furthermore, it is important that the notifications are communicated with the converters of packages and producers of packaging materials. In that way it could be possible to find new and creative packaging solutions in the future.

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APPENDIX I

Open comments of test package 1 given by customers who tested packages.

Positive/ Negative	**Comment**
Negative	Package does not keep salad as fresh as plastic package when stored in the fridge over night
Negative	After testing the package plastic package was preferred as it was seen better
Negative	Unpractical as there is risk of leakage (lid is not tight enough)
Negative	Unpractical as there is risk of leakage when put in the bag (lid is not tight enough)
Negative	Plastic package was preferred as it was seen better
Negative	Package was too high: difficult to eat directly from the package
Negative	Plastic package was preferred as it was seen better because it is easier to open
Positive	Square/rectangle form is good
Positive	This is seen good way to decrease the amount of plastic
Positive	Nice package (outlook); Nice to have an option to plastic package
Positive	It is glad to have an option to plastic package
Positive	Nice package (outlook)
Positive	It is glad to have an option to plastic package
Positive	Seems to be practical package
Positive	It is glad to have an option to plastic package
Negative	Unpractical as there is risk of leakage when put in the bag (lid is not tight enough)

APPENDIX II

Open comments of test package 2 given by customers who tested packages.

Positive/ Negative	**Comment**
Positive	Seems to be practical package; easy to eat food directly from the package
Positive	It is glad to have an option to plastic package
Negative	Plastic package was preferred as it was seen better because paperboard package may leak
Positive	Paperboard package was seen as good as plastic package
Positive	It is glad to have an option to plastic package
Positive	Nice outlook of package (printing and form of package); It is glad to have an option to plastic package
Positive	Good size of package
Negative	Paperboard lid instead of plastic lid should be preferred
Positive	Nice outlook of package
Positive	Nice outlook of package and easy to use (easy to open and close)
Negative	Plastic package was preferred as it was seen better because it is easier to open
Negative	Plastic package was preferred as it was seen better
Positive	Easy to eat food directly from the package
Negative	Lid may open in the bag
Positive	Nicer outlook of package compared to plastic package

APPENDIX III

Recycling fees (€/ton) of packaging materials in 2019. *) Value added tax is added to the fees. (Source: Rinki Ltd 2019).

MATERIAL GROUP	**MATERIAL**	**Recycling fee ***	
		2018	**2019**
		€/ton	**€/ton**
FIBRE	Corrugated cardboard packaging for consumers	9.50	**9.00**
	Corrugated cardboard packaging for firms	9.50	**9.00**
	Industrial wrapping and sacks	14.50	**14.50**
	Industrial cores	14.50	**14.50**
	Carton and paper packaging	52.00	**47.00**
	Carton liquid packaging	96.00	**96.00**
PLASTIC	Plastic packaging for consumers	35.00	**30.00**
	Plastic packaging for firms	35.00	**35.00**
METAL	Aluminium packaging for consumers	130.00	**130.00**
	Aluminium packaging for firms	28.00	**28.00**
	Tinplate packaging for consumers	130.00	**130.00**
	Tinplate packaging for firms	28.00	**28.00**
	Steel packaging	28.00	**28.00**
GLASS	Glass packaging (non-deposit)	112.00	**98.00**
WOOD	FIN, EUR and EPAL pallets, rental pallets, cable reels	0.95	**1.20**
	Other wooden pallets and other wooden packaging	1.25	**1.60**