

The dilemma between a circular economy and food safety in the paper and board industry

A systems perspective

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ABBREVIATIONS

ADI = Acceptable Daily Intake

CE = Circular Economy

CEPI = Confederation of European Paper Industries; Its members in 2015 include: Austria, Belgium, Czech Republic, Finland, France, Germany, Hungary, Italy, The Netherlands, Norway, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom

EC = European Commission

ECMA = European Carton Makers Association

EFSA = European Food and Safety Authority

EU = European Union

FCM = Food Contact Materials

FS = Food Safety

GMP = Good Manufacturing Practices

HACCP = Hazard Analysis and Critical Control Points

ISO = International Organization for Standardization

KIDV = Kennis Instituut Duurzaam Verpakken

MOAH = Mineral Oil Aromatic Hydrocarbons

MOSH = Mineral Oil Saturated Hydrocarbons

ABSTRACT

The focus of the research is on the dilemma between food safety and the move towards a more circular paper and board packaging industry in Europe. Systems thinking will be used to discuss all parts of the system separately to eventually create a system overview. By mapping trade flows of paper and board in Europe and on a global scale, insight is gained into how complex the paper and board industry is and how complex the research problem is to solve. As mineral oils are the main reason for concern, it is shown how these can get into contact with food. An in depth study into the newsprint sector as main source of mineral oils, shows that printing inks are indeed a big source of mineral oils. Only looking at the newsprint sector for blame or solutions is not reasonable, as the mineral oils can originate in other sources as well (TU Darmstadt, 2012) and only a small part of printed newspapers actually ends up in food packaging. Comparing food safety criteria to European policy on food safety and a circular economy show that many indicators are already covered, but policy is not yet specific enough or at a large enough scale when it comes to paper and board. Also, there are no set limits for the intake of MOAH. More specific policy needs to be created and technology needs to be further developed to be able to set clear limits. Some possible solutions already exist, but are not effective yet, form a barrier for recycling or are not feasible in the short term.

Key words: European policy, food safety, circular economy, paper and board, recycling.

CHAPTER ONE: INTRODUCTION

1.1. Problem Statement

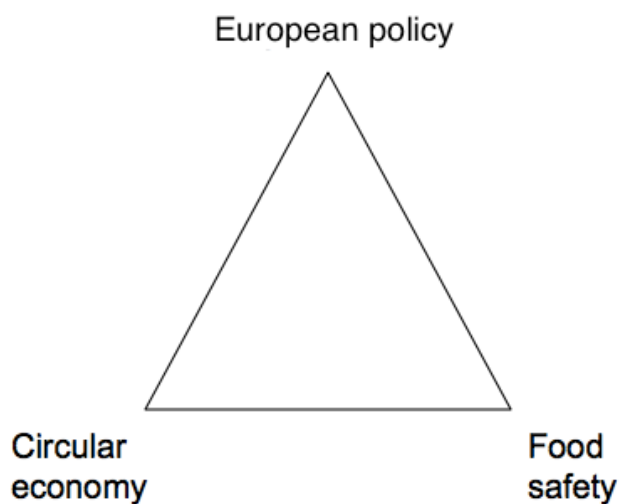
Our current economic model of production is mostly a linear one. This means that the way we are producing is based on taking a material, making a product and then disposing of it in the form of waste. This production method is leading to an intensive use of resources and is reaching its physical limits (Ellen McArthur Foundation, 2017). Therefore it is necessary to move towards a more circular economy in which recycling and waste prevention are crucial. The role of recycling has increased over the last years and is of great importance in for example the paper and board industry. Worldwide, the utilization of recycled material is two-thirds against one-third virgin fiber (RISI, 2016).

The Netherlands are the most effective recycling country in the world with a recycling rate of 82% (CEPI, 2015). This means that 82% of the collected paper and board is recycled and used for production of different paper types, making the paper and board industry in the Netherlands relatively circular already. The use of recycled material is by far the highest in the packaging industry, as this material has lower quality standards than for example graphic — or tissue paper (CEPI, 2015). However, there seems to be a dilemma between the wish for food safety and the wish to make packaging more circular (KIDV, 2016). Recycled paper and board is used in the production of food packaging papers, but the quality of recycled paper and board is lower than that of virgin wood fibers. In the production process and also in other steps like transport, the recycled material can get polluted, before it is used for the production of food packaging, which results in the polluted material getting in contact with food and migration of hazardous substances into the food taking place (Goeyens, 2014). Thus, the use of recycled materials as source for paper and board production can lead to possible food safety concerns. The newsprint industry is blamed for a lot of contamination through the use of printing inks, which contain a high amount of mineral oils (Goeyens, 2014). As newspapers and magazines are part of the recycling chain and thus also part of recycled food packaging materials, they are seen as the main source of pollution and reason for food safety concerns (Goeyens, 2014). However, as will be explained further in the research, the contamination of recycled paper and board materials can have other origins too. There are many complicating factors that make it hard to blame one sector. One of the knowledge gaps lies in the fact that the problem is not placed in context of the whole paper and board industry. This view needs to be broadened and the mineral oil pollution problem needs to be put into a broader perspective, which is why the paper and board material flows within and outside of Europe have been

mapped. This has impact on food safety as it is harder to trace back hazardous substances and we have less control over materials entering the market. In preventing health risks, food safety policy is very important in Europe. An analysis of food safety related policy in place in Europe will lead to the identification of possible policy lacks and overlap. This will be based on certain criteria set later in the research. The main research problem is that the wish for a circular packaging industry is in conflict with the wish for food safety in Europe (KIDV, 2016).

The following figure (Figure 1) shows the most important concepts of the research. These concepts are discussed in the theoretical framework, after which criteria are developed to be able to analyze existing EU and European policy. As previously explained, there is an ongoing dilemma between food safety and the wish to make packaging more circular in the paper and board industry. The research dilemma is therefore presented as a triangle with European policy at the top, as the main discussion is on how policy interferes in the dilemma between food safety and a circular economy.

Figure 1: Representation of the research dilemma



1.1.1. Mineral Oil Pollution

The food safety problem that has recently come to light, is that of consumer exposure to contaminants and mainly mineral oils. Contact takes place via food packaging and oils can be divided into two groups: Mineral oil saturated hydrocarbons (MOSH) and mineral oil aromatic hydrocarbons (MOAH) (European Food and Safety Authority, 2012). Exposure to mineral oils is regarded as a concern, because of the potential carcinogenic risk. “In humans exposed to MOSH, micro-granulomas have been observed in liver spleen, lymph nodes and other organs ...” (EFSA, 2012). It is very difficult to set a certain limit for the intake of MOSH and MOAH for humans. However, a classification of mineral oil products and acceptable daily intake (ADI) was still provided by the joint FAO/WHO Expert Committee on Food Additives (JECFA) (Biedermann & Grob, 2010).

Paper and paperboard are materials that are able to absorb many contaminants, of which the MOSH and MOAH are most common (Thoden van Velzen, Leeman & Krul, 2017). It is said that: “A significant source of dietary exposure to MOH may be contamination of food by the use of recycled paperboard as packaging material” (EFSA, 2012). Recycled paper and board contain mineral oils from materials such as newspaper and other heavily printed paper that ends up in the recycling process. This includes oils from printing inks, adhesives, etc. (EFSA, 2012). Paper products based on recycled paper have a higher chemical load than products based on virgin fiber (Pivnenko, Laner & Astrup, 2016). Table 1 shows the different chemicals present on average in reused paper fibers (in Germany) and where they originate. From this data can be seen how many different contaminating substances can be present in recycled paper and paperboard, of which MOSH and MOAH are by far the most substantial and have the highest content in recycled paper fiber (Table 1: BMELV, 2012; as stated in Thoden van Velzen, Leeman & Krul, 2017). They are said to originate in newspapers, which is a statement that can be found in literature more often (Biedermann & Grob, 2010; Goeyens, 2014). To see whether this statement is valid, an in depth study into the newsprint sector was done. This subject will be elaborated on in chapter three.

The chemicals in recycled paper and board packages come into contact with food through migration, which can happen in three possible ways: 1. Direct contact between the package and liquid or semi-solid food, 2. Through the gas phase into ‘dry’ food or, 3. Through penetration from outer packaging parts through inner pouches or bags (EFSA, 2012). Through migration, all chemicals can get into contact with foodstuffs and pose a potential health risk.

Tabel 1: Gemiddelde concentraties verontreinigingen in hergebruikte papiervezels en hun oorsprong in Duitsland [BMELV 2012].

Verontreiniging	Gemiddeld gehalte in hergebruikte vezels, [mg/kg]	Molecuulgewicht, [g/mol]	Oorsprong van de verontreiniging
MOSH C ₁₆ -C ₂₄	317	226-339	Kranten
MOAH < C ₂₄	90	<339	Kranten
Poly gealkyleerde aromaten	0,3	150-340	Kranten, tijdschriften
2,6-diisopropylnaftaleen en isomeren	20	212	Kantoorpapier, papierspecialiteiten, gelijmd papier
diisobutylftalaat	9	278	Kantoorpapier, papierspecialiteiten, gelijmd papier
di-n-butylftalaat	5	278	Kantoorpapier, papierspecialiteiten, gelijmd papier
Bis-(2-ethylhexyl)ftalaat	9	391	Folders, advertenties, tijdschriften
Diethyleenglycol-dibenzoaat	13	314	Folders, advertenties, tijdschriften
Benzofenon	3	182	Folders, advertenties, tijdschriften
Bis-(2-ethylhexyl)maleaat	2	341	Folders, advertenties, tijdschriften, decoratie-materiaal
2-(fenylmethoxy)-naftaleen	3	234	Thermisch papier
Bisfenol-A	10	228	Thermisch papier
Som van totale gemiddelde hoeveelheid verontreinigingen in hergebruikte papiervezel	481		

Table 1: Average concentrations of contaminants in reused paper fibers and their origin in Germany (BMELV, 2012; as stated in Thoden van Velzen, Leeman & Krul, 2017). Last column: Oorsprong van de verontreiniging = origin of pollutants; Kranten = Newspapers.

1.2. Research Questions and Research Aim

This section lays out the aims of the study and the research questions. From my internship, there was the need to create more overview of the European/global trade flows of paper for recycling, finding out how big the mineral oil problem actually is and what the main sources are and what possible solutions are available. As one of the only ways to interfere in the research dilemma lies in the change or creation of European policy, the analysis of existing policy to identify policy gaps became one of the main focus points as well.

AIM: To explore the dilemma between food safety and a circular economy in the European paper and board industry and find out how European policy regarding food safety interferes in this dilemma and creating an overview of possible solutions by making use of literature, an in-depth study into the newsprint sector and the development of criteria for policy analysis to make recommendations for future research.

Research questions

Main research question:

What is the current dilemma between food safety and a circular economy in the European paper and board industry and how can EU and European policy interfere in this dilemma?

Sub-questions:

1. What does the European paper and board market look like regarding production, use and trade of paper and board, paper for recycling and packaging materials?
2. Why is blame for food safety problems in the European paper and board industry put on the newsprint sector and can this be justified?
3. How does existing European and international policy relate to the established criteria and where can possible policy gaps or overlap be found?

Sub-question 1

The first sub-question will be answered by using CEPI data to show the amounts of paper and board and paper for recycling that are being imported and exported within Europe and on a global scale. An overview of these trade flows will give insight into the complexity of the paper and board industry in Europe and place the dilemma between food safety and circularity in a European context, as well as showing the range of the dilemma.

Sub-question 2

The second sub-question is answered in chapter five, when the in depth study of the newsprint sector will be discussed. First, the choice for this study and how it is related to food safety issues in the paper and board industry is explained. This leads to a more detailed explanation of the relation between printing inks and packaging papers. The biggest problem with printing inks is that their mineral oil content. To find out how big the influence of the oils originating in printing inks is (in comparison to other sources), several data sources were used to show the amount of mineral oils present in different paper grades and how they end up in the paper and board recycling chain. The discussion of this data will lead to a conclusion on whether it is justified to put blame for food safety problems in the European paper and board industry mainly on the newsprint sector.

Sub-question 3

The third sub-question will be answered in three parts. The first part consists of a general overview of existing European policy regarding food safety and a circular economy, based on the use of official policy documents. After this, a policy analysis will follow using criteria that are developed in chapter two. An overview of policy and criteria as well as an identification of policy laps or overlap will form the conclusion.

1.3. Demarcation of the Research

In this section the use of concepts and choices made in the research are explained, based on the research question.

1.3.1. Focus on Europe

First of all, the research only focuses on European policy and trade flows. Discussing national policy/trade flows will deliberately not be done.

As mineral oil pollution is a European (even global) issue, the logical focus is on European policy. There are certainly many national policies in place regarding food safety, but these are only effective on a national scale. Using national data would only show the complexity of the problem on a national level. Identifying policy gaps or recommending changes on a national scale would not change anything about the European food safety problem and would not be able to solve the research dilemma.

To show the scale of the problem, European data from CEPI is used and European/global trade flows are mapped. The complexity of the national paper and board market in the Netherlands can be seen in figure 2. This figure shows that the Netherlands trade most paper and board within Europe and a small percentage with countries outside of Europe. Figure 3 also shows the export rates for different paper types. It shows that graphic paper is exported the most, followed by packaging paper and sanitary paper (figure 3). In a bigger context, this means there are many different trade flows between the Netherlands and other countries, but also for different paper types. Figure 4 and 5 show the amount of virgin finer as opposed to paper for recycling used as a resource in the Netherlands and its origin to show the reliance on outside sources even more. For the Netherlands alone it is already difficult to find information on where the paper and board goes to and comes from and which type of paper this would be. Though, as most paper and board is traded within Europe, it suffices to use CEPI data to get a general image of the paper and board market and origins of paper for recycling.

Figure 2: Paper and board distribution of the Netherlands (VNP, 2015; translated).

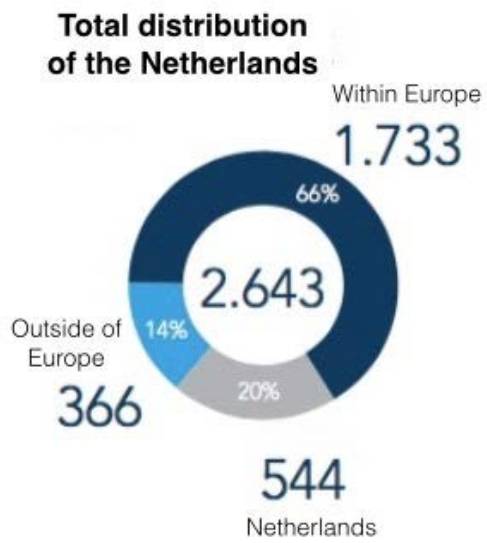


Figure 3: Domestic use and export of different paper types (VNP, 2015; translated).

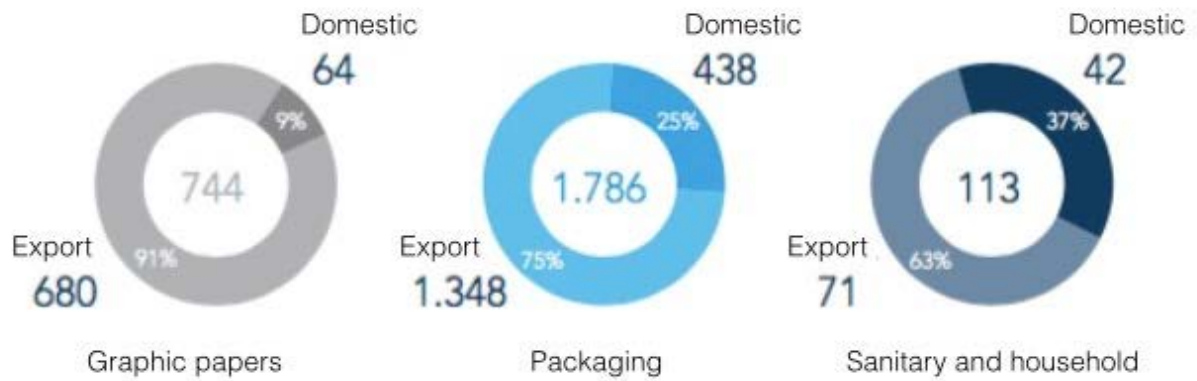


Figure 4: Use of virgin fiber/paper for recycling in the Netherlands (VNP, 2015; translated).

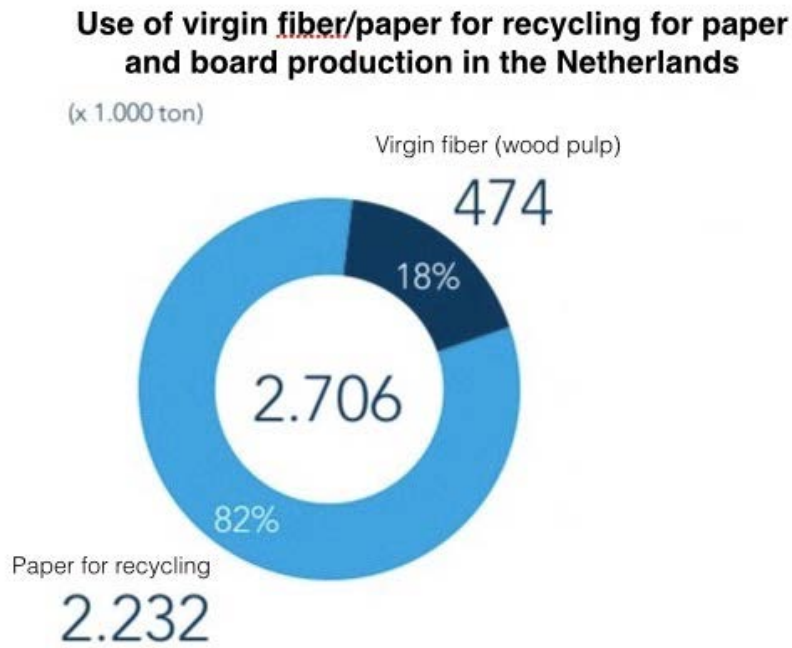
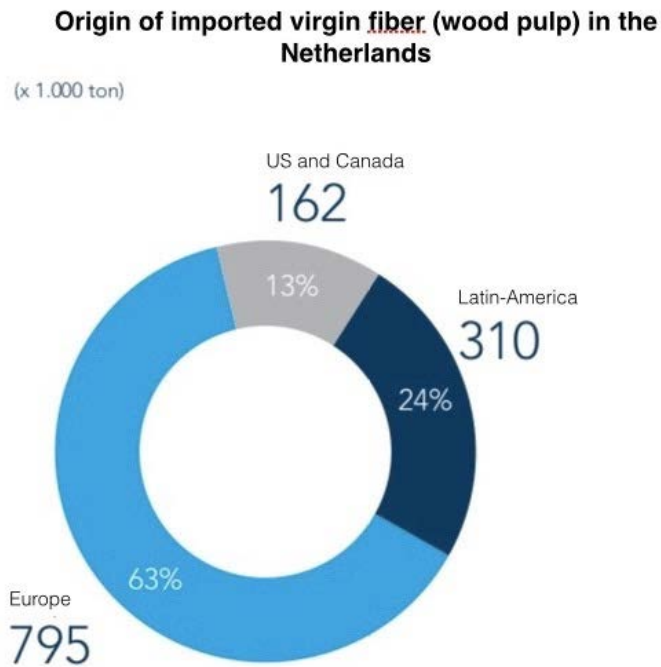


Figure 5: Origin of imported virgin material in the Netherlands (VNP, 2015; translated).



1.3.2. Definition of European

In the context of paper and board, 'European' is hard to define. The EU is central in the research, but the involved countries in European policy and data differ. The most important European numbers are derived from CEPI, which collects data from eighteen countries within Europe, namely Austria, Belgium, Czech Republic, Finland, France, Germany, Hungary, Italy, the Netherlands, Norway, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden and the United Kingdom. The EU consists of twenty-eight countries in Europe: Bulgaria, Cyprus, Denmark, Estonia, Greece, Ireland, Croatia, Latvia, Lithuania, Luxemburg, Malta and, minus Norway, all CEPI countries mentioned before. Norway is the only CEPI country that is not part of the EU. The use of CEPI numbers does not reflect the complete EU and even reflects Norway as well, which is not part of the EU. The total production, material use, recycling, collection and trade flows could be different from CEPI data. This makes it more difficult to map the paper and board packaging industry in Europe correctly, as there is no available data for almost half of the EU. However, CEPI numbers are the only and most recent data available of the paper and board industry in Europe. This is why, even though they do not reflect the situation in the entire EU, these numbers will be central in the research. This has consequences for the research. A policy review is central to the research. The reviewed policies are mostly applicable to the EU and would thus not be relevant for all of CEPI. In turn, policy recommendations for Europe would be based on incomplete numbers. The situation (mostly different recycling flows, rates and collection schemes) in specific countries could differ from the general situation as derived from the numbers. As a result, different policy target areas could be relevant and giving specific and correct policy recommendations for the entire EU is not possible. However, the available numbers are still believed to give a good general insight into the paper and board packaging industry. The focus will therefore lie on creating a general overview of the paper and board packaging market and trade flows and concluding with general (policy) recommendations.

1.3.3. Mineral Oils

As could be seen in Table 1, many different types of pollution exist in paper and board. The research will only focus on mineral oils MOSH and MOAH. These mineral oils are present in the highest amount by far in recycled paper and board (Thoden van Velzen, Lee-man & Krul, 2017). Mineral oil pollution is also the most relevant subject in literature and

the main reason for food safety concerns (Goeyens, 2014). Most food safety regulations in the paper and board industry also focus on mineral oils and only set limits for this type of pollution (EFSA, 2012). The focus will therefore lie on only MOSH and MOAH in this research. Other polluting substances in paper and board will not be discussed. The term 'Mineral oils' will refer to MOSH and MOAH.

1.3.4. Focus on State and Market

In each theme (food safety and circular economy), three different social mechanisms play a role: state, market and civil society (Lemos & Agrawal). Civil society is impacted by the research dilemma (health problems), but does not play an active role in solving it. Society is a stakeholder in the circular economy, as it puts demands on the economy as a whole by increasing material and product demand, the amount of waste and resource dependency (Lieder and Rashid, 2015). This puts a strain on businesses to perform and deliver more products. There is no stopping the growing global demand and it is up to businesses and technological development to increase resource efficiency. This research will therefore focus on economic and governmental solutions to create a more circular and environmentally friendly economy whilst safeguarding human health.

Regarding the market aspect, global trade flows of paper and board and paper for recycling will be mapped. This is done to show the complexity of the market and traceability. There is much dependency on external resources which causes transparency to suffer and processes to be hard to monitor (Manning & Baines, 2004). More focus on the internal market would generate more control, but as the scale of the paper and board market is global, this is almost impossible to get done. At the same time, this shows how far reaching the consequences are if contamination of packaging materials and food even occur at only one point in the industry.

This is also why it is so important to focus on food safety. In the last years, responsibility for food safety controls has shifted from government inspectors to individual food businesses (Manning & Baines, 2004). This means there is less control on food safety from top-down. There are some private standards in place in the industry itself. However, these private standards have not been developed to ensure compliance with more broad legislation regarding food safety (Manning & Baines, 2004). This bottom-up approach is therefore not working. There is a need for clear separation and transparency in who is responsible as well as accountable for production and waste management (Manning & Baines, 2004).

The paper and board industry is global and the reduction of potential hazards involves applying preventive and control measures in the entire food chain, thus it is important these measures are effective and able to control the hazard at hand (Doménech & Martorell, 2015). Policy is thus very relevant and policy analysis regarding food safety and a circular economy will be central to the research. Several documents will be discussed. First, regarding a circular economy, several regulations and action plans, mainly on EU level, will be discussed together on how they relate to the paper and board industry and the circular economy criteria developed later in the research. Regarding food safety, there will be a separate discussion of policy documents on EU, European and international level. A table will be presented beforehand on what policies will be discussed, on what level they are active and whether they are binding or not. In the conclusion, an overview will be presented, showing to which criteria the policies relate, also leading to an identification of policy gaps/overlap. Private standards will not be discussed as their overall (possible) impact on the research dilemma is not big enough and not relevant to the creation of possible solutions.

1.4. Relevance of the Study

1.4.1. Scientific Relevance

As stated in a spreadsheet drawn up by the KIDV (2016), there seems to be a dilemma between the wish for food safety on the one hand and the wish for a more circular economy on the other. An example of this can be found in the addition of a protective coating on paper packaging materials to prevent hazardous substances from migrating into the food. This would improve the safety of the food, but make recycling that much harder or even impossible to realize (KIDV, 2016). A research gap also lies in the fact that there is a lack of transparency in the paper and board industry. This includes material flows and on what geographic scale they occur, as well as what materials are being collected (Manning & Baines, 2004). It is not clear who is responsible for the paper and board materials and products, and thus also for upholding their food safety standards. Further research is necessary to create more overview in responsibility, traceability and how quality can be controlled and improved. This research can contribute to a better understanding of the industry as a whole by generating an overview of trade flows, the recycling chain and collected materials, existing policy and possible solutions. Using systems thinking, the research will look closely into the structure of the system and possible feedback loops. Taking a closer

look at the roles of state and market in the research dilemma will lead to a clear identification of policy lacks/gaps. This is necessary in order to define what steps need to be taken to ensure food safety. The concluding overview of the system and policy interference will add onto existing research by generating more transparency into the paper and board industry and better understanding of responsibility in quality control. The conclusion and recommendations can serve as a basis for future research.

1.4.2. Social Relevance

The research is focused on solving a dilemma which will increase food safety and decrease risks for human health. As the circular economy concept is a very topical subject and the focus of many new economic developments, it is in the interest of society as a whole to do more research into the consequences this may have for the economy and general food safety. With global population growing exponentially, we need to be aware of the risks of a circular food packaging industry, possible solutions and sustaining our future planet and generations.

1.5. Dissertation Structure

The dissertation consists of seven chapters. The introduction lays out the background of the study, as well as the research problem, questions and aim. Chapter Two provides a review of literature on Systems thinking and Circular Economy and Food Safety related to the European paper and board industry. From this literature, criteria will be derived that serve as the basis for policy analysis. Chapter Three outlines the research methods and in depth study approach. The European trade flows of paper and board will be presented in Chapter Four. In Chapter Five, the in-depth study into the newsprint sector will be elaborated on, which will result in an answer to the second sub-question. Existing European policy regarding circular economy and food safety relevant to the paper and board industry will be presented in Chapter Six, which will then be analyzed according to the set criteria. Chapter Seven offers possible solutions, conclusion, limitations of the study and future recommendations.

CHAPTER TWO: LITERATURE REVIEW AND THEORETICAL FRAMEWORK

The most important theoretical concepts in the research are circular economy, food safety and European policy. An explanation of how both food safety and circularity can be interpreted in the context of the paper and board industry will be given. It is important to know how the main concepts are to be interpreted and applied to the paper and board industry. This is why criteria are presented for Circular Economy and Food safety in general (based on the theory) before they are translated to criteria specific to the paper and board industry. All criteria will be summarized in tables to serve the policy analysis later on in the research. The criteria were matched against International, European and EU policy applicable to the paper and board industry to analyze where possible policy gaps/overlap can be found. European policy will not be discussed in the theoretical framework. The literature and derived criteria are presented below, at first for circular economy, secondly for food safety. Before that, systems thinking and its role in the research will shortly be explained.

2.1 Systems thinking

‘Systems thinking as a methodology is based on the assumption that a system’s elements are best understood in the context of their relation to other elements and systems’ (Perdicoulis, 2016). These relations can be seen in feedback loops. For example, international trade consists of several economic feedback loops. These feedback loops are not as straightforward as one might expect, especially when it comes to cause and effect (Lezak & Thibodeau, 2016). It is based on an understanding of interconnectedness, the structure of a system and trying to see the whole system instead of separate parts (Arnold & Wade, 2015). To recognize and understand the structure of a system, improves the capability to understand the system as a whole. It is therefore essential to discuss criteria used to understand parts of the research separately before being able to understand the system as a whole and ‘see both the forest and the trees’ (Arnold and Wade, 2015). In the method section will be discussed how the theory will be operationalized.

2.2. Circular Economy

Generally, circular economy is seen as an important issue in environmental management and a strategy for the pursuit of global sustainability (Smol, Kulcycka & Avdiushchenko, 2017). It means “retaining the added value in products for as long as possible, extracting their maximum value and eliminating waste” (Smol, Kulcycka & Avdiushchenko, 2017). The general definition as given by the Ellen McArthur Foundation and Granta design (2015) is: “A circular economy is a global economic model that aims to decouple economic growth and development from the consumption of finite resources.” This definition also encompasses the global importance, as it not only positive for economic reasons, but also necessary because some resources are finite.

Recently, circular economy emerged as a policy goal with the aim to move away from the existing linear economic model. A linear economy is defined as generating waste through production, using natural resources (Murray, Skene and Haynes, 2015). A circular model is based on using this waste as resource again through recycling and reuse (Gregson, Crang, Fuller & Holmes, 2015). Civil society and state have started introducing the element of ‘restoring’ into the linear economy concept, moving from reduce-recycle-reuse to reduce-recycle-reuse-restore (Smol, Kulcycka & Avdiushchenko, 2017). The ‘restore’ part relates to the notion that a circular economy does not only aim to reduce pollution but also to repair previously done damage by designing better systems (Murray, Skene and Haynes, 2015). In more simplified terms, the linear concept could be summarized as ‘take-make-dispose’ and the circular concept as ‘take-make-reuse’ (Gregson, Crang, Fuller & Holmes, 2015). The ‘take-make-dispose’ model is the easiest way to arrange our economic production, but it is not the most environmentally friendly. As we produce many materials and products, this also leads to a high amount of waste being generated. We don’t use all the products that we make, which sometimes leads to valuable substances being discarded where they could be reused instead. Incineration also could also lead to hazardous substances being released to the air. Thus, the movement towards a more circular economic system could have economic as well as environmental benefits.

According to the Ellen MacArthur Foundation (2012), a circular economy is based on a few simple principles, one of the most important ones being the total elimination of waste. Biological nutrients should be non-toxic and technical nutrients should be able to be used again at high quality levels (Ellen MacArthur Foundation, 2012). To quote: ‘On the biological nutrient side, the ability to reintroduce products and materials back into the biosphere through non-toxic, restorative loops is at the heart of the idea’ (Ellen MacArthur

Foundation, 2012). The three main principles of a circular economy can be defined as: 1. Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows, 2. Optimize resource yields by circulating products, components and materials at the highest utility at all times in both technical and biological cycles and 3. Foster system effectiveness by revealing and designing out negative externalities (Smol, M., Kulczycka, J. and Avdiushchenko, 2017).

The successful implementation of circular models depends on four key building blocks: rethinking product design, innovative business models, new reverse logistics and certain system conditions (Ellen MacArthur Foundation & Granta Design, 2016). These building blocks translate to criteria that are used for the policy analysis. Rethinking product design can be based on the selection of different materials, design for easy end-of-life sorting and taking into account possible applications of generated by-products and waste (Ellen MacArthur Foundation and Granta design, 2015). In the paper and board industry, this is seen in the high amount of recycling that takes place. Recycling is fundamental to the circular economy, as it is linked to cycling resources (Murray, Skene and Haynes 2015) and decreases the need for virgin materials, which reduces the needed material (wood) input, simultaneously preserving natural capital. The decrease in need for virgin fiber can even be seen in global numbers, as two-thirds of the world's paper and board production is now based on paper for recycling instead of virgin fibers (RISI, 2016).

New business models focus on mainstreaming circularity by replacing existing linear models or improving them. In the case of the paper and board industry, again, this can be seen in the high amounts of recycling. Effectiveness of paper and board recycling is presented as the recycling rate, which is defined as: "the percentage of paper for recycling 'utilization + net trade' compared to total paper and board consumption" (CEPI, 2015). In other terms, the recycling rate is expressed as the percentage of total consumption of paper and board that traded and collected from households and companies as paper for recycling. In Europe, this percentage is about 72%, which is quite high (CEPI, 2015). One of the main criteria of a circular economy mentioned in literature is the Material Circularity Indicator. This measures how restorative material flows of a company are (Ellen McArthur Foundation and Granta design, 2015). As the recycling rate accounts for recycling collection rates, efficiency of recycling and is also based on how restorative flows are, it can be seen as the MCI of the paper and board industry. Recycling rate will therefore be one of the criteria for policy analysis.

Reversing cycles is based on recovering products back from consumers and re-entering them into the supply chain, improving treatment systems and decreasing leakage of

materials from the system (Ellen MacArthur Foundation and Granta design, 2015). Levels of recycling in the paper and board industry are increasing steadily and are replacing the linear business model by reversing cycles. As stated before and visible in CEPI numbers, much of the used paper and board is collected as paper for recycling from consumers (CEPI, 2015) and re-entered into the supply chain, which causes more material to stay within the system. The existence and improvement of collection schemes can therefore be derived as another criterium.

For businesses to make the transition to circularity, new system conditions are also necessary. Examples of these conditions are education, providing a set of international environmental rules, more collaboration and access to financing (Ellen MacArthur Foundation and Granta design, 2015). The existence of rules for recycling can be seen as a separate criterium to be able to guarantee circularity in the paper and board industry, for example when it comes to rules about using waste as resource.

The following table of indicators will be used for a policy analysis regarding circular economy:

Circular economy in the paper and board industry
Recycling rate
Decreased use of wood/virgin fiber
Improved collection schemes (of paper for recycling)
Rules regarding recycling of paper and board

Table 2: Circular economy criteria

2.3. Food Safety

Food related risks have to be managed to secure human health. Mineral oils contaminating food through migration from packaging materials can be a hazard to human health. Food markets are however becoming increasingly globalized and hazards can appear at any stage of the food chain, so regulators are concerned about how to manage these hazards properly (Doménech & Martorell, 2015). Finding the source of pollution in paper and board to make sure food products are healthy is an issue that goes across borders, especially in the European Union, where a lot of the food we eat, originates in countries outside the EU (European Commission, 2014). Food safety is not only the responsibility of the state, but will also continue to be the responsibility of the industry. This could be a problem, because the industry is more focused on economic interests and private standards instead of more generally applicable ones (Manning & Baines, 2004). Every sector and company is only responsible for their own product and quality thereof (Federal Ministry of Food and Agriculture, 2012). The increased global food trade has promoted the idea that the same level of protection has to be provided in different countries (Doménech & Martorell, 2015).

When trying to find the most suitable food safety criteria for policy analysis, One of the concepts that came forward was the HACCP. This stands for Hazard Analysis and Critical Control Points, it is applicable under EU law and is meant to manage food safety in seven steps:

1. Conduct a hazard analysis
2. Identify critical control points
3. Establish critical limits
4. Introduce a monitoring system
5. Implement corrective actions in the case of deviations
6. Establish record keeping procedures
7. Produce documentation

A hazard analysis can identify the potential dangers to food safety. The identification of critical points in the system that lead to endangerment of food safety can lead to the establishment of limits that cannot be passed without threatening food safety. When these points are established, a monitoring system can be set in place that checks whether the limits are not surpassed. To make sure this does not happen, corrective actions should be

taken in case of deviations from the set rules. Record keeping is important in this regard, to see whether no deviations over multiple time periods occur. Transparency is created in the form of documentation, which also serves as sort of control measure, since breaches of the protocol would be made public and could create damage to a business' image (Federal Ministry of Food and Agriculture, 2012).

When following these steps, the quality and food safety of a product can be assured (Federal Ministry of Food and Agriculture, 2012). The HACCP was developed as a tool on private scale to comply with standards and regulations. It mainly serves food operators as hazard analysis and compliance tool, which they are obligated to have in place (Manning & Baines, 2004). This is an effective way to perform a hazard analysis.

Several of the HACCP steps match other principles drawn up by the Federal Ministry of Food and Agriculture. Although these principles seem useful for policy analysis as well, it was chosen to use the German Food safety principles as criteria for policy analysis. The HACCP is more a private tool and is not suitable for management of food safety on a larger scale. The German Food safety principles are more general, but partially coincide with steps of the HACCP. They include more information and cover more aspects of food safety. Therefore these principles are more useful for policy analysis. The food safety principles are also very useful because they are operationalized already, which makes it easier to apply to them to the paper and board industry and policy documents. The seven basic principles are elaborated on in the next section. They are presented in figure 6.

Figure 6: Seven basic principles of food safety, Federal Ministry of Food and Agriculture (2012)



1. Corporate Responsibility

Corporate responsibility can be defined as “All those involved in the food production chain must ensure the safety of a food product within their area of responsibility” (Federal Ministry of Food and Agriculture, 2012). Every sector and company is responsible for their own product and safeguarding the quality thereof.

2. Traceability

The official food control authority is responsible for addressing deficiencies in food safety and food inspectors collect random samples or take a sample of certain food flagged by consumers as unsafe (Federal Ministry of Food and Agriculture, 2012). All food business operators in the EU have to document where their food is sent to and where the raw materials or food they use for production come from. This means materials and food can be traced to their source in case of contamination and in case of a threat, recalled from the shops. To do this, food packages have to contain a batch number or date, so it can be traced back easily and quickly (Federal Ministry of Food and Agriculture, 2012). Tracing paper and board trade flows is very difficult, but important in the light of food safety, as a threat has now occurred and possible policy should be suited to the scale of the problem.

3. Official food controls

Checking whether requirements of national and European food law are complied with is the task for food control authorities. In the EU, this is the task of the European Food and Safety Authority (EFSA). Special control plans exist for each product group and the authorities inspect microbiological composition, residue composition, contaminants, sensory composition, composition, other unwanted substances and correct labelling (Federal Ministry of Food and Agriculture, 2012). Without official controls, a possible health threat like the presence of mineral oils in food packaging would maybe never have been discovered.

4. The Precautionary principle

As science is not always able to determine risk in a conclusive manner, the precautionary principle has to be applied. This means precautionary measures can be taken to minimize risk until new scientific data should come available (Federal Ministry of Food and Agriculture, 2012). Precaution is one of the guiding principles of the European Union's environmental law and was characterized in 1998: "when an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically" (Kriebel et al., 2001). This is a very important point in addressing polluted food packaging materials, especially with regard to the potential harmful substances and scientific research thereof. The precautionary principle is the at the basis of and should lead to precautionary policymaking.

5. Independent scientific risk assessment

Connecting to the precautionary principle is an independent risk assessment. Public control authorities, such as The Dutch food and safety authority (NVWA) in the Netherlands, conduct research into significance of certain risks posed in food and feed (Federal Ministry of Food and Agriculture, 2012). As stated by the Commission of the European Communities (2000): "Information gathering and analysis are essential elements of food safety policy, and are particularly important for the identification of potential feed and food hazards". The risk assessment is made independently of political, social and economic influences. After the conduction of research, the possible risk is communicated to the public.

6. Separation of risk assessment and risk management

As a risk assessment is made by scientists and public control authorities, who draw up an independent statement before risk managers are involved (Federal Ministry of Food and Agriculture, 2012). Risk management goes into identifying the appropriate measures to be

taken, who needs to be protected and what risks are acceptable or not. This is necessary to make and implement (environmental) policy in efficient manner. It is important to separate risk assessment and management, as risk assessment should be independent and objective before decisions are made on management. If risk managers would also assess the risk, this probably would not lead to an objective assessment and possibly risk being neglected because management would cost too much.

7. Transparent risk communication

After the risk assessment is conducted, the scientific community together with the political and economic sector discuss possible consequences. Policy-maker then decide on what measures will be taken to mitigate risk (Federal Ministry of Food and Agriculture, 2012). The next step is informing the public. Especially when a potentially hazardous food enters the market, consumers will be informed and the products will be called back by the food business operator (Federal Ministry of Food and Agriculture, 2012).

Safety
Corporate responsibility
Traceability
Official food controls
The precautionary principle
Independent scientific risk assessment
Separation of risk assessment and risk management
Transparent risk communication

Table 3: Food safety criteria

CHAPTER THREE: METHODOLOGY

3.1. Research Strategy

This research will be based on the qualitative data collection and analysis (Bryman, 2012). Data will be derived from available literature online and through my internship organization. An inductive and constructivist approach will be used, starting from separate parts of the system, leading to a more general overview of the industry and conclusion. An in depth study of the newsprint sector will be part of the research to offer more insight into the origin of the food safety problem and the effectiveness of certain possible solutions.

To answer the main research question and sub questions, certain steps are made in the research. As a big part of the problem is set in a circular economy context, it is important to use a way of cyclical thinking when executing the research. This is one of the key aspects of systems thinking, which is based on the idea that elements of a system can be understood best in context of their relation to other elements (Perdicoulis, 2016). An important part of systems thinking is traceability, which increases when the system and relation between elements is clearly defined (Technopolis Group, 2016). Traceability comes back as an important step in generating food safety as well.

Systems thinking will be applied to all facets of the research separately. An overview will be presented in the form of a table at the end of each chapter, showing that part of the system with its most important elements and relations between those elements. Feedback loops also play a crucial role in a circular economy. According to the Ellen MacArthur Foundation (2012): “the ability to understand how different parts influence each other within a whole system is crucial in a circular economy and problems we aim to solve can be framed from a systems integration perspective.” The first part will consist of the analysis of international and European trade flows of paper and board and paper for recycling. At the end of the chapter, an overview will be presented of material flows within the paper and board industry. This is important when looking at possible solutions and understanding the issue of traceability which is one of the issues of food safety policy.

The case study that follows, will investigate the claim (derived from literature) that the newsprint sector is the source of the mineral oil problem and go into whether removing pollution from the newsprint sector can solve the food safety problem. To support my findings on this issue, different material groups and their mineral oil contents will be discussed. How the recycling of paper and board works will also be discussed, so there is a better un-

derstanding of how and where mineral oils enter the recycling chain and how this is eventually causing food safety problems. An overview of this part of the system will be presented in a table at the end of the chapter.

Next, existing European and international policy regarding food safety and circularity relevant to the paper and board industry is discussed. It is also shown how these policies are related to the indicators presented in the theoretical framework. The regulations/policies will be presented and discussed according to level of effectiveness. In the conclusion, a table will show an overview of all policies and their relation to the indicators. Lastly, a chapter is dedicated to the most commonly presented possible solutions to the mineral oil problem in literature and why these solutions are not effective. This will support my recommendations for future research and possible policymaking. As final conclusion, all separate tables will be combined in one, creating a complete overview of the system, feedback loops, possible solutions and knowledge/policy gaps. Using this table, the main research question will be answered.

3.2. Research Methods and Data Collection

Research will mostly be based on literature review and the analysis of annual statistics of the Confederation of European Paper Industries (most recent version, published in 2015). Numbers and figures presented in these statistics will be the basis of the analysis of European and global paper and board trade flows. Some figures in the report show total amounts of paper and board and paper for recycling that were traded with from and within Europe and with continents and countries on a global scale. This gives insight into production, collection and recycling of paper and board in Europe and how much packaging material is produced to establish the scale of the mineral oil and food safety problem. The trade of different grades was looked at, as not all paper grades are used in the production of packaging paper. It also shows the amount of trade of newspapers and magazines, which is important to clarify before elaborating on this in the case study.

Numbers on the amount of newsprint being produced and recycled, in which paper and board flows this ends up, and how these flows are related to the production of packaging material were used to calculate the amount of newsprint that ends up in food packaging for example, which is needed to perform the case study into pollution in the newsprint sector. This in depth study was done by further analyzing CEPI and other numbers to find out how much newsprint is collected and recycled, to what purpose it is used as resource

again and how much mineral oils it actually contains compared to other paper and board products.

Relevant European and international policy regarding food safety and circularity of paper and board was found by an online literature search. Most official policy documents are found through EUR-Lex, which is the official website offering access to EU law. The official policy documents were used to establish relevance and relation to food safety and circularity policy.

3.3. In depth Study Approach

An in-depth study of the newsprint sector was chosen as basis to study the food safety problem. It is not a case study, as it looked into a phenomenon that has not been researched before this way. It is also a specific case that cannot be generalized completely. After reading several articles, it began to stand out that the blame for food safety issues and mineral oil pollution was being put on the newsprint sector. Mineral oils were said to be originating mainly in newspapers and the recycling of these materials (and use in food packaging) was what was causing food safety problems. The focus lay so strongly on this sector, that looking into the claims made in literature and seeing if they were in fact justifiable, was a logical step. This would mean food safety problems could be solved by focusing on eliminating pollution from the newsprint sector. The first step was the collection of data on printing inks, production of newspaper and packaging papers. An analysis of how newspapers end up as packaging papers and the amount of mineral oils this would contain was done. Other possible sources of mineral oils were also looked into.

3.3.1. Reliability

The reliability of the data will be high, as it was collected over multiple years and reflects the entire paper and board industry. Papier & Karton has a wide range of knowledge through different employees and sections of the paper industry that are reflected within this institute. I will only make use of scientific and peer reviewed data. One of the contact persons I have contacted for this research is Hans Wortman. He is an expert in the recycled paper industry provided me with more information, mainly about the newsprint sector and mineral oils. Through my internship I was also able to buy a chapter about mineral oils from the TU Darmstadt that gave more insight in the mineral oil contents of different paper grades. For the analysis of trade flows, I decided to use annual statistics of CEPI from

2015. CEPI is a non-profit organization that acts independently from the government. The Confederation of European Paper Industries represents the European pulp and paper industry and represents about 510 pulp, paper and board producing corporations across Europe through member associations. The data that is presented is mainly provided on a voluntary basis by CEPI member National Associations and complemented with data from other (clearly stated) sources. The data that is provided is reliable, but incomplete, as not all associations are obligated to provide data. In some cases, data from different countries are taken together in a category such as 'other countries within CEPI', which decreases the transparency on specific country data. National Associations of 18 countries are part of CEPI, which means this is not completely representative for the whole of Europe or the European Union even, as this consists of 28 countries. However, CEPI numbers are the most used in the paper and board industry and provide the most insightful and complete information about the European paper and board industry needed to execute this research.

Even within all numbers from CEPI, not everything is based on actual data. From some countries, CEPI has made an estimate. This is noted in the definitions page at the end of the statistics and for example applies to Portugal's utilization of paper for recycling. This decreases the reliability of the data, as actual numbers could differ from presented statistics. CEPI is the authority most invested and specialized in the paper and board industry. It is also an independent authority not linked to any government. Therefore it is assumed that the estimated numbers are based on objectivity and expertise and give the most realistic (general) image possible.

3.3.2. Validity

The internal validity of the research is positively influenced by the fact that information from different players within the industry was collected and used to draw conclusions. Not only were CEPI numbers used, but also numbers from the VNP, TU Darmstadt and other peer reviewed articles were used. The numbers represent the year 2015, which is the most recent year the numbers are available for. Official policy documents were used for analysis, together with peer reviewed sources.

Validity is negatively influenced by the usage of numbers and choices for certain policy documents. In choosing which policy to analyze, the focus was on EU, European and international existing policy regarding a circular economy and food safety. Private standards as well as national policy are not reflected in the research as this would not be

effective in creating a solution of the research dilemma. There was also no time to include this data into the research. However, it could give more insight into the complete existing policy framework. The private standards do not impact the system enough by themselves, but possibly together this could have substantial influence and be an effective method in solving the research dilemma. This negatively influences the internal validity, as the complete overview and analysis could be more elaborated on in future studies and is not representative for all of the industry and all countries.

There is also a lack of numbers on the amount of packaging papers actually intended for food contact. No certain numbers were found to indicate this amount. As a result, the conclusions may not be representative for the actual real life situation. The same goes for the lack of numbers on mineral oil content in packaging papers. No complete sources were found that indicate the mineral oil content in packaging papers on a large scale.

Overall, the conclusions were made based on available literature and numbers, as recent as possible. Based on the current knowledge, many numbers probably represent the current recycling chain quite well, rendering external validity high.

CHAPTER FOUR: TRADE FLOWS

4.1. Introduction and Global Numbers

The following table contains a few concepts that were used in the following chapter and their definition (CEPI, 2015):

Concept	Definition
Wood Pulp	Pulp produced from wood fibres. Also; virgin finer
Collection	Separate collection of paper and paper products from industrial and commercial outlets, from households and offices for recovery (= utilisation plus exports minus imports of paper for recycling)
Paper for recycling	Substitute term for 'recovered paper'; intended use of collected paper for recycling in paper mills
Paper and board consumption	Production + imports from other CEPI countries + Imports from outside CEPI - Exports to other CEPI countries - Exports to outside CEPI
Mixed grades	Waste and scrap of paper or paperboard, including unsorted waste and scrap
Corrugated & Kraft	Unbleached kraft paper or paperboard or corrugated paper or paperboard
Newspapers and magazines	Paper or paperboard made mainly of mechanical pulp. Including old and unsold newspapers and magazines, telephone directories, brochures and printed advertising material
Other grades	Other paper or paperboard made mainly of bleached chemical pulp, not coloured in the mass
Graphic papers	Includes newsprint, uncoated mechanical and wood free paper, coated papers
Sanitary and household	Wide range of tissue and other hygienic papers for use in households or commercial and industrial premises
Utilisation rate	Percentage of paper for recycling utilisation compared to the total paper production
Packaging papers	Includes case materials, carton board, wrappings and other paper and board for packaging

Table 4: Definition of commonly used concepts (CEPI, 2015).

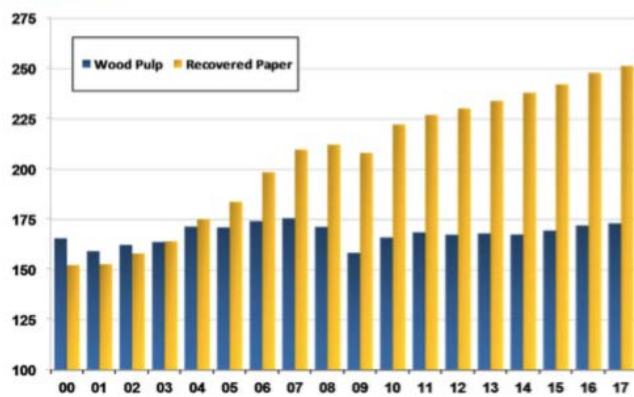
The world's paper and board industry is becoming more and more dependent on paper for recycling. Together with wood pulp, this forms the basis of paper making. As can be seen

in Figure 7, the share of recovered paper compared to wood pulp has gone up over the last decade. It now constitutes about two-thirds of the material used for paper and board production and has thus become quite irreplaceable. The increased use of recycled materials is a positive development for the environment, as less trees have to be cut for resources and an increasing amount of used paper is collected, recycled and re-used instead of discarded as waste and incinerated. The recycling rate in Europe has gone up over the last years, making Europe global leader in this regard. The recycling rate can be defined as: “the percentage of paper for recycling ‘utilization + net trade’ compared to total paper and board consumption (CEPI, 2015). In Europe, this percentage is about 72%, so of the total amount of paper and board that is consumed within Europe, 72% originates in paper for recycling. The recycled material is used for production of paper in all sectors and it is therefore very important that the material is of good quality and does not cause health risks for users/consumers. To be able to control pollution and contamination of recycled paper and board, it is important we know where the paper for recycling comes from, especially the paper and board that is used in (food) packaging materials.

Figure 7: World usage of Recovered paper and wood pulp (RISI, 2016).

World Usage of Recovered Paper and Wood Pulp

Million Tonnes



RISI

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4.2. European Trade Flows of Paper and Board/Paper for Recycling

4.2.1. General Trade Flows

The Confederation of European Paper Industries (CEPI) is a very large non-profit making organization that represents 93% of the European paper and board industry in terms of production (CEPI, 2015). CEPI collects and presents data on the paper and board industry that was collected from members on a voluntary basis (CEPI, 2015). The data is then published in annual reports and statistics, which is where most tables and numbers in this chapter are derived from.

Figure 8: Trade flows of paper and board (CEPI, 2015).

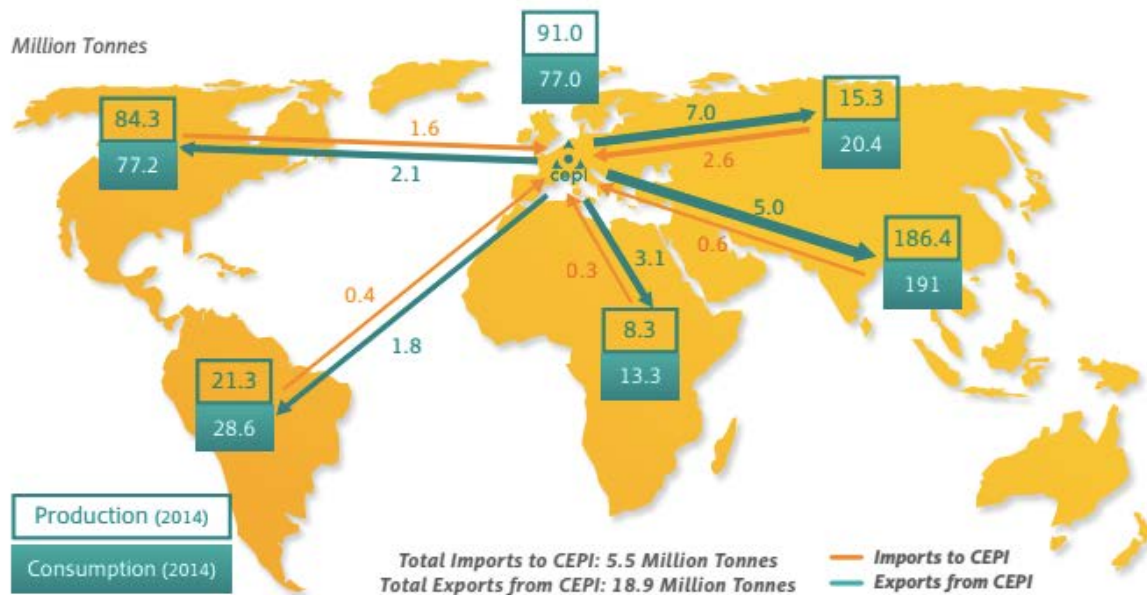
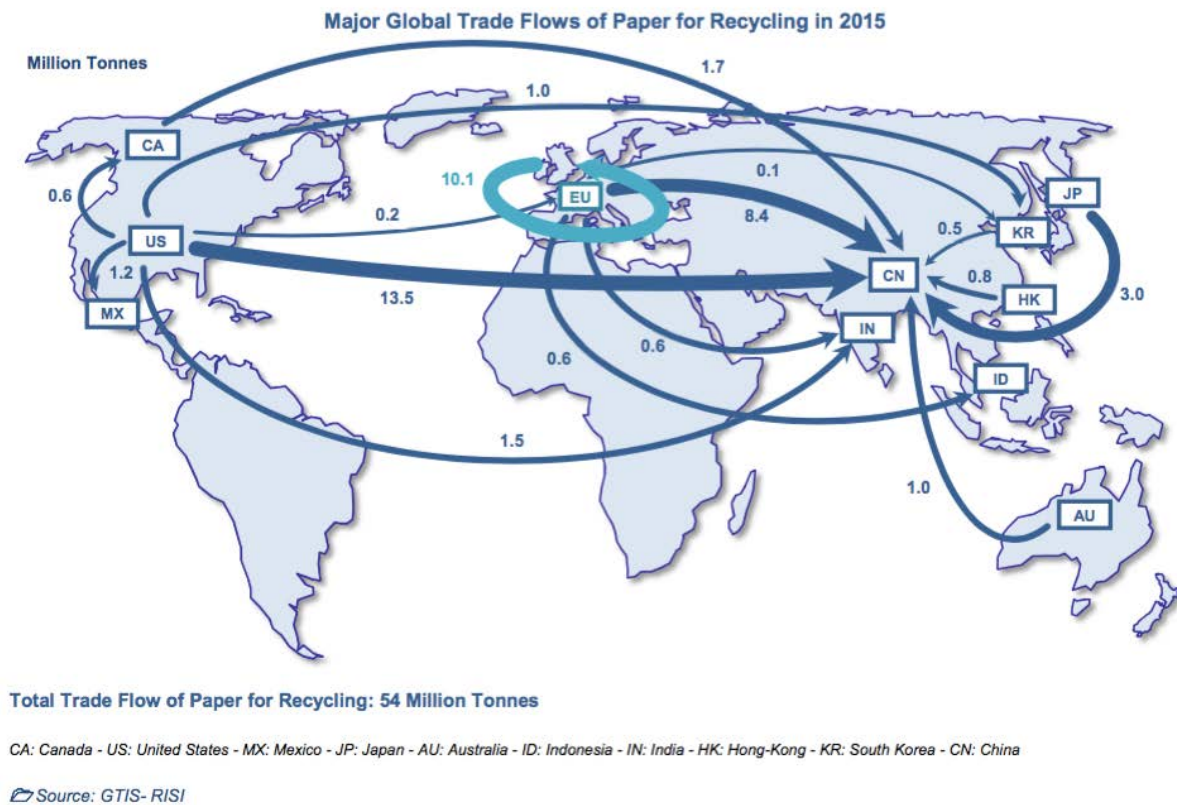


Figure 8 represents the main global trade flows of paper and board in 2014. Production and consumption of paper and board are presented per continent. What stands out is that Europe (members of CEPI) together with North America, is the only player that produces more paper and board than it consumes and is the biggest exporter of paper and board worldwide (Figure 8). When it comes to paper for recycling, Europe is also the largest collector. Collection of paper for recycling is defined by CEPI as: "Separate collection of paper and paper products from industrial and commercial outlets, from households and

offices for recovery. Collection = utilization plus exports minus imports of paper for recycling” (CEPI, 2015). The figure shows global trade of paper for recycling and different continent’s total collection and utilization of paper for recycling. Utilization is defined as: “Use of paper for recycling as raw material” (CEPI, 2015). Even though CEPI collected more paper for recycling in 2014 than necessary for production, there was still import from different regions in the world. Still, CEPI is the main exporting area globally, with exports being almost four times as high as imports (Figure 8).

From both figures can be derived that Asia is Europe’s biggest trade partner in paper and board as well as paper for recycling. Mainly China is one of the biggest partners of Europe when it comes to export of paper for recycling. What stands out is that although we export most of our paper for recycling to China, there is no import from that region (Figure 9). China’s utilization is a lot higher than its consumption and as can be seen in Figure 8, it does not export any paper for recycling to other countries, only paper and board (Figure 8). Still, the biggest flow of paper for recycling is traded within the EU (Figure 9). This means Europe mostly uses its own materials and therefore seems to have a high level of control over the market and general overview of the origin of paper for recycling. However, the exported paper for recycling is imported as paper and board again, which decreases the amount of control, as there is no monitoring of the foreign production process and possible substances being added to the paper and board material. The imported paper and board (which could for example enter the European market in the form of packaging boxes) is collected as paper for recycling again and thus ends up in the European recycling chain after all.

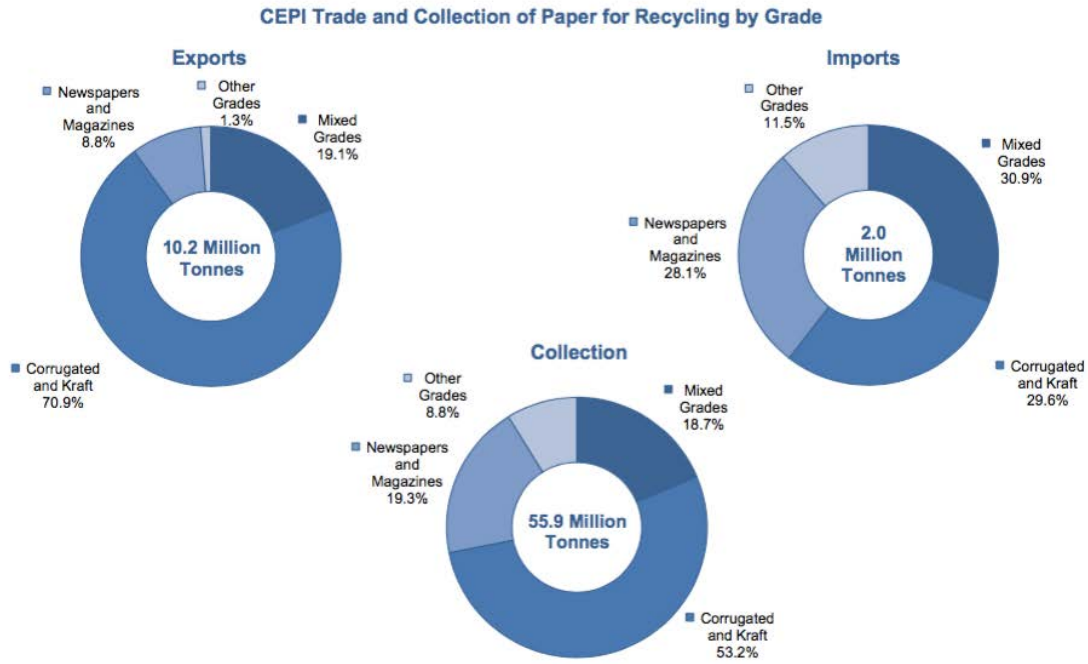
Figure 9: Major Global Trade Flows of Paper for Recycling in 2015 (RISI, 2016).



4.2.2. Usage of Paper for Recycling

The collection of paper for recycling in Europe is more specified in Figure 10. The collected paper for recycling consists of different types of material. Corrugated and Kraft materials form the biggest group of paper for recycling that is collected, with newspapers and magazines as second biggest, and mixed grades as third biggest group (Figure 10). Imports of these three materials is somewhat even, while export mainly consists of Corrugated and Kraft materials.

Figure 10: Trade and collection of paper for recycling by grade



CEPI Utilisation of Paper for Recycling by Sector in 2015

'000 Tonnes Paper Sector	Grades of Paper for Recycling							
	A Mixed Grades	B Corrugated and Kraft	C Newspapers & Magazines	D Other Grades	E Total Use of Paper for Recycling	F Usage by Sector ¹ %	G Total P&B Production	E:G Utilisation Rate ² %
Newsprint	27	0	6,428	59	6,514	13.7	7,019	92.8
Other Graphic Papers	165	22	2,733	686	3,606	7.6	28,246	12.8
Total Newsprint + O.G.P.	192	22	9,161	745	10,120	21.2	35,265	28.7
Case Materials	4,517	19,760	241	881	25,400	53.2	27,059	93.9
Carton Board	1,804	566	120	866	3,357	7.0	8,710	38.5
Wrappings, Other Pack.	2,036	1,708	161	491	4,395	9.2	8,803	49.9
Total Packaging Papers	8,357	22,034	522	2,238	33,152	69.5	44,572	74.4
Sanitary and Household	285	108	620	1,878	2,890	6.1	7,153	40.4
Other Paper & Board	264	961	151	172	1,548	3.2	3,881	39.9
Total Paper & board	9,098	23,125	10,454	5,034	47,710	100.0	90,872	52.5
Share of Total	19.1%	48.5%	21.9%	10.6%	100.0%			

¹Utilisation by sector: total use of paper for recycling in a sector as % of the total paper for recycling used by the industry

²Utilisation rate: use of paper for recycling in a sector as % of total paper & board production in that sector

Table 5: Utilization of Paper for Recycling per Sector in 2015 (CEPI, 2015).

Table 5 shows how the paper for recycling is utilized per sector in Europe and the different purposes for which paper grades are used. The most important sector for this study is that of packaging papers. It shows that in production of packaging papers, Corrugated and Kraft materials are the main source of paper for recycling used as raw material (table 5). The packaging sector is also the biggest user of paper for recycling, coming down to 69,5% of the total use of paper for recycling. Most paper for recycling is thus used for the production of packaging papers. This is also reflected in the utilization rate (74,4%) in this sector, defined by CEPI (2015) as the: “percentage of paper for recycling utilization compared to the total paper production”. This means that of the total production of packaging papers, 74,4% of the used raw material is paper for recycling (Table 5).

4.3 Sub-Conclusion

The following table gives a general overview of the paper and board market and trade flows for CEPI in 2015:

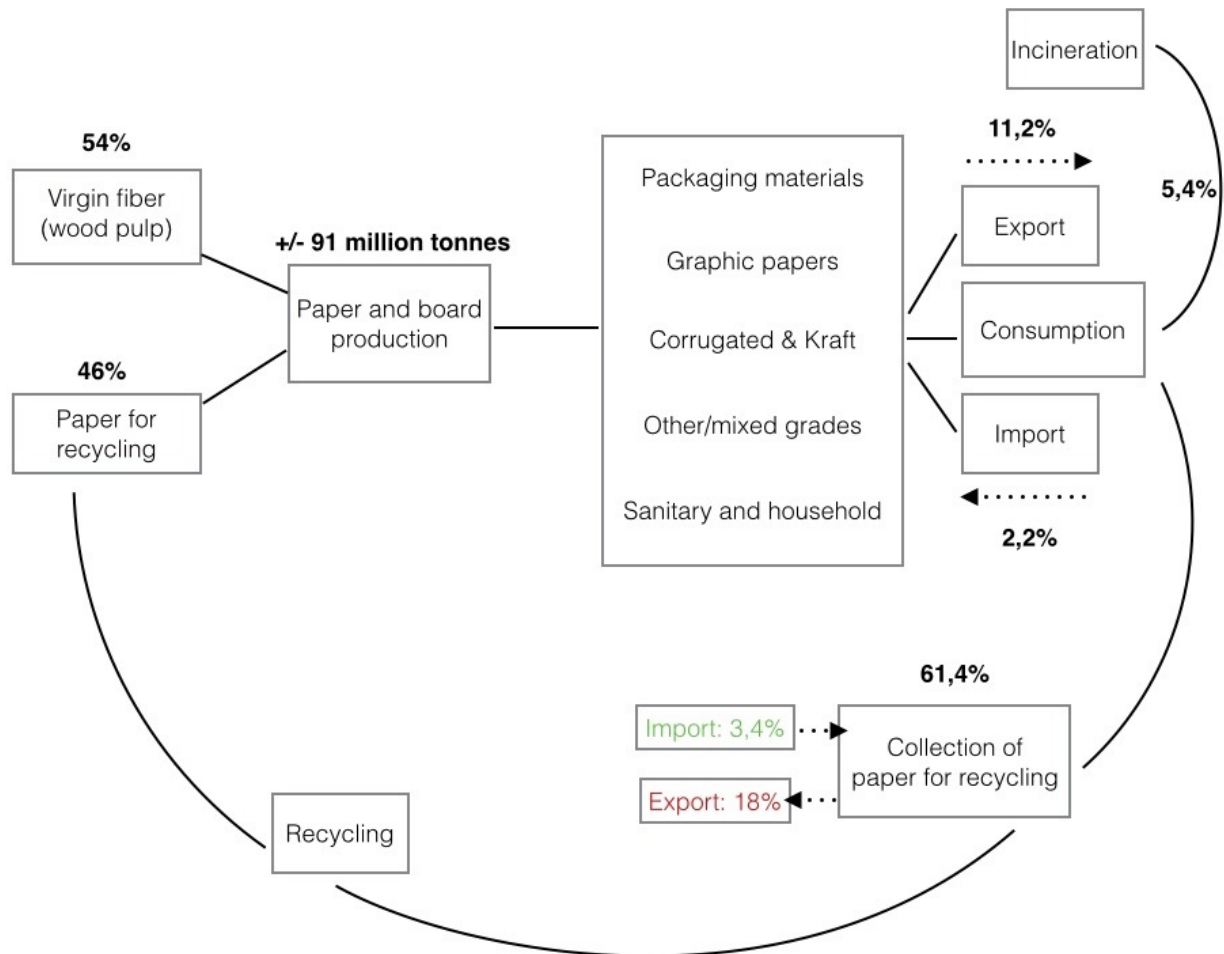


Figure 11: Schematic overview of paper and board market and trade flows (based on: CEPI, 2015).

Explanation of figure 11:

Paper and board production within CEPI comes down to about 91 million tonnes. As resource for production, 54% of the material is virgin fiber and 46% is paper for recycling. Different paper and board types are produced within CEPI. These are packaging materials, graphic papers, corrugated and Kraft, other/mixed grades and sanitary and household papers. Of all these products, a total of 11,2% of total production is exported to countries within and outside of CEPI. 2,2% of total production is imported from countries within or outside of CEPI. After products are used by consumers, 5,4% of total production is incinerated whereas 61,4% of total production is collected as paper for recycling. Paper for recycling is then also being traded. In total, 3,4% of total production on paper for recycling is

imported and 18% is exported. After paper for recycling is collected, it is recycled into suitable paper for recycling to enter the production chain again. Some detailed steps in the production process were left out intentionally to avoid too much complication. This figure shows the complexity of the system and trade flows entering the recycling chain, without knowing what materials these paper and board and paper for recycling are made from.

On a global scale, paper and board production is becoming more and more dependent on paper for recycling, and so is the European paper and board industry. This is reflected in utilization rate and recycling rate, one of the criteria of a circular economy. Numbers from RISI (2016) prove the importance of decreased use of virgin fiber/wood pulp and growing reliance on paper for recycling. Paper for recycling is imported and exported from and to many different countries. Globally, Europe trades most paper and board with Asia (mostly China) but the largest trade flows are still within Europe. Mainly Corrugated and Kraft materials are used as raw material, though the second biggest group of collected paper and board consists of newspapers. The packaging sector is the biggest user of paper for recycling in general in Europe. The large amount of countries recycled paper and board comes from, makes it very difficult to trace back materials and possible pollution. All in all, the paper and board industry is very circular on European level, though a lack of traceability makes it more difficult to make effective policy to guarantee food safety.

CHAPTER FIVE: IN-DEPTH STUDY OF THE NEWSPRINT SECTOR

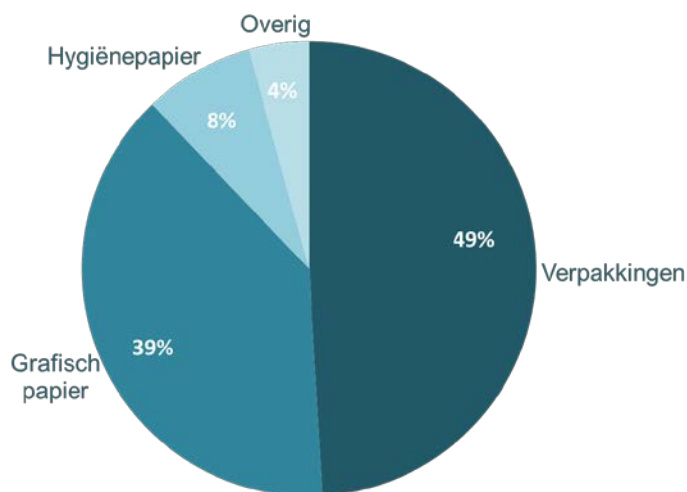
5.1. Introduction (Printing inks are related to food safety issues)

The mineral oil problem is mainly blamed on the newspaper and magazine sector as these are regarded as the main source of printing inks in recycled paper and board material (Goeyens, 2014). In recycled board, substantially less mineral oil is found than in newspaper, though this is partly removed through evaporation in the paper drying process (Biedermann & Grob, 2010). So if most mineral oils originate in the newspaper sector, can this be seen as the main cause for food safety concerns? To answer this question, we need to take a closer look at the paper and board industry in Europe.

5.2. Printing inks and Packaging Papers

When looking at the different sectors within the paper and board industry in Europe, we can see that packaging papers have the upper hand. Almost 50% of the total Paper & Board production is intended for packaging purposes. A small share is used for Sanitary and Household purposes and graphic paper holds a share of about 39%, including newspapers and magazines. Newsprint accounts for 7019000 tonnes (Table 5) which rounds up to 20% of the total amount of produced graphic paper. These percentages are obtained by dividing the total CEPI production per grade by the Total Paper and Board production of CEPI in 2015. A clear representation of the industry division in percentages can be found in figure 12.

Figure 12: Presentation of CEPI production of paper and board in 2015, in percentages, by grade; based on numbers of CEPI (2015), Annual Statistics.

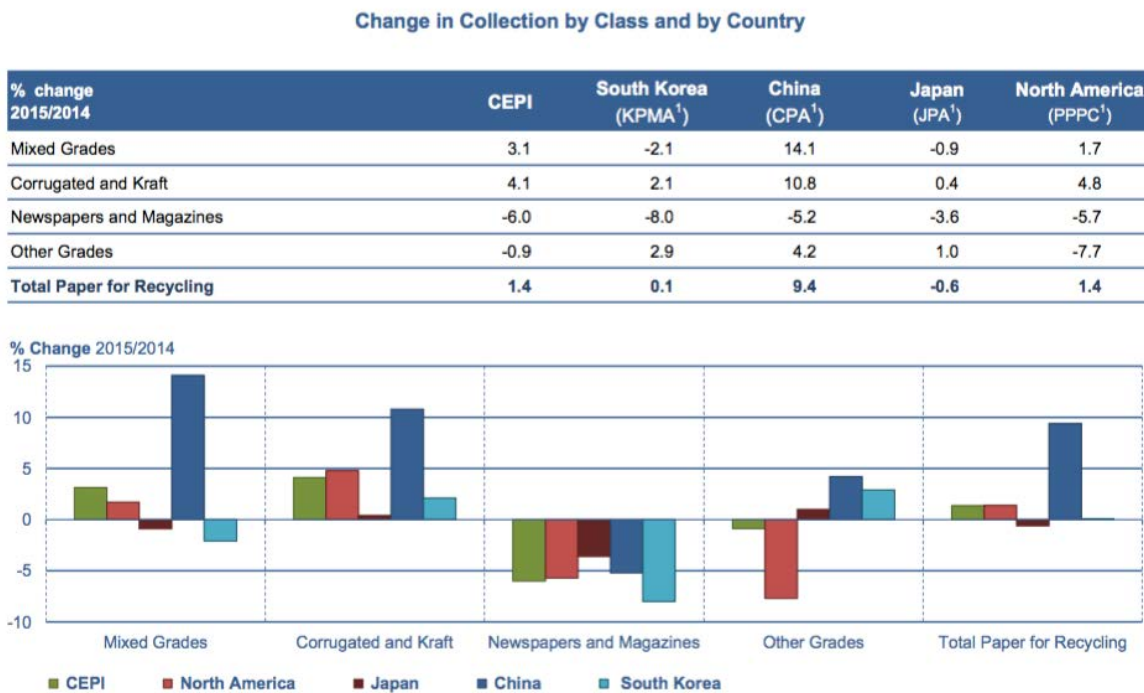


CEPI, Annual Statistics, 2015

The total paper and board production within CEPI countries has gone down by 0,2% (Table 5). As can be seen in table 5 as well, this decline is mainly caused by a decline in the Graphic paper sector (-3,8%), which, in turn, is mainly caused by a decline in newsprint production of 7,6%. The newsprint sector has not only experienced a decline in production in Europe, but production and collection have gone down globally. This can be seen in Figure 13.

The amount of collected paper directly relates to production, as what is not produced, cannot be collected. It also indicates that less newspapers and magazines end up in the recycling cycle and account for a lower percentage of the total collected paper and board used for recycling in Europe and globally, as the total amount of collected paper for recycling has generally increased (except for Japan) (Figure 13).

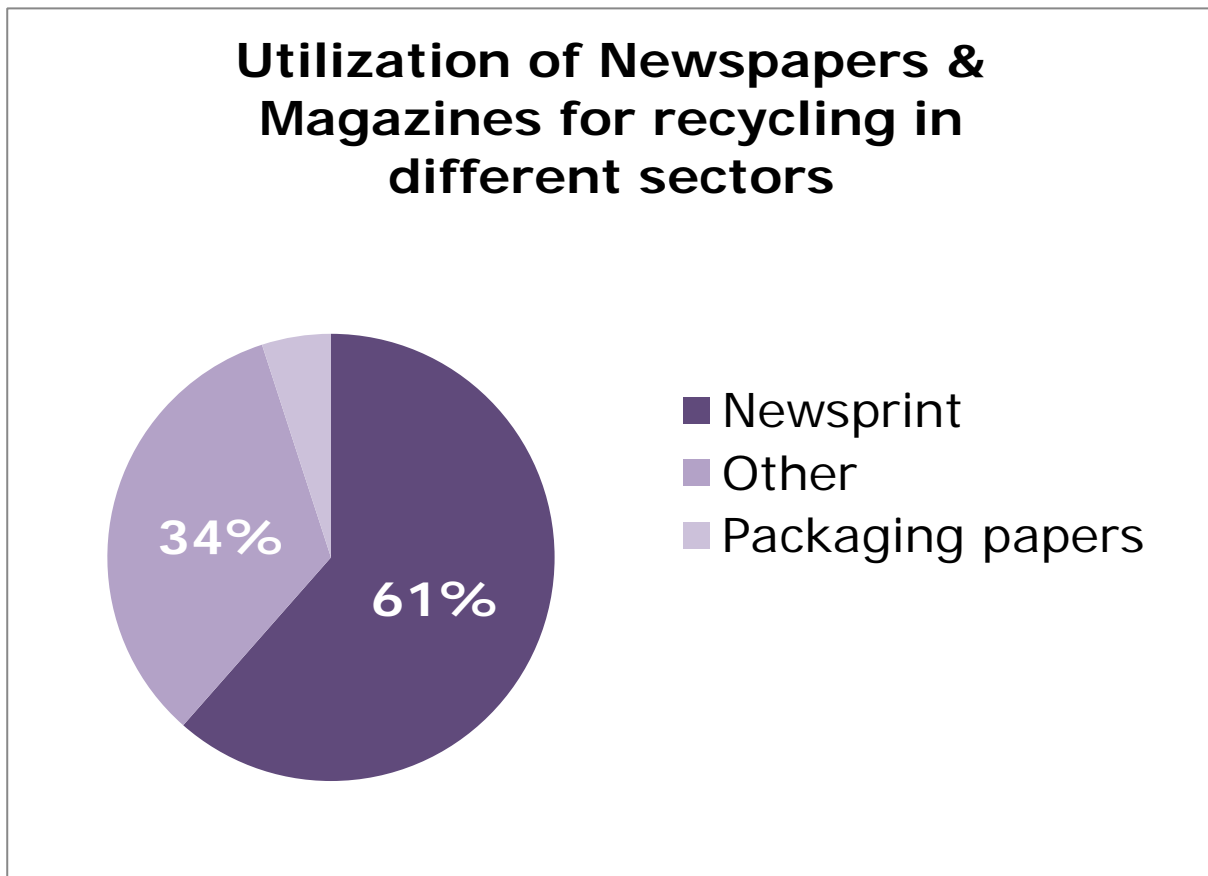
Figure 13: Change in collection by class and by country; CEPI (2015), Annual Statistics.



However, the amount of newspapers and magazines that was collected has drastically declined between 2014 and 2015. It was even the only class that experienced such a drastic decline in all countries (compared to the other paper classes). This can be explained through the fact that news and articles are increasingly being published online instead of on paper. Internet articles are also easily and freely accessible from any location, which is also one of the reasons the newspaper and magazine industry is shrinking globally.

The amount of newsprint that is collected and ends up in the recycling chain, does not necessarily end up in packaging papers. Table 5 shows the different paper sectors and their use of different grades of paper for recycling. This shows how much of recycled material of each grade is used in the production of products in all paper and board sectors. When we look at the graphic paper sector, the total use of paper for recycling is 10,120 ('000 tonnes). This amount consists of mixed grades, corrugated and kraft, newspapers & magazines and other grades. The largest part, 9,161 ('000 tonnes) comes from newspapers and magazines. This amounts to about 90% of the paper for recycling used by newsprint and other graphic papers. Only looking at newsprint, this even amounts to almost 99%, meaning the newsprint sector mainly uses its own materials for recycling. In other words, newsprint mostly ends up as newsprint again after going through the recycling process.

Figure 14: Utilization of newspapers and magazines for recycling in different sectors, in percentages; based on numbers of CEPI (2015), Annual Statistics.



Packaging papers are using the most paper for recycling of all sectors (Figure 14). Corrugated and kraft materials are the main source of paper for recycling, whereas newspapers and magazines contribute the least. Only 5% of the newspapers and magazines are used as paper for recycling in the packaging sector (Figure 14). This is a total share of newspapers and magazines of only 1,6% in the total use of paper for recycling in packaging papers. In other words: only 1,6% of packaging papers made from paper for recycling consists of newspapers and magazines. Of these packaging papers, only a certain amount is used as food packaging. The precise amount cannot be found in literature, but Leo Goeyens mentions in his book: “Food products account for 62% of all paper and paperboard packaging” (Goeyens, 2014). This number originates in 2014 and it is not clear whether Goeyens means on a European or global level, but assuming this would be somewhat correct on a European level, it would mean that of the 1,6% share of newspapers and magazines in packaging papers, 62% would end up in food packaging. This is a share of only 0,992%. It has been proven that newsprint is indeed the main source of mineral oils, though the market share is so low that other sources must exist as well for mineral oils to

end up in packaging papers and food and a broader perspective has to be used when looking for effective solutions on European scale.

5.3. Other Origins of Mineral Oils

Besides the newsprint sector and printing inks as biggest source, other sources of mineral oils and contact with food packaging and food exist. Food can be contaminated with mineral oils during different steps of production and transport. The CONTAM Panel identified numerous sources for the occurrence of MOH in food: “Among food contact materials, sources are food packaging materials made from recycled paper and board, printing inks applied to paper and board, MOH used as additives in the manufacture of plastics, etc.” (EFSA, 2012). The health risk mainly lies in the presence of MOAH, as it is currently impossible to assess the risk of oral intake of MOAHs, which means the lowest possible amount of exposure could already lead to health concerns (Goeyens, 2014). However, it is very difficult to measure the amount of MOAH present in food. Data on mineral oils in food is only available for a limited number of food groups and countries. Almost all the collected data is on total MOSH as most samples did not have a MOAH measurement available. Concentrations of MOAH are estimated based on composition of the detected mineral oil product (EFSA, 2012). Even if MOAHs are present in an amount that would be acceptable for MOSH (0,01mg per kg body weight), there are no guarantees of food safety (Goeyens, 2014). Detection limits only go as low as 0,1 mg/kg, which is higher than the acceptable daily intake (EFSA, 2012), meaning every product where MOAH is detected in even the smallest amount, would be a health concern.

An illustration of mineral oils being present in food is found in a report of the GMELV, which is the German ministry for food and agriculture and German consumers association. In a report about mineral oils in foodstuffs and packaging, they published a table in which several types of foodstuffs, their packaged weight and the concentration of MOSH/MOAH present in the food was packed are presented (Table 6). From the numbers can be derived that the amount in the food without packaging exceeds the acceptable daily intake of 0,01mg/kg as established by the EFSA (EFSA, 2012).

Tabelle 21 Liste der verwendeten Lebensmittel, deren Gewicht in der Packung sowie die Gehalte an MOSH und MOAH vor der Verpackung

	Gewicht (g)	Konzentrationen (mg/kg) vor Verpackung	
		MOSH	MOAH
1 Schokoladen-Kekse	125	1,1	< 0,2
2 Maisgries	150	0,4	< 0,1
3 Nudeln	100	5,0	< 0,1
4 Reis	150	2,2	0,6
5 Paniermehl	100	1,0	< 0,1
6 Haferflocken	100	0,8	< 0,1

Table 6: List of used foodstuffs, their packaged weight and the content of MOSH and MOAH before packaging (German ministry for food and agriculture and German consumers association, 2012 p.118).

When looking at some more numbers on mineral oils, it is clearly visible that most mineral oil pollution indeed comes from the newsprint sector. In table 7, different MOSH/MOAH contents are presented for different types of paper products. It shows that Newspapers by far contain the most mg/kg of mineral oils in comparison (Table 7). The other products contain mineral oils in far lower amounts. Although this is the case, they are still present in other products in amounts exceeding the ADI advise of 0,01 mg/kg (EFSA, 2012) and can also be cause for food safety concerns. These numbers are confirmed by Biedermann, Uematsu & Grob (2011). A table published in this article shows different types of recycled paperboard materials and their MOSH as well as total mineral oil concentrations. This table coincides with the table from TU Darmstadt, stating that newspaper contains the highest amount of MOSH and MOAH compared to other types of material (table 8).

Table 4 Model validation

MOSH/MOAH content of paper products (printed)	Newspapers	Magazines (wood containing)	Corrugated board	Folding boxes made from RCP (food packaging)	Folding boxes made from RCP (non-food applications)
Calculated (mg/kg)	4,313	540	270	403	620
Relation calculated vs. measured (=100%)	108%	81%	119%	76%	83%
Measured (avg.) (mg/kg)	3,988	667	226	527	744
Measured (min.) (mg/kg)	1,870	189	64	177	433
Measured (max.) (mg/kg)	7,457	1,090	447	1,826	1,967

Table 7: MOSH/MOAH content of different paper product (TU Darmstadt, 2012).

Table 1. Overview of $<C_{24}$ MOSH and mineral oil (MOSH + MOAH) concentrations in sources for recycled paperboard.

Type of material	Number of samples	MOSH $<C_{24}$ (mg/kg)		Mineral oil $<C_{24}$
		Range	Mean	Mean (mg/kg)
Newspaper	17	1100–5700	2650	3240
Leaflets	8	780–4200	1900	2300
Paperboard, recycled fibres	54	50–3800	711	845
Magazines	6	205–710	440	258
Paperboard, virgin fibres	30	5–1900	230	262
Reports	6	2–579	180	218
Corrugated board	30	37–270	127	156
Books	4	4–230	80	94
Office paper	5	18–50	35	40

Table 8: Overview of MOSH and MOSH+MOAH concentrations in sources for recycled paperboard (Biedermann, Uematsu & Grob, 2011)

5.4. Sub-conclusion

The following table gives an overview of the system and where mineral oils/pollution enter the recycling chain:

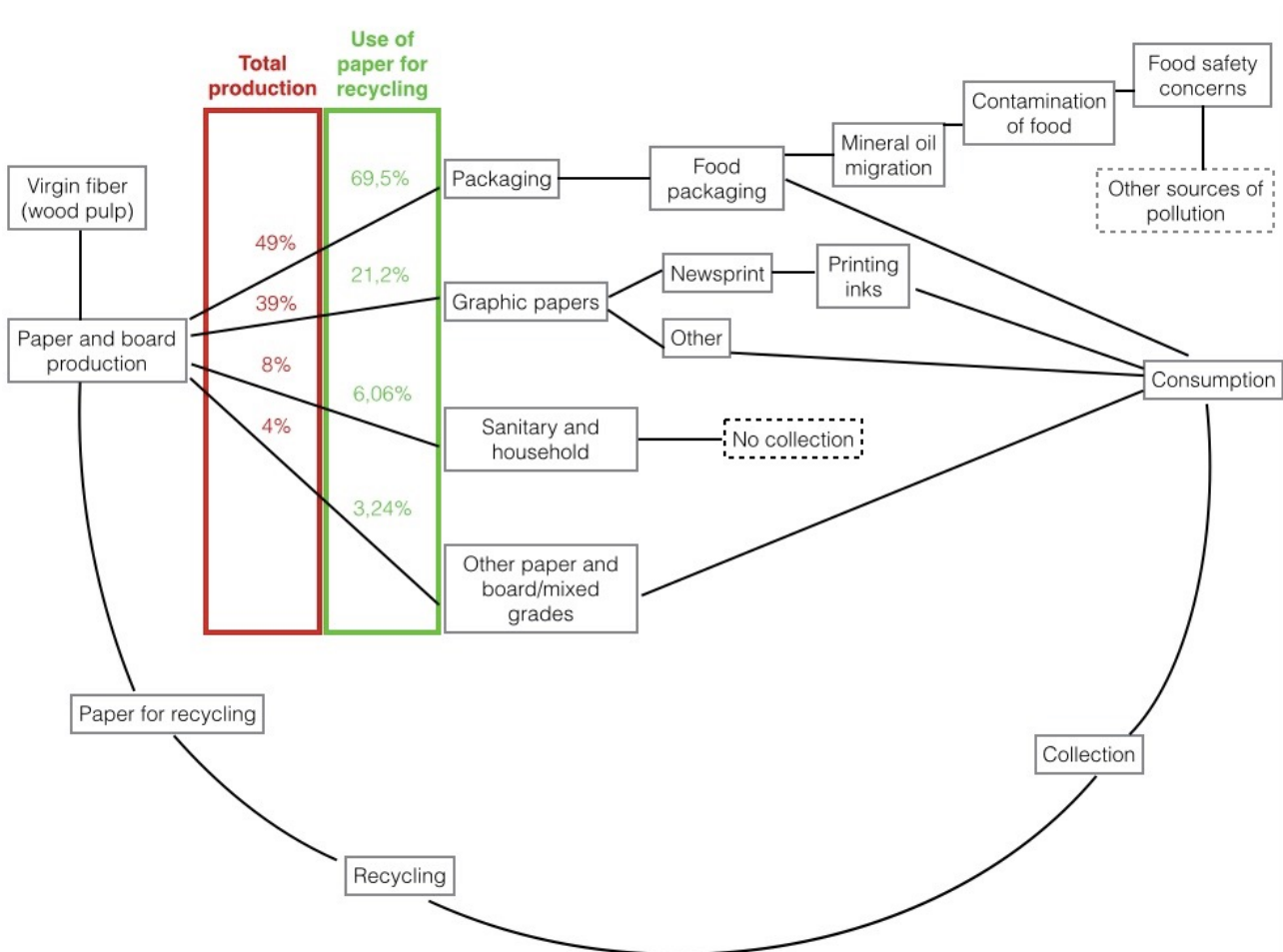


Figure 15: Overview of mineral oils entering the paper and board recycling chain (based on: CEPI, 2015).

Explanation of figure 15:

Paper for recycling and virgin fiber are (as named before as well) the resources for paper and board production. Of all the paper and board produced, 49% consists of packaging papers, 39% graphic papers, 8% sanitary and household and 4% other paper and board/mixed grades. The amount of virgin fiber and paper for recycling used to produce each grade differs. As can be seen in the figure, packaging papers contain the highest amount of paper for recycling, followed by graphic papers, sanitary and household and last, other paper and board/mixed grades. As packaging holds the highest market percentage (about 50%, table 5), this makes sense.

Starting from the bottom, other paper and board/mixed grades are collected for recycling/use as paper for recycling after consumption. Sanitary and household papers are an end-of-use product. They are not collected for recycling after consumption, as the material is not suitable for this as the quality is not high enough.

The production of graphic papers consists of newsprint and other graphic papers. In the production of newsprint, many printing inks are used. Together with the newsprint and other graphic papers, printing inks find their way through production to collection and use as paper for recycling again. This way, printing inks enter the recycling chain in paper for recycling as resource for production, ending up in different paper types again. As packaging papers use the highest amount of paper for recycling, the highest amount of printing inks end up here.

From all produced packaging papers, a certain amount (no definite numbers available) is used for food packaging. Through the recycled material containing printing inks, which contain mineral oils, migration from the packaging material into the food takes place. This leads to the food being contaminated, which is cause for food safety concerns. 'Other sources of pollution' is framed by a dotted line, as there are several points within the system where contamination may occur, though it can also originate outside the recycling chain. This is why other sources are not included multiple times, but summarized as one.

From the in-depth study into the newsprint sector can be derived that the sector is indeed the main source of mineral oil pollution through printing inks. Though even if pollution was prevented and completely removed from the newsprint sector, this would not lead to a complete disappearance of the food safety problem, as there are other sources of pollution that exist. Current norms set a limit of 0,01 mg/kg. As can be seen in German numbers, the minimal amount of MOSH measured in an individually packaged food was 0,4 mg/kg for cornflower ('maisgrries'). This exceeds the limit by 40 times the acceptable amount. In the least possible scenario presented, the limit is even exceeded by 500 times the acceptable amount (noodles). Even though the measured MOAH is in most cases below detection limit, it cannot be ruled out that this does not exceed 0,01 mg/kg. Since MOAH cannot be measured in amounts lower than 0,1 mg/kg, the most minimal present amount has to be assumed to exceed the limit (EFSA, 2012). Consequently, health problems like cancer could develop a lot more rapidly in humans. Based on current knowledge, mineral oils would have to be banned completely to meet required standards.

A focus on the newsprint sector could lead to a reduction of the problem, but contact with mineral oils and food safety concerns will also be present through other sources.

The answer to the sub-question is therefore twofold: yes, the newsprint sector can be pointed at as the main source of mineral oils in paper and board, but it is not the only reason for food safety problems. Elimination of food safety problems in the European paper and board industry is a difficult task that needs to be focused on the industry as a whole instead of looking for solutions in one sector alone.

CHAPTER SIX: EUROPEAN POLICY

Although there are several private standards and regulations effective on industry level, these will not be discussed. As has been shown in previous chapters, mineral oil pollution is a global problem. Private regulations can be of help, but will never solve the problem. It is necessary to look at a larger scale at what policies are in place and where possible overlap or policy gaps can be found. The policies and regulations used for the policy analysis will therefore regard policy made by EU, European or international authorities which is effective on EU, European or international level and are relevant to the paper and board industry. Policies will be discussed in two separate paragraphs, dividing between food safety and circular economy. The policies will be discussed according to level of effectiveness and they will be related to the set criteria. The discussion will conclude with a general overview of the criteria policy relates to and where policy gaps can be found, **which will be useful for the identification of effectiveness of possible solutions.**

6.1. Policy regarding a circular economy

For a circular economy, only European policy will be discussed. Table 13 shows the most important existing circular economy policies that will be discussed, by whom they were made and whether they are officially binding or not. The same table is made (in threefold) for food safety policies in the next paragraph.

Circular Economy	Who?	Officially binding?
Waste Framework Directive 2008/91/EC	European Parliament and Council of the European Union	Yes
Packaging Waste Directive 94/62/EC	European Parliament and Council of the European Union	Yes
Towards a circular economy: A zero waste programme for Europe	European Commission	No

Table 9: Circular economy policy

The Waste Framework Directive serves as a regulatory framework on the handling of waste. It defines the use of concepts such as waste, disposal and recovery. It also sets rules on how waste should be managed, what permits or registrations are necessary for establishments to be able to manage waste and establish principles regarding waste management (European Parliament and Council of the EU, 2008). Part of this is the avoidance of negative impacts on human health and the environment. The framework gives direction

to recycling targets and needed collection, but how this is done is not uniform within Europe (Technopolis group, 2016). To manage waste as efficiently as possible, the waste hierarchy was created, prioritizing waste management. In the first place, a focus should be on prevention of waste. When waste is created, priorities, in order, should be on: preparing for re-use, recycling, recovery and in the last place disposal (European Parliament and Council of the EU, 2008). The waste hierarchy is also effective for packaging waste and described in the Packaging Waste Directive as well (European Parliament and Council of the EU, 1994). The hierarchy encourages the industry to be as circular as possible, with the least amount of waste being created and waste being used as resource instead of being discarded. An important aspect of the Waste Framework Directive is also the polluter-pays principle. This is a 'requirement that the costs of disposing waste must be borne by the holder of waste, by previous holders or by the producers of the product from which the waste came' (European Parliament and Council of the EU, 2008). The responsibility for waste is thus put with producers.

The Packaging Waste Directive is aimed at packaging and packaging waste directly and focuses on harmonizing management between countries. The general principle also entails that measures taken in one Member State should not affect the ability of other Member States to achieve objectives of the Directive in a negative way (European Parliament and Council of the EU, 1994). Reduction of waste is again central and seen as essential for sustainable growth of the European Union. It also says 'health and safety problems are to be avoided' if recycling of packaging materials is done at a high level (European Parliament and Council of the EU, 1994). The responsibility for this is put with the collectors and processors of packaging waste instead of the industry/production side. There are no measures to enforce the essential requirements in place, however. Requirements are set specific to the reusable nature of packaging, manufacturing and composition and specific to the recoverable nature of packaging (European Parliament and Council of the EU, 1994). The regulation is not specific to paper and board packaging. The created requirements and agreements are in enforceable in general, but how they are enforced specifically is not mentioned (European Parliament and Council of the EU, 1994). Both regulations are also very focused on preventing any impact of waste management on the environment or human health while keeping trade and the internal market function intact.

Towards a circular economy: A zero waste programme for Europe, is a communication from the European Union to the European Parliament, Council of the EU, the European economic and social committee and committee of the regions. It pushes the need for

a move towards a circular economy as opposed to linear, whereas this is essential for resource efficiency and keeping added value in products by eliminating waste (EU, 2014). It says the EU will work on providing a regulatory framework that enables the circular economy in a better way, providing instruments and incentives for businesses to adopt models of waste prevention, reuse and recycling instead of discarding waste and moving it to landfills (EU, 2014). Modernization of waste policy and waste targets is also part of the objectives. The communication is focused on the development of instruments to support the move towards a circular economy in different areas such as finance and product design (EU, 2014). Potential is seen in improvement of implementation of legislation at national levels throughout the EU. One way of doing so is through economic measures, such as setting landfill and incineration taxes or landfill bans (EU, 2014).

However, the communication is a way to inform higher authorities of future research and the importance of the circular economy than an actual legally binding framework.

6.1.1. Relation to the criteria

The circular economy criteria that were set are recycling rate, decreased use of wood/virgin fiber, improved collection schemes and rules regarding recycling of paper and board. Though the focus on waste prevention and setting rules for waste management, the Waste Framework Directive aims mostly at improving the recycling and setting certain system conditions for the usage of waste in recycling (European Parliament and Council of the EU, 2008). It encourages the use of recovered materials instead of raw material. Translated to the paper and board industry this leads to decreased use of virgin fiber and an improved recycling rate. System conditions are aimed at permits and registrations mainly. The Waste Framework Directive also invokes the polluter-pays principle, relating to the financial responsibility for waste management (European Parliament and Council of the EU, 2008). This promotes recycling and the decreased use of raw materials as well, as it is more expensive to create and get rid of waste than use it as resource again. The same focus is found in the Packaging Waste Directive, just more specific to packaging materials. Though the packaging directive also focuses on trade more and puts responsibility for health and safety with collectors and processors of packaging waste (European Parliament and Council of the EU, 1994). This could lead to improved collection, as there is more direct responsibility for quality and also better separation as waste is being processed. There is still no specific method put forward for how collection schemes could be improved, however. The zero waste program relates to many different system conditions and has a lot of ambition to create the conditions necessary for a complete move from a linear

to a circular economy. However, since this is not legally binding, it does not yet in fact lead to improvement of the indicators and a more circular economy.

6.2. Policy regarding food safety

EU Level	Who?	Officially binding?
Food Contact Materials Regulation 1935/2004	European Parliament	Yes
Good Manufacturing Practices 2023/2006	European Commission	Yes
Plastics Regulation 10/2011	European Commission	Yes
Hygiene Regulation 852/2004	European Parliament and Council of the EU	Yes
Regulation 178/2002	European Parliament and Council of the EU	Yes
Control Regulation 882/2004	European Parliament and Council of the EU	Yes

Table 10: EU level food safety policy

The general legal food contact frame in the EU consists of two legally binding regulations at EU level: the ‘Food Contact Materials Regulation (EC N° 1935/2004)’ and the ‘Good Manufacturing Practices Regulation (EC 2023/2006)’ (ECMA, 2013). The food contact materials regulation sets general requirements for food contact materials and lists how certain measures for materials may be developed. It applies since 2008 and is set in EU law (ECMA, 2013). It also lays down a rules of Good Manufacturing Practice for materials and articles intended for food contact. The basic principle of the regulation (1935/2004) is set in Article 3: “The principle underlying this Regulation is that any material or article intended to come into contact directly or indirectly with food must be sufficiently inert to preclude substances from being transferred to food in quantities large enough to endanger human health or to bring about an unacceptable change in the composition of the food or a deterioration in its organoleptic properties” (European Parliament and the Council of the European Union, 2004). Regulation (EC) N° 178/2002 serves as the basic legal reference that lays down the basic principles and requirements of food law. This regulation applies to all food products (including packaged food) in all Member States (ECMA, 2013).

To assure compliance with Regulation 1935/2004, the European paper and paper-board food packaging chain set up a sectoral guideline for producers of paper and paper-

board materials meant for food contact (CEFIC, CEPI, CITPA & FPE, 2012). It is not a legally binding document but serves as a reference point and guide for producers to show conformity of packaging with the Regulation to ensure safe products for producers as well as consumers (CEFIC et al., 2012). It is an example of how Regulation 1935/2004 leads to further action. However, it is a private standard which is not legally binding, so it will not be further discussed.

Regulation 2023/2006 defines good manufacturing practices as: ‘those aspects of quality assurance that ensure materials and articles are consistently produced and controlled to ensure conformity with applicable rules and quality standards’ (<http://www.paper-forrecycling.eu/the-recycling-process>, consulted on 22-05-2017). EC 2023/2006 sets demands for production methods of food packages so a certain quality can be obtained (Commission of European Communities, 2006).

The HACCP, as explained in chapter 2, is a private standard, but it is legally binding. It became officially applicable under EU law in 2006 as part of the Hygiene Regulation. The Regulation (EC No 852/2004) states in Article 12: “Food safety is a result of several factors: legislation should lay down minimum hygiene requirements; official controls should be in place to check food business operators’ compliance and food business operators should establish and operate food safety programs and procedures based on the HACCP principles” (European Parliament and the Council of the EU, Regulation 852/2004, 2004).

European Level	Who?	Officially binding?
EN 15593 Packaging	CEN	No
EN 643	European Recovered Paper Council	No

Table 11: European level food safety policy

Two European regulations exist, which mainly concentrate on hygiene. The EN 15593 Packaging deals with hygiene management in production, storage and transport of food packaging. Producers need to be aware of hygiene risks and control them through an appropriate hazard analysis and risk evaluation (ECMA, 2013). EN 15593 Packaging is a standard norm set for Europe. The norm was set by the CEN (European Committee for Standardization) and can help companies to obtain a certain packaging standard, but is not an officially binding regulation (<https://www.en-standard.eu/csn-en-15593-packaging->

[management-of-hygiene-in-the-production-of-packaging-for-foodstuffs-requirements/?gclid=CjwKCAiAqIHT-BRAVEiwA6TgJw2VNwILfg0NTYD3fhAqjW9IrqU6ygvmsSgsOxeo54s1VXb-SuyfEI4RoC8EEQAvD_BwE](https://www.iso.org/standard/62492.html), consulted on 18-01-18).

The EN 643 is specifically aimed at the paper and board industry and includes a list of different grades of paper and board. It also lists unwanted materials in paper and board recycling and prohibited materials (European Recovered Paper Council, 2013). It was created as a guidance document, giving advice to sellers and buyers of paper and board on use of materials and recycling purposes (European Recovered Paper Council, 2013). Prohibited materials are defined as: “any materials which represent a hazard for health, safety and environment, such as medical waste, contaminated products of personal hygiene, hazardous waste, organic waste including foodstuffs, bitumen, toxic powders and similar” (European Recovered Paper Council, 2013). Mineral oils are not specifically named as hazardous substance or focus point.

International Level	Who?	Officially binding?
ISO 22000	ISO	No
International Food Standard	HDE	No

Table 12: International level food safety policy

An international standard regarding food safety is the ISO 22000. Companies that are involved in food manufacturing directly or indirectly should comply to the ISO 22000 Food safety management systems. This standard demands the checking and documentation of the success of all measures before, during and after their implementation (ECMA, 2013). The ISO 22000 was set by ISO which is an independent NGO that develops voluntary international standards together with 162 national bodies (<https://www.iso.org>, consulted on 18-01-18).

The International Food Standard is a global food safety initiative that applies to food manufacturers supplying store brands. It is a standard for companies that process food or pack loose food products and is only applied where “...the product is ‘processed or handled’ or if there is a danger of product contamination during the primary packaging” ([ifs-certification.com](https://www.ifs-certification.com), consulted on 18-01-18). The standard works with certain criteria that a

retailer has to oblige to in order to get certification (ifs-certification.com, consulted on 18-01-18).

6.2.1. Relation to the Criteria

Corporate Responsibility

The HACCP is the first step in quality control of food products, set in the Hygiene Regulation. This regulation is binding and set on EU level. The HACCP system is an instrument for business operators in order to obtain higher food safety levels, not an official control method (Hygiene Regulation, 2004). The Hygiene Regulation sets that: “primary responsibility for food safety rests with the business operator” (Hygiene Regulation, 2004). Through the official establishment of the HACCP, responsibility is given to the market instead of state.

This is also confirmed in Regulation 178/2002, which lawfully states the responsibilities of food operators. The food operator is himself responsible for risk communication to the authorities when he suspects food to be of risk to the public and may be injurious to human health. He is also responsible for withdrawing the food from the market immediately in this case (European Parliament and Council of the EU, Regulation 178/2002).

The EN 15593 aims to help businesses to uphold a certain packaging standard by creating a European norm for companies to maintain a certain packaging standard (CEN, EN 15593, 2008), again putting responsibility on the market side.

Traceability

As was presented in Chapter Three, the paper and board market is very complicated, which is why it hard to trace back products and materials to their specific source, which is important in the case hazardous substances are present. These substances could originate anywhere in the industry and end up in so many different paper and board sectors and flows, they are almost impossible to trace back to the point of origin.

The basis of food law, Regulation 178/2002, covers traceability of food. It mentions that a system of traceability is needed so accurate withdrawals of dangerous products can possibly be made quickly (Regulation 178/2002, 2002). The responsibility for this is also put with the manufacturer, which has to be able to assure traceability of his products in case of inspection (Regulation 178/2002, 2002). A food or substance incorporated in food has to be traceable through all stages of production, processing and distribution (Regulation 178/2002, 2002).

The Food Contact Materials Regulation also states more traceability throughout the EU as an important aspect of food safety. Mentioned strategies involve training business operators and enforcement officers so documentation of food contact materials and origin is more complete and transparent and controls are carried out in a more uniform way (European Parliament, Food contact Materials Regulation 1935/2004). Traceability of imported food contact materials should also be improved in collaboration with third countries so compliance is shared between importers and the EU market (European Parliament, Food contact Materials Regulation 1935/2004).

Official food controls

Official food controls are carried out by the EFSA, which is an independent control authority for the EU. The EFSA was established through Regulation 178/2002, in which is stated: "Food controls are obligated and even if the importing country agrees to importing a certain food product, food that is injurious to health cannot be exported" (Regulation 178/2002, 2002). Business operators also have ensure quality and perform controls. As stated in the GMP: "The business operator shall establish, implement and ensure adherence to an effective and documented quality assurance system" (GMP, 2006). This quality assurance entails the monitoring and implementing of GMP and identification of measures to correct any failure of the GMP. GMP consists of a quality assurance system, quality control system and documentation (GMP, 2006). This is not only a way to instate official food controls, but also related to corporate responsibility, as this is the job of the business operator instead of government.

The International Food Standard is also related to official food controls. Criteria are set that a food retailer has to oblige to in order to receive certification from the IFS ([HDE, ifs-certification.com/](http://ifs-certification.com/), last visited on 27-08-2018). It is specifically designed for food retailers supplying store brands and intended for audits to check on companies and compliance with criteria. Having certification in place is also a way of controlling food safety and manufacturers capabilities. The document is not officially binding.

Precautionary principle

Regulation 178/2002: "The precautionary principle has been invoked to ensure health protection in the Community, thereby giving rise to barriers to the red movement of food or feed. Therefore it is necessary to adopt a uniform basis throughout the Community for the use of this principle. In those specific circumstances where a risk to life or health exists but

scientific uncertainty persists, the precautionary principle provides a mechanism for determining risk management measures or other actions in order to ensure the high level of health protection chosen in the Community” (Regulation 178/2002, 2002). Though the precautionary principle seems to have been adopted in European policy as an important standard which must be upheld, this does not seem to be the case with mineral oils. If products containing more than the maximum amount of mineral oils in their package would not have entered the market, food safety would be of much less concern.

The Food Contact Materials Regulation envisages the adoption of safety requirements for specific FCMs. Currently, these only exist for plastics, ceramics, regenerated cellulose and active and intelligent materials (European Parliament, Food contact Materials Regulation 1935/2004). There are no specific safety requirements for paper and board, which makes it hard to control the safety of this industry’s products before entering the market. Regulation 1935/2004 also applies to the precautionary principle, with the aim to prevent dangerous chemicals from being present in food contact materials. The FCM Regulation applies to all materials possibly getting into contact with food, which should also include paper and board, though specific requirements don’t exist for this category (European Parliament, Food contact Materials Regulation 1935/2004). Regulation 2023/2006 sets quality demands for production methods of food packaging, also intended to create as little risk as possible of food getting contaminated (Good Manufacturing Practices Regulation, 2006).

One form of the precautionary principle can be found in the waste hierarchy. This states that the first priority should be with waste prevention and re-use before focusing on recycling (European Parliament, Food contact Materials Regulation 1935/2004). Even though recycling places third in the waste hierarchy, this is the main focus in many sectors, as can be seen in the paper and board industry, where recycling is the dominant practice (Bartl, 2014).

The EN 643 is also related to the precautionary principle. It sets a list of unwanted and hazardous materials and substances not to be used in production of paper and board (European Recovered Paper Council, EN 643, 2013). This is the only regulation specific to the paper and board industry, identifying hazardous substances and trying to avoid food safety problems in the first place. However, this document serves as a guideline and is not officially binding.

Independent scientific risk assessment, separation of risk assessment and risk management & transparent risk communication

Regulation 178/2002 lays out that risk assessment should be taken in a transparent manner, based on independent scientific information. Assessment is separated from risk management, which is based on independent assessment. Documentation is obligated for business operators under the GMP (2006): “The business operator shall establish and maintain appropriate documentation in paper or electronic format...”. It also obligates the business operator to make this documentation available to control authorities, which should create greater transparency and the possibility for risk communication. This is also done by the EFSA, which was established in 2002 as the main control authority in the EU. The EFSA is also responsible for risk communication within the EU (European Parliament and Council of the EU, Regulation 178/2002). It was established in 2002 as an independent scientific reference point in risk assessment, ensuring the internal market functions smoothly and be an independent source for advice and information (European Parliament and Council of the EU, Regulation 178/2002). Food business operators are also held responsible for collaborating with the authorities and EFSA to avoid and reduce food risks as much as possible. This means their data and connected risks have to be transparent (European Parliament and Council of the EU, Regulation 178/2002).

6.2.2. Enforcement

In the move towards a circular economy regarding paper and board, there is no current enforcement of rules present. The only enforcement is in general, through the legally binding waste and packaging frameworks and is focuses on waste management and responsibility mostly. Enforcement is only named as a general point of focus, but how this is done in practice specifically is not discussed.

Regarding food safety, the EFSA was established as a control authority in Regulation 178/2002. It has a few tasks including the development of uniform food safety risk assessment and providing independent scientific information about food safety and risks (European Parliament and Council of the EU, Regulation 178/2002). It is also said in the regulation that Member States are responsible for the enforcement of food law and monitoring food and feed business operators at all stages of production to ensure whether they uphold food law requirements (European Parliament and Council of the EU, Regulation

178/2002). A system of official controls has to be in place and Member States have to lay down rules on penalties and other rules when food law is infringed on ((European Parliament and Council of the EU, Regulation 178/2002).

There is not much policy on enforcement to be found. Many of the discussed policies say something about the need for certain rules to be enforced, but there is no clear 'action plan' on how to do this, especially in the paper and board industry. For packaging it is said in Directive 94/62/EC on packaging and packaging waste that the European Commission shall come up with proposals to take measures in enforcing requirements to packaging and ensure to minimize environmental impact of the packaging material (European Parliament and Council of the EU, 94/63/EC). It is said that agreements are enforceable, thus punishable by law, though how controls are executed is not mentioned specifically.

Several guidelines for printing of food packaging were published by the European Printing Ink Association (EuPIA). Manufacturers of ink are recommended to follow the guidelines by the EU's expert Scientific Committee for Food (SCF) and European Food Safety Authority's expert Panel (CEF) in setting limits for the substances used (ECMA, 2013). Official controls are carried out to ensure compliance with the EU's high standards. The Control Regulation (EC No 882/2004) lays down responsibilities of national and European control authorities (Federal Ministry of Food and Agriculture, 2016).

Should a manufacturer, retailer or restaurateur not comply with these standards and regulations, this can have serious consequences. When food does not meet legal requirements for hygiene, residues or labelling and when it is regarded unsafe, it has to be taken of the market by the relevant control authority (Federal Ministry of Food and Agriculture, 2016). Penalties for breaching Regulations will be given by regulatory authorities in question (Federal Ministry of Food and Agriculture, 2016). These penalties and consequences are determined on a national level, which means they are not the same throughout the EU or Europe. There is thus no uniformity in penalties for breaching food safety law, standards and agreements.

The Food Contact Materials Regulation pleads for the creation of EU specific measures and creating a single standard to ensure food contact materials are tested for example on migration (European Parliament, Food contact Materials Regulation 1935/2004). This would ensure food contact materials are tested with one standard for analysis throughout the EU, so there will not be a possibility for misleading testing results and the risks that come with this.

6.2.3. Overview

The following table was constructed by studying the different regulations and summarizing the main points of importance to generate an overview of all policy, who created it, on which level it was made and applies, whether it is officially binding or not and what criteria it relates to.

	Regulation/policy?	Who?	Level?	Officially binding?	Relation to criteria?
Circular Economy					
	Waste Framework Directive 2008/91/EC	European Parliament and Council of the European Union	European	Yes	Recycling rate, decreased use of wood/virgin finer, rules regarding recycling of paper & board
	Packaging Waste Directive 94/62/EC	European Parliament and Council of the European Union	European	Yes	Improved collection schemes, recycling rate
	Towards a circular economy: A zero waste programme for Europe	European Commission	EU	No	Rules regarding recycling of paper & board
Food Safety					
	Food Contact Framework Regulation (1935/2004)	European Parliament	EU	Yes	Traceability, precautionary principle
	Good Manufacturing Practices Regulation (2023/2006)	European Commission	EU	Yes	Official food controls, corporate responsibility, separation of risk assessment and risk management
	Plastics Regulation 10/2011	European Commission	EU	Yes	Precautionary principle

Regulation/policy?	Who?	Level?	Officially binding?	Relation to criteria?
Hygiene Regulation (852/2004)	European Parliament and Council of the EU	EU	Yes	Corporate responsibility
Regulation 178/2002	European Parliament and Council of the EU	EU	Yes	Corporate responsibility, traceability, official food controls, Independent scientific risk assessment, separation of risk assessment and risk management & transparent risk communication
Control Regulation (882/2004)	European Parliament and Council of the EU	EU	Yes	Official food controls
EN 15593 Packaging	CEN	European	No	Corporate responsibility
EN 643	European Recoverd Paper Council	European	No	Precautionary principle
IFS Food	IFS (Company)	International	No	Official food controls
ISO 22000	ISO	International	No	Transparent risk communication

Table 13: Summary of policy documents, responsible authority, level, whether it's officially binding or not and what criteria it relates to

6.3. Sub-Conclusion

As came forward in the policy analysis, Regulation 178/2002 can be seen as the basis of food law. This Regulation has the most binding rules concerning many of the food safety criteria, but only applies in general to all food and foodstuffs. The other regulations can be seen more as supportive and adding onto this regulation, designed from the paper and board industry and specifying in different areas more elaborately.

Most criteria are definitely incorporated in policy, such as the independent assessment, management and risk communication. Manufacturers and business operators are responsible for their own process documentation and forced to open this up to authorities, improving transparency in the paper and board market.

Many policies mostly go into setting limits for hazardous substances in food and packaging materials though. This could be good in obtaining food safety, though not all Regulations are officially binding. In case of paper and board, there is only a Plastics regulation in place on which the accepted hazardous substance amounts are based. There is no specific regulation for printing inks and the substances that these contain. Specific demands also do not exist in the Food Contact Regulation Framework. This should be the regulation that would prevent hazardous substances getting into contact with food, though there are many foods which are packed in paper and board, requirements specific to paper and board and recycled paper and board getting into contact with food are not included in the policy. There is a clear lack of specific and binding policy for paper and board and printing inks.

For paper and board, no specific binding EU legislation has been adopted. Of course, EU member states have to comply to EU standards, but each member state can maintain or introduce national regulations (ECMA, 2013). The Confederation of the European Paper Industries (CEPI) and International Confederation of paper and board converters in Europe (CITPA) issued an Industry Guideline and a Good Manufacturing Practice document. These are meant for the compliance of paper and board materials and articles for food contact (ECMA, 2013). The Food Contact Materials Framework also provides a guideline for food manufacturers. None of the guidelines are legally binding, however.

Regarding food safety and the mineral oil/pollution problem, there is no legislation that applies to printing inks directly. The general migration limits that apply to Plastics, as established in the Plastics Regulation (EU) No 10/2011, also apply to paper and board. These limits do not include printing inks or substances used in the manufacturing of printing inks (ECMA, 2013).

A policy gap also lies in specific rules and practices for enforcement. As scientific limits of materials and substances allowed are lacking, compliance with food safety standards will not be possible for business operators to uphold.

Binding regulations are clearly more important as they have a broader focus. At the same time, these are more general and could translate differently throughout the EU and Europe when being implemented. Private standards and guidelines are more specific to the paper and board industry and hazardous substances, but these have not been developed to ensure total compliance with food safety legislations (Manning & Baines, 2004).

There is a lack in official food controls taking place, precautionary measures taken to avoid mineral oil content in paper and board, enforcement and legally binding regulations specific to the paper and board industry. There are only legally binding regulations on EU level, which does not apply to the whole of Europe. International and European Regulations, frameworks and standards are only guiding when they hold important information (such as unwanted materials for food contact) that should be legally binding.

Responsibility is mainly put with the market instead of state. There is a lot of trade and focus on external markets. This makes the possibility of monitoring very complex. More focus on the internal market would create more control and more transparency in the market. This would also be easier to monitor. The question is whether state should be more involved. The market could be more focused on making profits than protecting consumers, which is why more legally binding measures could be of positive influence on food safety.

After conducting the policy analysis, all parts of the system have been discussed. From this, the following general systems overview can be derived:

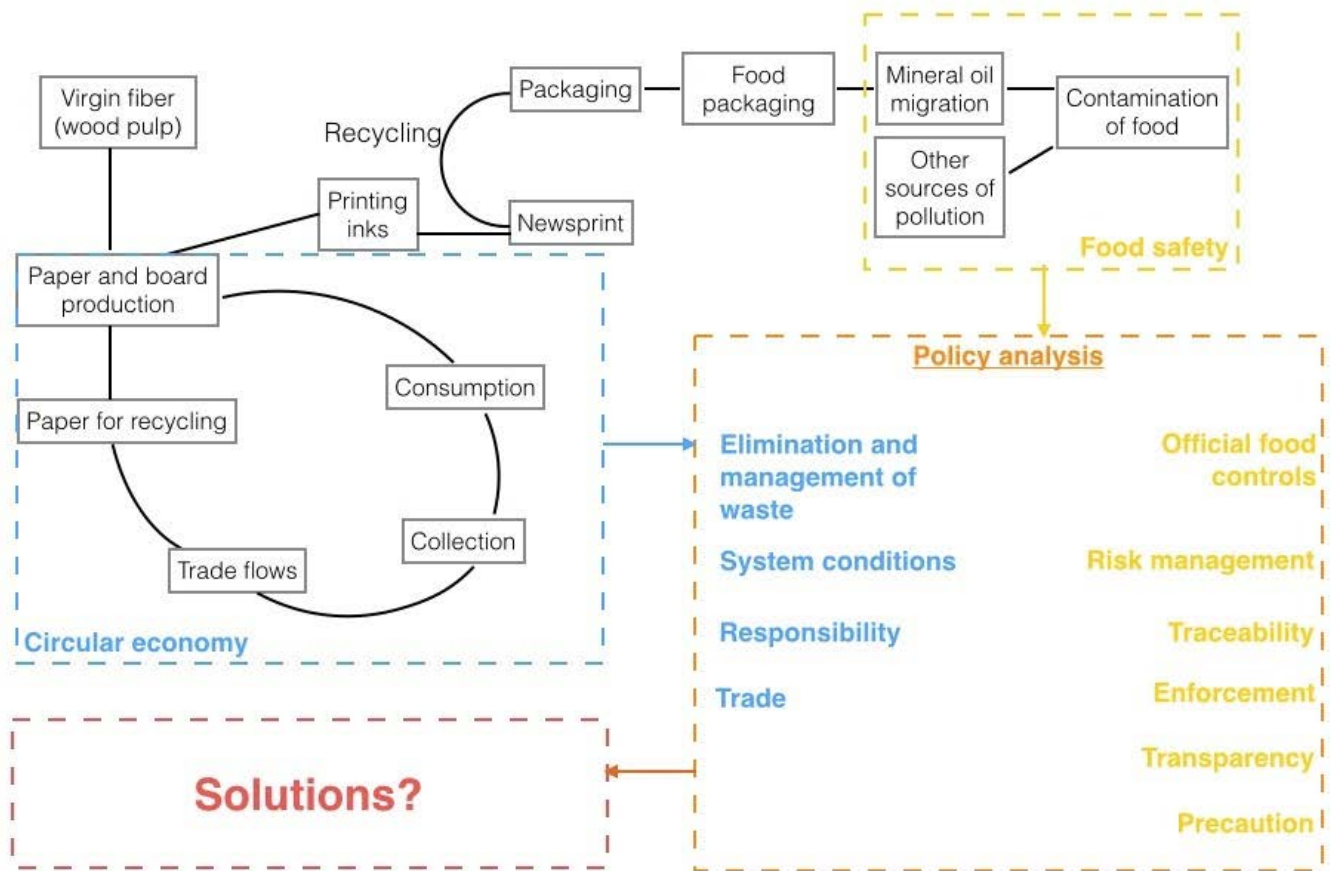


Figure 16: Systems overview

Explanation of figure 16:

The paper and board industry and workings of recycling was already discussed in previous chapters and figures. The blue dotted line shows the part of the paper and board industry that is most representative of the circular economy and where circular economy policy focuses on and is mostly applicable. The yellow dotted line shows the part of the industry where food safety problems lie. Both concepts come together in the policy analysis. From the analysis it was derived that circular economy policy mainly focuses on elimination and management of waste, creating certain system conditions for paper and board recycling, where responsibility for waste management, recycling and collection should be put and ensuring trade stays intact. Food safety policy mainly focuses on the establishment of official food controls, risk management, traceability of food contact materials and possible food

risks, enforcement of regulations, transparency in food related risks and the practices of business operators and taking precautionary measures to prevent hazardous materials and substances being used in the production of food or food contact materials. Eventually, policy relates to possible solutions, as this is the only tool to possibly be applied on EU or European level to be able to make a change in the system and keep food safe as well as encourage the move towards a circular economy. Possible solutions will be discussed in the next chapter. Because the perfect solution is not yet found, there are no specific measures named in figure 16.

CHAPTER SEVEN: CONCLUSIONS AND RECOMMENDATIONS

7.1 Answer to the main research question

What is the current dilemma between food safety and a circular economy in the European paper and board industry and how can EU and European policy interfere in this dilemma?

Food safety problems originate in the move towards a circular economy, but preventing food risks would in turn harm the circularity of the paper and board industry. As is shown in the overviews of parts of the system and the whole system, several bottlenecks exist. The European paper and board market produces a lot of paper and board, part of which is imported, but for the most part meant for own consumption and export. There is a lot of trade within CEPI countries, which makes it harder to trace back materials to their source. The recycling rate in Europe is very high, meaning many materials are collected and used for the production of paper and board again. As the largest part of produced paper and board goes into packaging materials, this is also the main user of paper for recycling, which is exactly where the problem lies.

In the production of newspapers, printing inks are used that contain mineral oils. As newspapers are collected and used for production as paper for recycling again, they end up in several material flows. The biggest one of these are packaging materials, which in turn end up as food packaging. Mineral oils migrate from the package into the food, which is contaminated and consumed, being a reason for food safety concerns. The blame put on the newsprint sector is justified, as this is in fact the main source of mineral oils ending up in food contact materials. Though, the European paper and board production knows many phases and purposes. Mineral oils could also get in contact with food during transport or through oils used in machines during production. As a lot of paper and board is being traded within and outside of Europe, it cannot easily be traced back to its source. The dilemma with food safety is twofold: recycling and re-using materials in paper and board production is the main cause for food safety concerns. In turn, one of the criteria for food safety policy is traceability. This is needed to ensure food safety on a larger scale, but is compromised by the scale and trade flows of the paper and board industry. To ensure food safety on a larger scale, there would be more focus on the internal market and monitoring, which is impossible with worldwide production and trade in these amounts of not only paper and board but also paper for recycling. As a consequence of the complexity of the research dilemma, it is very hard to find the best solution for both worlds. Possibly a

focus on waste prevention, as is supported in policy by the waste hierarchy, could improve circularity without bringing more recycled newsprint as resource into the paper and board production cycle. The responsibility for food safety is now put with individual food operators and businesses by the state, though market is more focused on making profits and using the least amount of material for production. Even though businesses have to comply to EU and European policy, food safety is not their main interest. A collaboration between market and state and the incorporation of private standards in more global policies could provide a positive starting point.

The dilemma between food safety and a circular economy is based on the wish for more recycling and the prevention of waste by using it as a resource for production of paper and board on one side and contaminating substances ending up in food packaging and in contact with food on the other side. The conflict roots in management by state and market and policy mainly aims to interfere in this dilemma from two sides. First, by pushing traceability, risk management, official food controls, prevention of substances entering food and transparency from the market in production and material usage to guarantee food safety. Second, by pushing for better recycling, better collection schemes and responsibility with collectors for separation of waste materials/qualities and giving responsibility to the market for safety control while still promoting trade.

7.2. Possible solutions

Focus more on waste prevention?! This is more in line with the waste hierarchy
Market-state? Now responsibility to market, but more focus on internal market creates more control and transparency, making processes easier to monitor.
However: very hard with amount of trade; needs to be more control?

Several possible solutions have been named in literature. A first, obvious option is to use more virgin materials instead of recycled paper and paperboard for the production of food packaging. This would decrease the amounts of mineral oils in packaging materials and thus lower health risks, increasing food safety (TU Darmstadt, 2012). However, using more virgin materials requires the use of more wood, resulting in the cutting down of more trees. It is uncertain this would satisfy the demand in Europe (CEPI, 2015). Cutting down more trees is not an environmentally friendly option and will result in a less circular packaging industry. It has also become clear from a conversation with Hans Wortman that wood naturally contains mineral oils even before it is processed. Although in decreased amounts,

mineral oils will always be present in paperboard packaging. Replacing recycled materials with virgin fiber is thus not an option that would increase food safety or promote circularity (Bartl, 2014).

Another solution is the improvement of the recycling process. How it works now, most paper grades end up in the same recycling chain and are mixed before serving as a raw material again (CEPI, 2015). This means newspapers and corrugated board for example end up in the same flow, mixing polluted materials with relatively clean paper and board. Filtering out the polluted materials from the recycling chain would increase the overall quality of materials used for food packaging. It is, however, very difficult to change the whole process and reform the recycling chain in a way this would be possible. It would be a costly process to do this, also requiring effort on the consumer's side. Consumers would have to separate their waste better and differently. Motivating consumers enough to do this is difficult and there is no certainty everyone would uphold these separation standards the right way or even at all. There is also the question of what to do with the polluted materials once they are filtered out. On the short term, this is not a feasible solution to increase food safety.

A third option would be to apply a barrier or coating to the packaging material (TU Darmstadt, 2012). By doing this, the side that is in direct contact with the food would have a layer to prevent mineral oils from migrating into the food. This seems like one of the best options to increase food safety, but most existing coating materials are either not bio-degradable or too expensive to develop and enter the market at a large scale (TU Darmstadt, 2012). Although a coating of synthetic material would keep oils from migrating, this material is harder or even impossible to recycle and re-use. This would drastically decrease the circularity of the packaging industry. If future developments allow for a bio-degradable coating or barrier that would be recyclable together with paper and board (without having to separate them), this could be the best solution to solve the dilemma between circularity and food safety in the paper and board industry.

A last option to consider, is using different printing inks, as these can be pointed at as the main source of mineral oil pollution (Goeyens, 2014). As becomes apparent from the conversation with Hans Wortman, in Japan, printing inks are already based on vegetable oils. These are a lot less polluted and using them as a basis can drastically reduce the problem in a country like Japan, as the country does not trade much and has somewhat of a closed economy. The paper and board industry is global (as has been shown before) and many flows of material enter the European market from outside countries (CEPI,

2015). This means replacing printing inks in Europe would be less effective as we still cannot control the global market and materials entering the recycling chain anyway. If somehow it was possible to base printing inks on vegetable oils globally, the food safety problem caused by mineral oils could be reduced for the most part, but never eliminated completely. Many other sources still exist through which mineral oils get into contact with food and packaging (TU Darmstadt, 2012). As mentioned before, oils from machines, contamination during transport or even originating in food itself (TU Darmstadt, 2012). Ruling out all these sources is not a feasible option so the question is what the actual impact on food safety would be.

On the policy side, more regulations could be developed to directly apply to the paper and board (packaging) industry. It is already known that policy does not exist for all areas yet, as even has been stated in the policy communication on food contact materials (European Parliament and the Council of the European Union, 2004). Regulations need to be put in place specific to paper and board to create more binding standards, set limits and be sure to have consequences if not obliged to.

Before we can even start looking at feasible solutions, an acceptable limit needs to be set for the intake of mineral oils through food. This also means the long term health effects need to be clear. As technology is not able to provide us with a limit for intake of MOAH yet, more research needs to be done to develop a method to detect MOAH precisely enough and find out what the actual effects on human health are. Only after a migration or intake limit has been set can suitable solutions and policy be further developed in an efficient way.

7.3. Limitations of the Study

Some limitations of the study include the used and available numbers and scope. The numbers from CEPI originate from 2015 and were obtained through my internship organization. More recent numbers were not completely available online. The numbers only include CEPI countries, which is not representative for the EU. This partially conflicts with EU policy, as in turn this does not cover all CEPI countries.

Numbers regarding the amount of paper and board packaging that ends up as food contact materials could not be found. This is the same for mineral oil contents of food packaging materials. Generally little exact numbers were available on mineral oil content of food stuffs, paper and board, paper for recycling and packaging materials.

Two policy documents could not fully be accessed online. These are the EN 15593 Packaging and the International Food Standards.

The study does not discuss all available policies regarding food safety and circular economy due to a lack of available time. Several private standards and national regulations exist that were not discussed. Because of this, some possibly useful frameworks in other countries could have been missed that may be applicable on a broader scale.

The in depth study into the newsprint sector is based on available numbers from some sources, though the study of more elaborate sources and exact numbers could lead to different conclusions.

7.4. Recommendations for Future Studies

Future studies should go into defining harmful amounts of MOSH and MOAH to humans more specifically and definite limits that can be used in policymaking. Research needs to be conducted into the specific amounts of MOSH and MOAH that are harmful to humans and detection methods. Research can also be done into possible solutions and replacements for the use of paper and board in food packaging, that would not create a health risk, but still have all the qualities of paper and board packaging. This solution would have to be cheap enough to be easily implemented and also be equally good for the environment as using recycled materials. This is not possible now, but there may be a possibility of finding a new material or revolutionary packaging method that is both safe and circular. A focus should be put on finding the exact sources of mineral oils and trying to find alternatives. This could be done by looking into the trade flows more intensively and determining mineral oil contents in different products in different stages of production. Several sources could be pointed at and be examined further. This could include the oils originating from food itself, as to where this comes from and how it ends up in the food, or oils that get into contact with food during transport or packaging.

Regarding policy, effort should be made to create policy specific to the paper and board industry that is binding. Several options could be looked into. These may include the creation of more local standards that are in line with existing European standards and guidelines. A move in responsibility from market to state may be an option to generate more control, though this should not take away the freedom of the market. Frameworks and regulations could be created that are result from collaboration between market and state, both satisfying the market's wish to make profits and move towards a circular economy and the consumer's and state's push for food safety.

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