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Evaluation of open information sources in order to estimate average contents of organic additives in plastic materials

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Industrial Ecology – for a Sustainable Society

CLARA THOLIN

Department of Energy and Environment
Division of Environmental Systems Analysis
CHALMERS UNIVERSITY OF TECHNOLOGY
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Department of Energy and Environment, *Division of Environmental Systems Analysis*
Chalmers University of Technology
SE-412 96 Göteborg
Sweden
Telephone + 46 (0)31-772 10 00

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Abstract

Plastics can be found everywhere in society and is used in wide range of applications. In order to make a plastic material functional and aesthetic, several chemicals are added to the polymer during manufacturing. These chemicals, or additives, can potentially leak out of the material during the use phase. In order to estimate these emissions, several parameters are required to be known about the material and how it is being used. One important source of information that will affect the leakage is the content of the plastic material. Since the chemicals are studied on a societal level, lists of average contents are desired for different materials or product groups.

The study has attempted at evaluating the possibility of estimating average contents of plastic materials, based on the information available from publically available information sources, by evaluating different information systems and attempting to combine different sources of information in search of additional information.

Two information systems show to be of more interest than the rest: the Product Register and the Commodity Guide, with respect to contents in chemical products and materials, respectively. The different combinations of information systems are largely limited due to lack in transparency of the different sources, and that the system boundaries differ. Based on what is being publically available today it is not possible to, at any larger extent, estimate the average contents of plastic materials. However, there is possibility for development and further use of the Product Register is recommended.

Keywords: *declaration of contents; average composition; mean content; information system; public information; additives; organic chemical; plastic*

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Preface

The project of *Organic **Ch**emicals **Emi**tted from **Tech**nosphere Article**s*** (*Chemitecs*) is a research program that started in 2007 by funding from the Swedish Environmental Protection Agency (EPA) (Chemitecs, 2010). It is a five-year program with the purpose of getting a better understanding and overview of the spread of organic chemicals in society. As opposed to focusing on specific chemicals already known or suspected to pose a risk, the Chemitecs project attempts to find information regarding all types of organic substances. The project aims at developing a method to approximate emissions from all organic chemicals that are currently in Swedish material flows. This master's thesis aims at making a contribution to Chemitecs, by looking at a selected part of organic chemicals in the technosphere, namely in plastic materials.

Terminology

Swedish Environmental Code – Miljöbalken
Activities harmful to the environment – Miljöfarlig verksamhet

Authorities and organizations

Statistics Sweden – Statistiska Centralbyrån (SCB)
Swedish Chemicals Agency – Kemikalieinspektionen (KemI)
Swedish Environmental Protection Agency (EPA) – Naturvårdsverket
Swedish Plastics and Chemicals Federation – Plast- och kemiföretagen
Swedish Plastics Industry Association – Svensk plastindustriförening

Classifications

Classification of Product by Activity (CPA)
Combined nomenclature (CN)
European Customs Inventory of Chemical Substances (ECICS)
Swedish Standard Industrial Classification – Standard för svensk näringsgrensindelning (SNI)
Swedish Standard of Products by Activity – Standard för svensk produktindelning efter näringsgren (SPIN2007)
Industrial use of purchased goods and services – Industrins förbrukning av inköpta varor

Databases etc

Swedish Environmental Report Portal – Svenska miljörapporteringsportalen (SMP)
Swedish Pollutant Release and Transfer Register (PRTR) – Utsläpp i siffror
Swedish Product Register – Produktregistret
The Commodity Guide – Varuguiden
Substances in Preparations in Nordic Countries (SPIN) – SPIN-databasen
Statistical Database – Statistikdatabasen

1 Introduction

Plastics can be found everywhere in society and have numerous applications, from packaging, construction, electronic devices to toys and household articles. In order to make the plastic material functional and aesthetic, several chemicals are added to the polymer during manufacturing (Murphy, 2001). Since the 1950's the industrial production of plastics has steadily been increasing (Plastics Europe, 2010), and the use of additives have naturally followed this increasing trend.

Many of these chemicals have not been carefully studied, and their health and environmental effects are largely unknown (Meeker et al, 2009). One of the Swedish environmental goals is to reach a non-toxic environment by year 2020 (Swedish EPA, 2011a), and the mapping of chemicals in plastics is an important step in order to reach this goal.

1.1 Background

In order to estimate the emissions of additives from different objects, versatile information about the products and their use will be needed. With respect to the use, information regarding where and how a product is being used will be relevant in order to estimate how the emissions occur (Tivander et al, 2010). With respect to the product, its properties in material composition, lifetime and surface area are of interest. Each product is unique, but products with common properties can be grouped together in product categories. For product categories on national level, there is statistical information regarding domestic production and trade, which means that a net inflow of products can be calculated according to eq. 1 (Westerdahl et al, 2010):

$$Net\ inflow = Import - Export + Domestic\ production \qquad \textbf{(eq. 1)}$$

A product can consist of several different materials, which all have different chemical compositions, densities and thicknesses. These parameters will all affect how the emissions are being spread (Tivander et al, 2010).

One of the intriguing questions in the estimation of emissions is how the compositions of different products can be estimated. This can be done both by looking at specific materials or groups of products on a national level (Westerdahl et al, 2010). The information doesn't need to be specific with respect to each individual product on the market; instead it is desirable to find ways of estimating the average contents of different materials or product groups. This thesis will focus on the different sources of information that can be used in order to perform these estimates, and discuss what will be

needed in order to estimate average contents in plastic materials. In order to access the information it needs to be publically available.

1.2 Aim and objectives

The aim of this master's thesis is to evaluate how different sources of publically available information can be used in order to estimate the average contents of organic additives in plastic materials.

The objectives are the following:

- Document and describe the previous work done regarding average contents in different materials, focusing on plastics.
- Document, describe and evaluate existing information systems, both from different authorities and industry, with respect to their content of available information regarding plastics and their additives.
- Attempt different combinations of these information systems, in order to see what additional information can be obtained.

2 Method

The thesis work was initiated with a general literature study, where an extensive search on the internet and different scientific publications was performed. The purpose of this was to see what kind of information that had previously been published about additives in plastics, and if the available information could be used in order to estimate average contents of organic additives. It was also of interest to see if similar projects of constructing average declarations of contents had been performed previously. Some important concepts which were thought to be of relevance for the continued work were also investigated in further detail; which also implied analysis of material safety data sheets, environmental reports, and other documents that potentially could contain information of interest.

The next phase of the project was to identify the sources of information where relevant information could potentially be found, both related to chemical content and trade statistics. This study aimed at already existing information systems from authorities and industry. The authorities which were considered to be most relevant were the Swedish Chemicals Agency, Statistics Sweden and the Swedish Environmental Protection Agency (EPA). The different information systems used were different databases, publications and through personal contact. The industrial information systems were mainly global websites which published general information about content in plastics.

Parallel to the phase above, the information available directly from companies was evaluated, mainly by investigating the information published directly on their websites. This was also complemented with personal contact with a selected number of companies. The main purpose of this was to see what kind of information that the companies would voluntarily share.

Finally, some attempts to combine these different sources of information were attempted. The plastic material ABS was chosen to be studied in more detail, in order to see how the available information could be used in order to estimate the average contents of organic chemicals in that specific material.

2.1 Limitations

2.1.1 Plastic materials

The materials of interest are plastic materials, meaning that these are the groups in e.g. trade statistics that will be investigated in further detail. With respect to SNI and SPIN2007, the groups 22.210-22.290 will primarily be investigated (see chapter 3.3.1-3.3.2, and Table 1 and Table 2). With respect to CN, the group of primary interest is 39: *Plastics and articles thereof* and its sublevels (see chapter

3.3.3). There are other groups in the CN structure which will also contain plastic materials, but these will not be in focus.

2.1.2 Organic substances

The focus of the study is the organic substances in the plastic materials. Primarily, information regarding substances that have been intentionally added during the production process is of interest. The information regarding these chemicals is desired to be as unambiguous as possible, meaning that it should be on a CAS level (see chapter 3.4).

2.1.3 Sweden

The area of study is Sweden, which means that the information search will be performed for this region. General searches and information from global actors will be searched from a wider perspective. Primarily, the focus will be on domestic production, and secondly information regarding trade will be searched for.

2.1.4 Public sources of information

The focus in the study lies on public sources of information, which means that primarily information on websites, databases, information sheets and similar have been used. In order to get a better understanding for the information, some companies have been contacted, but this has not been the primary purpose of the study. One limitation is that confidential data will not be available in these publically available sources. This study will attempt to discuss the information which is collected through different authorities (also the confidential data), but it will only be possible to evaluate the data which is accessed from different authorities, i.e. the non confidential information. The main sources of public information are: the Swedish Chemicals Agency, Statistics Sweden and the Swedish Environmental Protection Agency.

3 Fundamental information

There are some concepts and technical terms that need to be introduced before the results can be discussed, and they are presented below to give a foundation for the understanding. Their relevance will be further discussed later in the report. The different concepts relate to plastics production and the manufacturing process and the meaning of the different terms “product”, “good” and “article”. Further on, some key terminology used in trade statistics will be presented and the CAS nomenclature for chemical substances will be introduced. The term *information system* refers to any kind of system which provides information regarding a certain subject. The term *database* refers to a collection of data, which is made searchable in a systemized way. A database is one kind of information system which has been evaluated through the process of this project.

The names of authorities, regulations, and similar, and the used abbreviations are listed both in Swedish and English in the introductory pages (p. v).

3.1 Terminology of plastics

A *polymer* is a chain of repetitive units, which is the base used to produce *plastic* material. The polymer determines the name of the plastic, e.g. polyethylene. By combining the polymer, in the form of a *resin*, with several *additives*, this will result in a plastic material. The purpose of an additive is to give the polymer certain properties, such as making it more resistant to radiation or more flexible (Tolinski, 2009). Different examples of additives are fillers, stabilizers, plasticizers, pigments or dyes and flame retardants. Not all of these additives are organic, but when the term additive is used in this paper, organic additives are implied unless otherwise stated. A *masterbatch* is a concentrated mixture of additives, which is premixed before being added to a polymer (OECD, 2009).

3.1.1 Production of plastics

In plastics manufacturing, the initiating process is the *manufacturing of a polymer*, usually in the form of a resin (OECD, 2009). The use of an additive in the phase of polymer manufacturing most often has the purpose of enabling the production, such as the use of lubricants or heat stabilizers in order to make the resin more easily processed or not degrade in the heat (Plastipedia, 2011). The *compounding* phase is when additives are mixed into the polymers in order to give the material certain properties (OECD, 2009). *Conversion* is the phase where an article is made from the plastic material, for example the shaping of the material is taking place through extrusion. The mixing of additives into a

resin is usually done in the form of a masterbatch, which can be premixed either in house or from a masterbatch producer (Tolinski, 2009).

In Figure 1, the relations between the different actors in plastic production are visualized. The production of additives will take place outside of this hierarchy, where additives might be purchased by any of the polymer manufacturers, compounders or converters, and can also be added at any stage in the process. It is common that one manufacturer performs more than one of these stages, sometimes all of them.

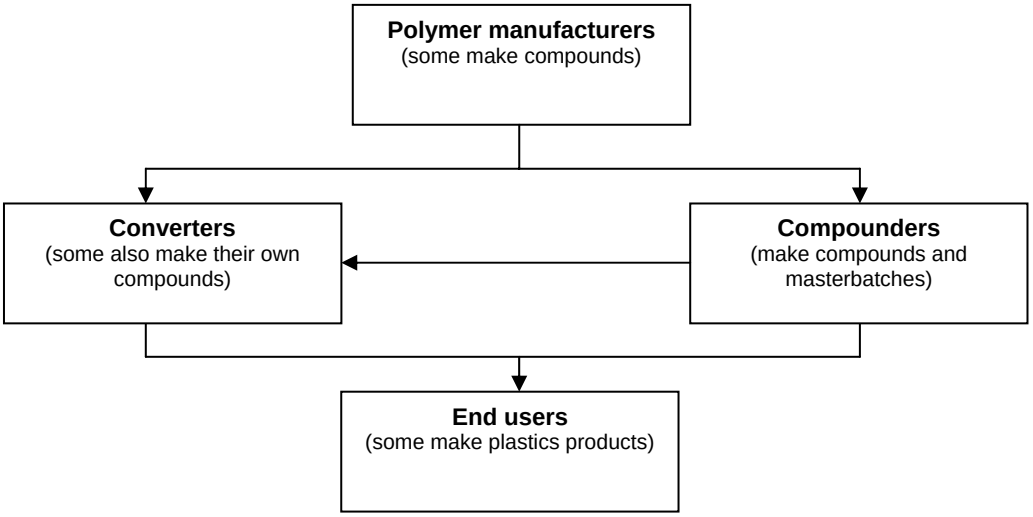

Figure 1. *The different manufacturing stages in the plastics industry (OECD, 2009).*

There are two trade organizations representing plastics manufacturers in Sweden: *The Swedish Plastics and Chemicals Federation* and *The Swedish Plastics Industry Association*, which represent about 200 and 150 member companies respectively (Swedish Plastics and Chemicals Federation, 2010; Swedish Plastics Industry Association, 2011). The member companies are represented from the whole production chain of plastics, but the dominating fields are compounders and converters.

3.2 Chemical product, article and good

According to the Swedish Environmental Code (1998:808), the following definitions are used for chemical product and article: *Chemical product* is a chemical substance or mixture of chemical substances (preparation) which is not an article. An *article* is an object which during its production receives a specific form, surface or design, which to a greater extent than the chemical composition decides on its function (Notisum, 2011; European Commission, 2006). The definition of article in the Swedish Environmental Code is equivalent to that of the definition in REACH, and was implemented

in the Code in 2008 through the instruction SFS 2008:240 (Swedish Chemicals Agency, 2010a). Both in the Swedish Environmental Code and in REACH, the terms chemical product and article are exclusive.

The definition of chemical product according to the Swedish Environmental Code is the one used by the Swedish Chemicals Agency, but the term used is most often simply “product”. In terminology concerning economic classifications the term “product” refers to a manufactured object which leaves a certain production facility whereas a “good” is something that is being put on the market for trade. However, these terms are not clearly defined, but the definitions above are implied (Eurostat, 2010). In trade terminology a chemical product can be defined as a good (Swedish Chemicals Agency, 2010a). Some more detailed information regarding the used terminology in economic classifications is presented in chapter 3.3.

According to the Chemitecs definition a product is defined as: “any physical matter that is produced or designed for a use purpose (…) A product is the result of a physical production process of some sort, e.g. assembling components, processing material, preparation or reactions of substances” (Tivander et al, 2010). According to this definition, both articles and chemical products can be considered to be products.

In this report, the term “product” will be defined when it is being used, in order to avoid confusion.

3.3 Terminology of economic classifications

There are different economic classifications being used on both national and European level, used to categorize different statistical data. The statistics uses three different classifications, which regard economic activities, products and goods. As stated above, both the term product and good is being used, where product refers to something being produced in an industrial activity, and a good refers to something which is put on the market for trade (Statistics Sweden, 2007). The context of these different economic classifications will be further presented in this chapter, along with some examples.

3.3.1 Classification of economic activities

In order to describe different types of businesses in the society, the European Classification of Economic Activities (NACE) is used on a European level (Statistics Sweden, 2007). It is a standard which is used to categorize different production units to specific branches of industry. NACE is set on a 4 digit level, while there is a further specification on a national level containing an additional fifth

digit, called Swedish Standard Industrial Classification (SNI, or more specifically SNI2007 from the year of the latest review).

The NACE has the following structure (Eurostat, 2010):

Level 1 – *Sections* where an alphabetical code is used for categorization
Level 2 – *Divisions* using a 2 digit numerical code
Level 3 – *Groups* using a 3 digit numerical code
Level 4 – *Classes* using a 4 digit numerical code

By adding a fifth digit to the class, the categories can get an even more detailed level in the SNI system. An example is shown in Table 1 below. As can be seen in the case of the manufactured plastic products, the Swedish categorization (SNI) is exactly the same as the European (class in NACE), meaning that no further details are found in this specific category. As the level increases (from 1 to 4), so does the level of detail.

Table 1. *The table illustrates the four levels of NACE (section, division, group and class), followed by the fifth level of Swedish Standard Industrial Classification (SNI), which in this case contains the same information as the fourth NACE-level (Eurostat, 2008; Statistics Sweden, 2009d; Statistics Sweden, 2010a) .*

Section	Division	Group	Class	SNI	Description
C					Manufacturing
	22				Manufacture of rubber and plastic products
		22.2			Manufacture of plastics products
			22.21		Manufacture of plastic plates, sheets, tubes and profiles
				22.210	Manufacture of plastic plates, sheets, tubes and profiles
			22.22		Manufacture of plastic packing goods
				22.220	Manufacture of plastic packing goods
			22.23		Manufacture of builders' ware of plastic
				22.230	Manufacture of builders' ware of plastic
			22.29		Manufacture of other plastic products
				22.290	Manufacture of other plastic products

In Sweden, all companies are categorized into one or several of the SNI groups (Statistics Sweden, 2009e). The classification is decided by the Swedish Tax Agency (Statistics Sweden, 2010c). If a company is registered for many SNI groups, the distribution between them is made based on turnover or work hours (Statistics Sweden, 2009e).

3.3.2 Classification of products

The classification of products by activity (CPA) is the European standard for categorizing products, where products are the result of an industrial manufacturing process. In this case, the product rather relates to the industrial activity which has produced the product, rather than the function of the product. It is based on the NACE structure, where the first four numbers of the CPA is shared with NACE. The national equivalence in Sweden is called SPIN[1]. Whereas SPIN2007/CPA refers to the product, where a product can be both a good and a service, SNI/NACE refers to the activity of production. In SPIN2007/CPA, the classification of products is done by activity, where the activity directly correlates with SNI/NACE (Statistics Sweden, 2009a; Statistics Sweden, 2010b).

An example of the construction in SPIN2007 is shown in Table 2 for the equivalent SNI category 22.210 *Manufacture of plastic plates, sheets, tubes and profiles*.

Table 2. *Description of SPIN2007 for the subcategories of 22.2 Plastic products.*

SPIN 2007		**Description**	**Reference in CPA 2008**
22.21		Plastic plates, sheets, tubes and profiles	
22.210		Plastic plates, sheets, tubes and profiles	
	22.210.01	Monofilament > 1 mm, rods, sticks and profile shapes, of plastics	22.21.10
	22.210.02	Artificial guts, of hardened proteins or of cellulosic materials; tubes, pipes and hoses, rigid, of plastics	22.21.21
	22.210.03	Other tubes, pipes, hoses and fittings thereof, of plastics	22.21.29
	22.210.04	Plates, sheets, film, foil and strip, of plastics, not supported or similarly combined with other materials	22.21.30
	22.210.05	Other plates, sheets, film, foil and strip, of plastics, cellular	22.21.41
	22.210.06	Other plates, sheets, film, foil and strip, of plastics, non-cellular	22.21.42
	22.210.07	Sub-contracted operations as part of manufacturing of plastic plates, sheets, tubes and profiles	22.21.99

As can be seen, the structure of SPIN2007 follows that of SNI very well, but it is important to remember that while SNI refers to the activity of manufacturing, SPIN2007 refers to the product which is the result of the activity (Statistics Sweden, 2010b).

To the very right in Table 2, the structure of CPA can be seen. This only shares the first four digits with the structure of SPIN2007.

[1] In this report, the acronym SPIN will be used in two different contexts and with two different meanings. In this first context, it refers to a Swedish classification of products. Later in the report, it refers to a database for product registers in the Nordic countries. In order to avoid confusion the classification of products will hereby be called SPIN2007 (since it is related to SNI2007).

3.3.3 Classification of goods

The combined nomenclature (CN) is a numeric hierarchical system used within the trade industry to classify goods that are being imported or exported from the European Union (EU) when declaring them to the custom (European Commission, 2011). The structure of CN can divide into subgroups that further specify the goods.

An example: At CN2 level, *Plastics and articles thereof* are given the code 39. At a CN4 level, different goods with the code 39XX categorize the different plastics into subcategories, such as 3901 *Polymers of ethylene, in primary forms* or 3917 *Tubes, pipes and hoses, and fittings therefore (for example, joints, elbows, flanges), of plastics*. These categories further have levels of more detail, both at CN6 and CN8 level (Taric, 2011).

The CN4 categories 3901-3914 include different kinds of polymers, silicones and resins in “primary forms”. The term “primary form” means that any substance needed for the hardening of the basic polymer is included, but also different kinds of additives such as softeners, stabilizers, pigments and fillers (Taric, 2007). However, going from the primary form by further manufacture into a plastic article, even more additives will be used in the process.

The CN categorization contains about 10,000 codes on a CN8 level, and on the more detailed levels (CN8) there are changes made annually in several of the groups (Statistics Sweden, 2009b). A CN8 group can either be split into several groups, or merged together with one or many groups, depending on the trends in the trade. If a study of a certain CN group is performed over a period of several years, the possibility of changes in the content of the CN codes must be considered.

A summary of the described classifications of economic activities, products and goods can be seen in Figure 2. In the figure it is also possible to see the connection between the different classifications. As can be seen in the figure, CN is linked to CPA codes through a classification system called PRODCOM (*Products of the European Community*) which categorizes the industrial activities within Europe (Statistics Sweden, 2007). The PRODCOM system gives an 8 digit code to each unit, where the first 6 digits are equivalent to the CPA code and the last 2 digits further specify the product. Most codes in the PRODCOM list are connected to one or several CN codes. In Sweden the CN categories are used for classification and when data is reported to the European Union it is translated into PRODCOM (Sörme & Brolinson, 2010). On a national level, it is therefore enough to study the CN categories.

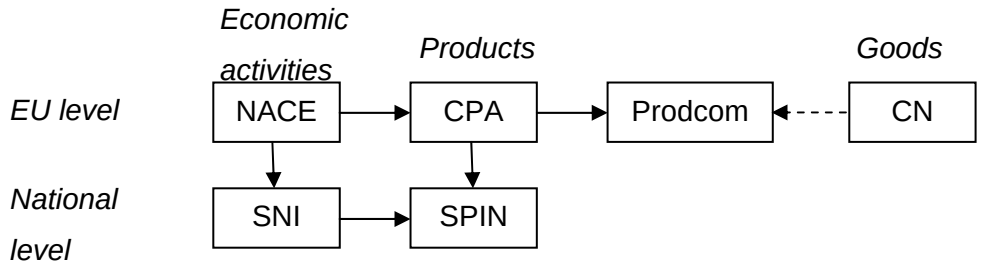

Figure 2. *Economic classifications on European and Swedish level. The arrows show which system that is the reference classification, e.g. SNI is the reference classification to SPIN (in this text called SPIN2007). If a full line, the classifications are linked by the structure. If a dashed line, the classifications are linked by a conversion table (Eurostat, 2010).*

There are also equivalences of the economic activities, products and goods on an international level, but these are not described in this report.

3.4 Classification of a chemical substance

Besides categorizing different economic activities, this thesis work also requires a categorization of chemical substances to be done in an unambiguous way. The system of CAS numbers (*Chemical Abstract Service Registry Number*) is a numeric nomenclature for chemical substances, which is often used in e.g. databases in order to make it easier to search for a chemical. A CAS number can be given to a wide variety of chemical substances, from elements to specific molecules to polymers (which can vary in molecular weight depending on the production) (CAS, 2011). There are also "non structurable materials", which are described as materials that can't be reproduced due to very varying compositions or complex reaction process, or sometimes biological materials. In the ideal case, each molecule is given a unique CAS number, however even if a substance is assigned with a CAS number it is not certain that the every molecule with that CAS number is identical.

An example: The molecule 2,4-Bis(n-octylthio)-6-(4-hydroxy-3,5-di-tert-butyldianilino)-1,3,5-triazine has the CAS number 991-84-4.

4 Results from the literature study

The work was performed in three parts, where the first part aimed at performing a literature study in order to see what kind of work that has previously been done in the field of mapping chemicals in different products, especially in plastics materials, and to see what kind of tools that are currently used in industry today to keep track of the information regarding these chemicals. The results of the literature study will be presented in this chapter, and the different sources of information that are being referred to can be found in Appendix I.

Different approaches were used to find if there was any information regarding similar projects and studies. The purpose was to find information regarding organic additives in plastics in order to see what kind of information that could be used to estimate the mean content of different additives in plastics. The results the literature study shows that there is very limited work that has been done in this field. Some projects touch the same subject and are further described below. The electronics industry is one example where information is well provided within the supply chain, but also the building and automotive sectors will briefly be described with respect to available information. Some tools currently used in industry to handle information regarding chemical contents and that potentially can be interesting for future studies are also described in the following chapter.

4.1 Previous work

Performing the search followed an explorative approach, where the searches would result in new perspectives and possibilities to further refine the search. The results of the literature study show that little has been done in the field of getting an overview of organic additives in plastics. For example, no publications or projects have been found where the aim is to get a complete overview of the content in plastics. In the searches, the plastics industry is demonstratively not appearing in the results despite the use of key words relating to plastics. Instead, the dominating industries were electronics and construction, where it is found to be more common to keep track of the different chemicals and materials used in the articles, often due to different legal requirements in these specific markets.

In searches where the information is related to additives in plastics, most publications focus on one or a few additives, such a phthalates, and the effects these might cause with respect to health or environment (Finnveden et al, 2001; Statistics Sweden, 2000). This means that for chemical additives that are believed to have no or small effects, these are not evaluated and most often not even mentioned in the reports. Also, the focus of these studies lies on the function of the additives (where

several chemicals with common properties are grouped together), rather than on specific substances. This means that for a study where the mapping of chemicals is desired on a substance level, where each compound can be connected to a specific CAS number, the available information will be too vague.

There are some projects that, similar to Chemitecs, aim at getting an overview of chemicals in articles. One example is the project *Chemicals in Products* (CIP) which is hosted by the United Nations Environment Program. The project focuses on four groups of products as their case studies: electronics, toys, building products, textiles, which implies that in the CIP context a product refers to an article. CIP focuses on information systems related to chemicals in articles and assesses this information with respect to its usefulness for different stakeholders, as a part of the framework *Strategic approach to international chemicals management* (SAICM) (UNEP, 2011b). The CIP project has primarily been investigating the information along the supply chain, but also identifies the information from authorities such as government agencies and customs as valuable and relevant (Kogg & Thidell, 2010). The information which is considered to be of the highest concern in the project refers to health, safety and environment during the product's lifecycle.

Other initiatives involve the *Substitute It Now* list (SIN list), where chemicals that are considered to be substances of very high concern, according to REACH, are listed (ChemSec, 2011). The list will provide some information regarding which industries the listed chemicals are being used in.

4.2 Examples from different industrial segments

The available information differs very much between different industrial segments, and there are a few sectors that have been more prominent in the aspect of information availability regarding the content of their articles: the electronics, automotive, and construction industries. Some examples from across the world will be provided below.

Due to the EU-legislation RoHS[2], the electronics industry is requested to limit the use of hazardous substances in their electronic equipments. This has put an increasing pressure on the electronics industry to declare the contents in their articles. The EU directive focuses on six different kinds of substances, out of which two are organic chemicals, namely the flame retardants PBB and PBDE (Swedish Chemicals Agency, 2006). To meet the increasing requirements of available information

[2] Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment (2002/95/EC)

regarding chemicals in articles, a Japanese cross-industrial initiative, *Joint Article Management Promotion-consortium* (JAMP), aims at improving the communication along the supply chain (JAMP, 2011). The project involves several hundred member companies in different industry segments, mainly electronics and automotive. However, since the project is Japanese, very limited information is available in English.

Another project for material declarations in the electronics industry is the Joint Industry Guide (JIG) which is a global tool to improve the information along the supply chain (UNEP, 2011a). In JIG, all chemicals which are part of the article or component should be listed. However, the focus lies on regulated substances, meaning that these are the only ones required to be presented.

In the CIP project, some case studies for different segments of industry have been performed. One example is toy manufacturing, where some manufacturers currently provide non-content declarations, but limited work is being done in order to inform about the contents of the articles (Dannwolf et al, 2011). However, it is stated that some manufacturers express a desire to be able to request information regarding the recipe, e.g. the content with respect to CAS numbers, in order to use this information in risk assessments.

In another CIP study, by Kogg and Thidell (2010), the automotive industry is pointed out as a positive example where collaboration throughout the industry has resulted in a successful information system about the material compositions of the different parts. The joint collaboration IMDS (International Material Data System) is an international web based system which covers the entire chain from supplier to end of life management. However, even in this case, the polymer industry is specifically mentioned as a case where the information is particularly difficult to share. It is possible for the supplier to list up to 10 % of the weight of a certain component as “confidential”, given that the substances of this 10 % are not prohibited or restricted substances.

In a previous study by Kogg and Thidell (2003), the building and textile industries have been evaluated with respect to the experiences that have been achieved from self-declarations from the companies within the two segments. Most of the declarations focus on the content on toxic and environmentally hazardous substances. Also, since they are not externally controlled it is stated that they vary a lot in quality.

Within the building and construction industry, the Swedish project BASTA is an online register which provides information about building and construction materials. The information system is free of use and publically available. The information is provided by the supplier, based on self-assessment

(BASTA, 2011a). No information of contents in the materials is provided through the register, instead the system is based on positive registration which means that by registering the building material the supplier vouches that it doesn't contain any of the listed hazardous substances, especially substances that are harmful to human and environment (BASTA, 2011b; Wilt et al, 2011). All materials registered in BASTA are required to meet the criteria of REACH (BASTA, 2011b).

4.3 Tools for systemized information gathering

In order to systemize information in industry, some tools are being used, mainly regarding to environment, health and security. Most of these concepts are well defined, and will provide a basis for the discussions regarding results later in the report. The following sources of information will be discussed: environmental reports, material safety data sheets, material declaration data sheets, and non content declarations. They will be introduced with respect to their contents and their usefulness as potential data sources will be discussed.

4.3.1 Environmental reports

An environmental report should be produced by every company with a production facility in Sweden, which performs such activities that they are required to report on their emissions to the Swedish Environmental Protection Agency (EPA), according to the settings dictated in the document NFS 2006:9 (Swedish EPA, 2006). According to the Swedish EPA there are about 1 million activities harmful to the environment in Sweden, but only 7,500 of these are required to produce an environmental report (Swedish EPA, 2010).

The environmental report should contain three parts where the first part consists of basic data about the company such as company name, contact information, authority of surveillance, etc (Swedish EPA, 2003). The second part describes the major changes during the year, reports on deviations, and so on. If a chemical product has been replaced during the year, this should be reported here. The use of raw material can be stated, but it is not required, and most often it is not. In earlier instructions regarding the content of an environmental report, it was required to present the consumption of different raw material, but this requirement has later been removed (Lidmark, 2011).

The third part is the declaration of emissions, which only is required for industries that are required to have permission for environmentally hazardous activities[3,4] (Swedish EPA, 2003). Industries that perform environmentally hazardous activities include chemical industry such as facilities for chemical production of organic bulk chemicals (including hydrocarbons, different kinds of organic compounds, halogenated hydrocarbons, pigments, etc). Within this industry, all facilities are required to report their emissions in their environmental report, meaning that there are no lower threshold values.

The emission declaration should present the values of the emissions to air and water on an annual basis. Also, the declaration should inform on how much waste that has been transported from the facility, where the waste should be divided between hazardous and non-hazardous waste (lower threshold values are 2 and 2,000 tons/year respectively).

The relevance of environmental reports will be further discussed in the next chapter, with regards to the Swedish Environmental Report Portal (5.1.2.1) and Swedish Pollutant Release and Transfer Register (5.1.2.2).

4.3.2 Material Safety Data Sheets

A *material safety data sheet* (MSDS) is a worldwide used concept which has the purpose of informing customers along the supply chain what a specific material from a specific producer contains, with focus on risk management. Material is implied in a wide context, referring to both e.g. chemical substances (such as additives) and polymers. The MSDS keeps information about the material, such as physical data, instructions in case of emergency and toxicity (ILPI, 2007). The audience is the worker who is exposed to the specific material, not consumers.

The information in an MSDS differs depending on the legislation in the specific country, and can also differ depending on the use of the material. Even in an MSDS some information can still be left out due to secrecy (UNEP, 2011a). One example is illustrated in Table 3, showing the material composition as it is presented in an MSDS from Borealis, a Swedish plastic manufacturer. As can be seen, the substance “Chlorinated flame retardant” is not given a CAS number in order to not reveal the

[3] *Environmentally hazardous activities* are defined in the Swedish Environmental Code (1998:808): 9th chapter, 1st paragraph (Notisum, 2011). This implies emissions of sewage water, solid substances or gases to different parts of the environment and use of soil, buildings and facilities which can be harmful to human health or the environment (including noise, light, radiation and such).
[4] In Swedish: *tillståndspliktig*

real content. It can also be seen that the compositions vary a lot, which is permitted in the construction of an MSDS (CSA, 2005). This also allows for varying concentrations in different batches.

Table 3. *The material composition as it can be presented by a plastic manufacturer in an MSDS (Borealis, 2000).*

Substance	CAS number	Composition
Antimony trioxide	1309-64-4	5-25 %
Dicumyl peroxide	80-43-3	0.25-5 %
Polyethylene	9002-88-4	60-95%
Chlorinated flame retardant	-	5-25%

Also, in some cases the content is not described, but only the properties of the material and the overall toxicity and safety measures that need to be taken. The following formulation is taken from another MSDS from Borealis under the headline “Composition/information on ingredients”:

“The product is a polyethylene polymer. Contains no substance classified as hazardous in concentrations, which should be taken into account according to EC directive” (Borealis, 2010b).

This means that no information regarding the content is revealed, except that it contains polyethylene.

The relevance of MSDS will be further discussed in chapter 5.2.

4.3.3 Material Declaration Data Sheet

A material declaration data sheet provides information about the content of different materials in a specific article (Dantes, 2006). In contrast to the material safety data sheet, there is no standardized way of presenting the information in a material declaration data sheet. In some cases, the declaration sheet will only list the content of restricted substances (Coilcraft, 2008; Petroferm, 2007). In other cases, the sheets provide a good overview of the overall content, but leaves out detailed information, e.g. regarding CAS numbers of certain components (AMD, 2004; Bourns, n.d.; Xilinx, 2006). One example of the last case is illustrated in Table 4, which shows a selection from a material declaration.

The information as described in the material declaration data sheet in the table is very much similar to what is desired, with respect to a total content adding up to 100 %, and a list of all chemicals used in the material. However, even if the information regarding contents in the resins were to be specified with regards to CAS numbers, the information in the material declaration data sheets have a very limited usability. This is mostly depending on the fact that the information is not standardized, which makes it difficult to use it in any systematic way. Its relevance will not be any further discussed.

Table 4. *Selected information from a material declaration data sheet for an electronic component with an average weight of 0.9408 g. As can be seen, the information of the two resins is both stated to be "trade secrets" in both cases (Xilinx, 2006).*

Component	Substance description	CAS number or description	% of component	Use in product	Component weight (in grams)	Component % of total
Die attach material		2300		Silver paste die attach material	0.0074	0.78%
	Silver	7440-22-4	78.00		0.0058	
	Resin	*Trade secret*	22.00		0.0016	
Mold compound		EME G770			0.374	39.84%
	Epoxy resin	*Trade secret*	12.00		0.0450	
	SiO_2	60676-86-0	88.00	Filler	0.3298	

4.3.4 Non content declarations

Despite the above examples, most efforts are put into informing about what substances different materials, chemicals or articles *don't* contain (UNEP, 2011a). This is usually done with different legislations or health alarms in mind, where different chemicals are grouped together, e.g. "biocides", "brominated flame retardants", and "recycled materials" (Borealis, 2011). When the aim is to find the real content in different materials, the information of non content declarations is too vague to be used in constructing lists of average contents.

5 Results from existing information systems

The focus in this chapter will be on the information that is provided through existing information systems, where information from one or several producers has been gathered in a systematic way. The information which is discussed is primarily the one that is presented in the interface of e.g. a database, but the raw data which is collected from e.g. an authority will also be discussed, i.e. the source of the information. All information systems discussed in this chapter are listed in Appendix I.

The stakeholders that have been defined to be the most important ones are: different authorities (mainly Swedish Chemicals Agency, Statistics Sweden and Swedish Environmental Protection Agency) and industry. In Table 5 below, the different information systems and their content are briefly introduced; they will all be discussed in further detail in the coming chapter following the same order as in the table. The categorizations are not intended to be clear-cut, instead it one way to present the information in a more comprehensible way. A discussion concerning the usability of each information system will take place in direct connection to each subchapter.

5.1 Information from authorities

The authorities that have been used in the study have primarily been the Swedish Chemicals Agency and Statistics Sweden, but information from the Swedish Environmental Protection Agency and the European Commission has also been used. The information is divided into different categories: related to chemical content, related to production site, and related to production and trade. The different categorizations are just one way of categorizing the different information systems.

5.1.1 Information related to chemical content

Four sources of information have been found to focus on the chemical contents, where all are hosted by the Swedish Chemicals Agency except for one which is hosted by the European Commission. The first to mention is the Commodity Guide which provides information about materials potentially existing on the Swedish market. Two of the other sources of information are both based on information from the Swedish Product Register, which gathers information regarding chemical products in Sweden. Both the Product Register and the two databases – KemI-stat and SPIN – will be presented. Finally, the database European Customs Inventory of Chemical Substances, which regards the chemical content of certain goods traded in EU, will be presented.

Table 5. *Summary of the information systems which have been analyzed in the study.*

Information system	Information provider	Content of information	Intended use and availability	Source of information	Potential
	AUTHORITIES				
		Related to chemical content			
Commodity Guide	Swedish Chemicals Agency	Content of different materials in Sweden	Inform the public about potential content in commodities. Public use	Case studies from Swedish Chemicals Agency Study from Danish EPA	Yes
KemI-stat	Swedish Chemicals Agency	Selected information about chemical products in Sweden	Inform the public about which chemicals are used in Sweden and what their functions are. Public use	Swedish Product Register	Yes
SPIN database	Swedish Chemicals Agency	Selected information about chemical products in the Nordic countries.	Inform the public about which chemicals are used in the Nordic countries and what their functions are. Public use	Swedish Product Register	Yes
ECICS database	European Customs	European Customs Inventory of Chemical Substances	Identification and classification of chemicals in CN categories. Public use or trading organizations	European customs	No
		Related to production site			
Swedish Environmental Report Portal	Swedish EPA	Focus on the facility, which companies belong to a certain industrial category	Reporting system for environmental reports. Industrial use, login required.	Environmental reports	Partially
Swedish PRTR	Swedish EPA	Emissions to water, air and soil	Inform the public about emissions from larger facilities. Public use	Environmental reports	No
		Related to industry and trade			
Substance flow charts	Swedish Chemicals Agency	Material flows	Providing information about some of the most common chemical products. Public use	Swedish Product Register	No
Statistical database	Statistics Sweden	All kind of official statistical information	Providing information about statistics, e.g. regarding trade and production. Public use	Official statistics	Yes
	INDUSTRY				
Plastics web	Ides.com	MSDS, manufacturers, trade names	Providing industrial information about plastics. Public use	Different manufacturers	Limited
Matweb		Material properties, trade names	Providing industrial information about materials. Public use	Different manufacturers	No
Msds.com		MSDS	Collection of different MSDS, searchable. Public use or industrial use, limited use (sign up required)	Different manufacturers	No
Plastics portal	BASF	MSDS, non content declarations	Inform customers about the range of products at BASF. Public use.	BASF	No
Chemical Information Search	International Council of Chemical Associations (ICCA)	MSDS, trade names	Provide information regarding substances from the chemical industry. Public use	International Council of Chemical Associations (ICCA)	No
	OTHER				
Allabolag.se	Allabolag.se	SNI categories of different companies, contact information	Combine information from different authorities about companies, for information to the public.	Statistics Sweden, Tax Office, etc.	Partially
CPM LCA database	Chalmers	Lifecycle Assessment information	Provide LCA information in research, scientific use	Previous LCA studies	No

5.1.1.1 Commodity Guide

The Commodity Guide is a database that presents systemized information concerning articles and materials in Sweden, hosted by the Swedish Chemicals Agency. The different articles are categorized according to the Combined Nomenclature and the different material groups are on a very general level, such as “Plastic”, but these are further specified into different plastic materials.

Different kinds of information are available, such as what kind of materials are used in an article (described as goods through categorization in CN groups), what kinds of substances are present in the material, and in which articles a certain material or compound is present. The data in the Commodity Guide is based on a Danish study (Miljöstyrelsen, 1995) performed in 1993, and has been complemented with information from handbooks and reports from the Swedish Chemicals Agency (the oldest data goes back to a study from 1991, concerning flame retardants) (Swedish Chemicals Agency, 2010b; Jansson, 2008).

The underlying information is described in Table 6.

Table 6. *The available information in the Commodity Guide.*

Information	Description	Details and source of information
Commodity groups	Which commodity group belongs to which section (group of products)	Commodity groups (approx. 1,000) are defined according to the Danish study. Sections (total of 21) are defined according to the statistical customs (number and name on the most general level) (Swedish Chemicals Agency, 2010c).
Commodity groups – Statistical customs number	Which commodity group belongs to which statistical customs number (CN8 level)	Commodity groups (approx. 1,000) are defined according to the Danish study. Statistical customs numbers (over 10,000) are defined according to the Combined Nomenclature, on a CN8 level (Swedish Chemicals Agency, 2010d).
Materials	Which material name belongs to which material group	176 materials are categorized into 12 material groups, according to the Danish study (Swedish Chemicals Agency, 2010e).
Substances	Which substance is associated with a specific CAS number	Approx. 900 substances are linked together with a unique CAS number (Swedish Chemicals Agency, 2010f)
Function of different substances	Which substances has a specific function	Only one function is possible, information is mainly based on previous studies from the Swedish Chemicals Agency (Swedish Chemicals Agency, 2010f).
Content of a material	Which substances can be part of a specific material, in weight-%	Information is mainly based on previous studies from the Swedish Chemicals Agency, since the studies look at a potential content, the total content will add up to more than 100%.

It is possible to combine the information in six different variations, which are presented in Table 7 below. In each different search, some parameters need to be selected:

- *Section* refers to a group of articles, e.g. “Plastics and plastic articles; Rubber and rubber articles”
- *Commodity group* is a subgroup of that section, e.g. “Various plastic and plastic goods”
- *Material group* refers to e.g. “Plastic”
- *Material* is a subgroup of that material group, e.g. “Polyethene” (Swedish Chemicals Agency, 2010g)

The parameter *Year* will determine which set of CN8 classifications to use, since these potentially can change from one year to another. The information is available for three different years: 1996, 2001 and 2007 where information regarding imports, exports and domestic production has been collected from Statistics Sweden (Swedish Chemicals Agency, 2010b).

Table 7. *Description of the possible search options in the Commodity Guide.*

Search	**Parameters**		
Substances that may be contained in a commodity group	Year	Section	Commodity group
Commodity groups that may contain a certain substance	Year	Substance name	CAS number
Materials that may be used in a commodity group	Year	Section	Commodity group
Commodity groups that may contain a certain material	Year	Material group	Material
Substances that may be used in a material	Material group	Material	
Materials where a certain substance may be used	Substance	CAS number	

The Commodity Guide provides an example of what substances and materials can be present in a certain commodity (Swedish Chemicals Agency, 2010b). The content of different substances is presented in a range of which in it could potentially be present in a certain material. However, the range is not presented for all materials, if this information has not been presented in the literature which is the source of the Commodity Guide, this information can’t be shown in the Commodity Guide (Östman, 2011). This means that the sum of the total content will add up to a much larger number than 100%. Consequently, all listed substances aren’t present in all articles, and the concentrations may vary over the listed range (or more). Also, there is a possibility that some articles include other materials or substances than those listed. It is also worth noting that the packaging usually is included in a material composition of a commodity group (Swedish Chemicals Agency, 2010b).

Usability of the Commodity Guide

The Commodity Guide includes information on what substances that a certain commodity potentially can contain, meaning that it does not reflect the real content but rather provides examples. The Commodity Guide could possibly be used as a reference, since the structure of the information is rather useful, connecting the Combined Nomenclature with a chemical content on a CAS level. However, it would be preferable to have more information on what substances different articles actually contain. Future development of the Commodity Guide, if any, will be to include substances for other materials or update the material compositions for some commodity group. The work with determining the chemical content within a certain range is not something that the Swedish Chemicals Agency will do (Östman, 2011).

All the information in the Commodity Guide is not up to date since some data dates back to the early 1990's. Since new articles increasingly enter the market, it is desirable to have as recent information as possible.

Due to the fact that the information in the Commodity Guide is based on information in publications from the Swedish Chemicals Agency, the focus in those studies sometimes has been on substances that are hazardous (Fischer, 2011). These substances have been observed carefully, and there is a risk that the amount of these substances has been over-estimated. Also, many of them have been phased out over the last years, which further increase the possibility of the Commodity Guide being a worst-case scenario.

If information from the Commodity Guide is used in mapping the average contents of different plastic materials in Sweden it is worth considering that the packaging, having a much shorter life time, is sometimes included in the material composition.

5.1.1.2 Swedish Product Register

The Swedish Product Register is a national register hosted by the Swedish Chemicals Agency. Registration in the Product Register only concerns chemical products[5], not articles (Swedish Chemicals Agency, 2010a). Any industry that manufactures products in Sweden, imports products

[5] In the context of the Product Register, a product refers to the definition of a "chemical product" as it is defined in the Swedish Environmental Code.

from or outside the European Union, or make changes to a product in Sweden (either by repacking or changing the trade name), in a quantity of 100 kg or more, are required to report this in the Product Register (Swedish Chemicals Agency, 2011a; Swedish Chemicals Agency, 2011b). The information which is to be registered related to each product is presented in Table 8.

Table 8. *The available information in the Product Register (Swedish Chemicals Agency, n.d.-a; Swedish Chemicals Agency, n.d.-b; Swedish Chemicals Agency, 2008)*

Information	Description	Details and sources of information
Company name and contact information	Ordinary contact information	Also contains information regarding municipality and county
Product name	The trade name of the product	
How does it enter the Swedish market	Manufactured/imported/name change	Import from within or outside the EU should be stated.
Quantity	Amount in tons	Some rounding off is allowed: 0.1-9.9 tons to the nearest tenth of a ton 10-999 tons to the nearest ton Above 1000 tons to the nearest tenth ton
Consumer availability	Yes/No	Indicate whether the product is available to customers.
CN6 category	The category to which the chemical product belongs	All CN categories which are required to be reported are listed in the document SFS 2008:245 available at: http://kemi.se/upload/Produktregistret/Docs/Tulltaxe nummer_ur_forordningen_2008_245.pdf
Functional code	The function of the chemical product, as listed in a publication from the Product Register.	If a product has more than one function, the main function is to be selected. Some relevant codes are: “Solvents”, “Softeners for plastic, rubber, paint and adhesive” and “Raw materials for production of plastics”.
SNI code	The SNI code of the industry to which the product is mainly being sold.	If a product has several functional codes that belong to different SNI codes, it will be assumed that the distribution is equal over the different codes (Fischer, 2011).
Approximated distribution between SNI codes	Only for products belonging to the CN categories 28 and 29.	
Composition of product	Ingredients used in the product (CAS number and name) and the content of each substance in weight-% (wt-%).	Not all ingredients are required to be declared; a declaration is only required if the substance is an active biocide or preservative or the substance is thought to be hazardous to health or environment. Special requirement for the CN groups 22, 28 and 29 (22: Beverages, spirits and vinegar; 28: Inorganic chemicals; 29: Organic chemicals), where all substances should be declared over 1 wt-%, including impurities. Also, if a substance constitutes a minimum of 5 wt-% of the final product it needs to be listed. Within the interval 0-1 wt-% the content should be declared as precise as possible, above 1% wt-%, the content can be rounded to the nearest percent. Use of an interval is allowed if the content differs in different batches, e.g. due to varying quality of raw material.

The CN categories which are being registered to the largest extent are the groups 28 and 29 (Inorganic and organic chemicals). In the group 39 *Plastics and articles thereof,* only the categories of 3901-3915 are considered as chemical products, where 3901-3914 refer to different kinds of polymers in their primary forms and 3915 refers to residues from the plastic industry.

The Product Register in itself is not possible to search for anyone outside of the Swedish Chemicals Agency, due to much information being considered to be corporate secrets. However, there are two databases which are connected to the Product Register that publish some of the information: KemI-stat and the SPIN database (Swedish Chemicals Agency, 2011c). All information is decoded before being published in any of the two databases meaning that no company information is available in the databases (Swedish Chemicals Agency, 2011d). Also, any information that could be specifically linked to a certain business is not being published in the databases.

KemI-stat

The database KemI-stat publishes decoded statistical information about chemical products in Sweden. It is a completely open database, where no login is required. It gathers information from the Swedish Product Register and the Pesticide Register, but these two sources of information are kept apart in the presentation of the information. Since this study only focuses on the information available from the Product Register, information related to the Pesticide Register will not be discussed any further.

Table 9. *Description of the possible search options in KemI-stat.*

Search	Possible selections	Description
Use	Customs number	One or several statistical numbers on either CN4 or CN6 level can be selected. The information shown can be either the total amount (in tons) or the number of products, either for a selected year or to see a trend over several years.
	Industrial category	The categorization used is the same as SNI, allowing for connections between different sources of statistics. The most detailed level is not used; instead the more general level “Group” at the NACE level is being used. The information shown can be either the total amount (in tons) or the number of products, either for a selected year or to see a trend over several years. It is also possible to get a list of all the ingoing substances in that category for a selected year.
	Product type	By grouping different products in different categories, it is possible to follow trends for certain product groups over time. Most of the product types are not specifically linked to a certain type of product or material but are rather general, e.g. “Flame retarding materials”.
Substance	Name/CAS	
	Substance amount	For a specific substance you will get information about how much of the chemical substance is being used yearly, and how many products it is being present in.

In KemI-stat, it is possible to focus the searches on either *use* or *substance*. The options are presented in Table 9 above.

There are also two other possible searches with respect to the use category: “Industrial and danger category” and “Product type and danger category”, which is the same information as “Industrial category” and “Product type” above, but also connected with the toxicological and health effects that are reported to certain substances. These two options have not been investigated any further.

SPIN database

The other database which provides some information from the Product Register is the SPIN database, where SPIN[6] stands for *Substances in Preparations in Nordic countries*. The database gathers information from the product registers of the Nordic countries. The structure is based on the different chemical products in the database, and the information is only accessed through searches of a specific chemical, either by substance name or CAS number. The available information is very similar to that of KemI-stat, but in SPIN the exports have been excluded and the overall information is not as complete as in KemI-stat (Fischer, 2011), which gives room for more information gaps.

For each chemical product, information is presented in tabular form, separating the information from the different Nordic countries and for each year where the product has been reported. A summary of the available information is presented in Table 10.

[6] Here, SPIN refers to the database and not the classification of product SPIN2007.

Table 10. *The available information as presented in the SPIN database. For each category, it is clearly stated which nation and year the data comes from. Sometimes all countries and years will have data, sometimes only a few.*

Information	Description	Details
Exposure	In what environments is the substance being used.	
Total use	No. of preparations; amount (in tons); consumer preparations; confidentiality of product	Only for non confidential data, amounts are rounded off to nearest ton
Industrial use (NACE)	In which industrial segment the substance being used	List of one or several industrial codes (NACE-division), and the no. of preparations and tons associated with that subgroup
Industrial use (national)	In which industrial segment the substance being used	List of one or several industrial codes (NACE-group), and the no. of preparations and tons associated with that subgroup
Use category (UC62)	Intended use of the chemical product with a general classification system shared between the Nordic countries.	The substances have been categorized according to a general categorization system called UC62 which is a general system shared between the Nordic countries.
Use category (national)	Intended use of the chemical product with a national classification, in the Swedish case the functional code.	The functional code is described in the Product Register. For each code there is information about the total amount (number of products and amount).

Usability of the Swedish Product Register

The information available in both KemI-stat and SPIN is, in most cases, very similar, which is not that surprising since the underlying information is the same. However, the information is presented in different ways, which sometimes enables for different interpretations. In the cases where the information differs, the systems are not transparent enough to allow for an understanding of the deviations. Requests to the Swedish Chemicals Agency have resulted in some answers, e.g. that KemI-stat includes exports while SPIN does not (Fischer, 2011), but this does not account for all deviations. Also, there are some substances in SPIN where exports are still being considered which means that the system is not fully consistent. According to Stellan Fischer at the Swedish Chemicals Agency, exports are defined as a separate industry in KemI-stat, and in SPIN it should have been completely removed (Fischer, 2011).

Since the two different databases are not always coherent or reveal the same kind of information, it could be interesting to investigate the possibility of combining the two sources of information in order to see if additional information could be acquired or if a better coverage of the information can be

achieved. This possibility will be further examined in chapter 7.2. However, one aspect that largely complicates a combination of the two systems is that in a case where a product is partly exported and partly used in Sweden, the industrial categories are not coherent (Fischer, 2011).

The Product Register collects information from the companies about what they report to be using, it will not reveal the real use in industry. It is likely that the Product Register will give an overestimation of the use of hazardous substances. This is because it is not uncommon that companies forget to report the change of use in different chemical substances. Sometimes, it is not until the Swedish Chemicals Agency reacts due to a company reports to be using a substance which is prohibited, and takes contact with the company that the change in recipe is reported (Fischer, 2011). At the same time, registration is only required for chemical products of higher quantities than 100 kg, implying that low production chemicals are never reported. This will account for a lower total quantity than the real value.

Another comment to the data is that the information provided to the Product Register refers to what has been sold to the market, not what has been produced (Fischer, 2011). If zero tons are reported to the Product Register, this means that zero tons have been put on the market, but there is still a possibility that the product has been produced and is kept in stock. This means that raw materials or products which are kept in stock will not be registered.

Some rounding off is made in both KemI-stat and SPIN, but it is not done in the same way. In KemI-stat, if the value is below 100 kg it will be rounded off to 0 tons. By looking at how many products the chemical exists in, it is possible to see if zero tons is also zero products or if there are products that contain the substance (Ljung, 2011). In SPIN, the rounding off is made to the nearest ton, making the information less detailed (Fischer, 2011). If data between the two databases will be combined in order to get more information, this will cause inconsistencies in the data.

The information regarding the SNI code of the producing company is not collected through the Product Register. However, it is easy to trace this information by contacting Statistics Sweden. If this is done, the information will reveal both which industry manufactures a specific chemical, and which industry is using it.

In addition to the above, the most challenging obstacle to getting valuable information from the Product Register is the fact that there is information which is never published due secrecy. If a product is produced by less than three companies, the information will not be published in either KemI-stat or SPIN (Swedish Chemicals Agency, 2011d). Since more than 8,000 of the 13,000 substances in the Product Register are substances which are being used in products produced by less

than three companies, this largely limits the usability of the databases. In these cases, the quantities of the chemicals are not published.

However, it is possible to make requests to the Swedish Chemicals Agency concerning specific chemicals or additional information besides that presented in the databases. The request will be considered, but only approved if secrecy can be kept since there needs to be a minimum of three companies that produce products within that category, in order not to jeopardize the confidentiality (Fischer, 2011). According to Stellan Fischer at the Swedish Chemicals Agency, practically any information is possible to be extracted from the Product Register, with respect to chemical use, amounts, industry sector, functions, products of use, etc, had it not been for the restrictions of secrecy. This also means that the Product Register contains the information required to find the average content for e.g. different CN groups, for the different CN groups that are listed in the Product Register, with the limitations as listed in Table 8 (Composition of product).

5.1.1.3 ECICS database

The last information system to be presented relating to the chemical content of different materials or articles is the European database ECICS (*European Customs Inventory of Chemical Substances*) where CN numbers (on a CN8 level) are linked with CAS numbers. A CN8 group might have one or several CAS numbers associated with it. ECICS has the purpose of enabling classification of chemicals in a coherent way, and making it easier to identify them (European Commission, n.d.-a). It is either possible to search on a CN number and get all the associated CAS numbers or search on CAS numbers to find which CN8 categories that the specific CAS number is present in.

However, the database is not in any an attempt to cover the whole range of chemical substances. Instead it is primarily focusing on pesticides, different kinds of pharmaceuticals, ozone-depleting substances, hazardous chemicals, dyes and pigments and “other commercially significant products”, meaning this is not a very transparent way of listing the contents (European Commission, n.d.-a).

Usability of the ECICS database

Some searches for different CN8 categories related to plastics have been performed. For the searches in the groups 3901xxxx-3914xxxx, the hits only result in the relevant polymers for each case. No additives or other chemical products are associated with that specific CN number. In several searches, not even the polymer is registered in the database. The usability is determined to be very low.

5.1.2 Information related to production sites

The Swedish EPA provides two different information systems, partially linked to each other, regarding environmental impacts at certain productions sites. The information in the two information systems, Swedish Environmental Report Portal and Swedish Pollutant Release and Transfer Register, are both based on the information provided from companies in their environmental reports, as described in chapter 4.3.1.

5.1.2.1 Swedish Environmental Report Portal (SMP)

The Swedish Environmental Report Portal (SMP) is used to gather all environmental reports that Swedish companies are required to provide to the Swedish EPA (Swedish EPA, 2011c). The system is based on self registration, where all industries which are required to present environmental reports upload the relevant information in the portal. It is possible to apply for a login to the portal, but the request will be evaluated on its purpose and relevance before a permission can be given (Lidmark, 2011).

The information which is made available through the SMP is the same as the one provided in any individual environmental report, except that in the SMP all information is gathered in the same location (Swedish EPA, 2011d). This means that the focus of the available information in the SMP lies on environmental data, especially emissions to water, soil and air.

In the portal, it is possible to search in different categories, e.g. by county, by municipality, by industry or by a specific company. All information is connected to a specific company, enabling the data to be traced, and the contact information is also available. The portal also saves historic data, meaning that previous environmental reports are also available.

The categorization of industries that is done in the SMP does not have the same structure as SNI. Instead of being related to what kind of objects are being manufactured as in the case of SNI, the industries in SMP are categorized with respect to the size of facility, divided into groups depending on the manufacturing activity (measured in amount of production) (Swedish Ministry of Environment, 1998). The categories of SMP are specifically designed to suit the purposes for the Swedish EPA. In the case of plastic production, there are three categories that could be of interest; 25.20, 25.30 and 25.50 (Swedish Ministry of Environment, 1998). The categories refer to the size of the production, where 25.20 refers to large-scale production (more than 20 ton plastic raw material yearly), 25.30 refers to smaller-scale production (more than 1 ton plastic raw material yearly), where both groups

refer to facilities where polymerization is occurring. In group 25.50, any facility that produces more than 1 ton plastic raw material yearly and polymerization is *not* occurring, should report it activities.

Usability of the SMP

The SMP will only give the user information about production in Sweden which is required to have permission for production of environmentally hazardous activities, and in that way give an indication of which companies could be more interesting to focus at. However, an interesting aspect is that the industries that are producing e.g. masterbatches or specific additives to the plastic industries, are not required to report their activities in the SMP, since they are only mixing different chemicals rather than producing them. However, companies such as Borealis (and similar polymer producers) are listed. This means that the demand to present an environmental report is put on polymerization companies but not on the compounding companies.

Another aspect that largely limits the use of the available information is that the categorization used is different to the one in SNI, and there is no logical way of combining these two industrial classifications since they are based on different parameters. This means that if synchronization with the information from SMP is desired with respect to SNI, this has to be done separately.

By using SMP, this can be a way to chose which industries with manufacture in Sweden that are the most important to focus at. However, besides getting a summary of which companies are relevant it is unlikely that SMP can be of any further use since the available information is that available in the environmental reports, and this has another focus (emissions) rather than use of chemicals used in manufacture and leaves the facility as chemical products or articles.

5.1.2.2 Swedish PRTR

The Swedish Pollutant Release and Transfer Register (PRTR) is hosted by the Swedish EPA, and the website unifies information available from the environmental reports from the 1,000 largest companies in Sweden that perform activities that can be harmful to the environment (Swedish EPA, 2009). It is a pollutant register, where the pollutants of interest are those spread to the air, water or sewage plants. The diffuse emissions from chemical products after they have left the manufacturing site are not considered. Only larger facilities with a need to have permission for production are registered in the Swedish PRTR (Swedish EPA, 2011b).

Usability of the Swedish PRTR

The information in PRTR comes from the data delivered to the SMP, except that PRTR only focuses on the largest facilities. This means that there is less information in PRTR than in SMP, and the relevance is determined to be very low.

5.1.3 Information related to production and trade

By knowing the production and trade of different products, it is possible to calculate the net inflow into Sweden of a product group, such as goods with respect to a certain CN number, by using eq. 1. This kind of information is provided from Statistics Sweden through the Statistical Database which provides information about groups of goods. Some information regarding specific chemicals can also be found through the substance flow charts which are produced by the Swedish Chemicals Agency, and these will briefly be introduced before the more detailed discussion of the Statistical Database.

5.1.3.1 Substance flow charts

The Swedish Chemicals Agency produces flow charts for some of the most important chemicals in Sweden, based on information from the Swedish Product Register. The flow charts show information concerning imports and exports of raw material, how the substance is being used, and in what kind of imported product groups that the specific chemical is present, and if it is being exported. Each flow chart refers to a specific year; some chemicals have a selection of years while others have only been studied once. There are a total of 249 chemical substances that have been studied concerning this kind of information.

Usability of the substance flow charts

The flow charts provide a quick overview of a specific substance, but since they are only made for such a small amount of chemicals, it is not very useful. The information is the same as the one available in the KemI-stat, but everything is provided in one chart which enables a good overview. The approach to secrecy is maintained also in the substance flow charts.

The substance flow charts can’t be used in order to estimate the average content of additives, it can only be used in order to see if a substance is used in the plastic production industry. If there were more information available on other chemicals it could also be possible to determine to what extent the raw

material of the plastics is used in the Swedish plastics production based on the information of imports and exports of specific additives.

5.1.3.2 Statistical Database

The Statistical Database is a provided by Statistics Sweden and gathers most of the official statistics in Sweden. The database is free of charge, and open for anyone to use, but if very large information is requested it is necessary to register (Statistics Sweden, 2011c). All information is available for several years (most often by a yearly update), which makes it possible to do time series on the data.

There is no summary of all the available information, and there is an enormous amount of information that can be combined in different ways. In this study, information concerning the plastic manufacturing companies has been in focus, where the search for relevant SNI codes has been used to map the available information. Also, the CN categorization, focusing on plastic polymers in their primary form, has been used to find relevant information. Two different fields of subject have been found to potentially contain relevant information and have been investigated further: *Business activities*[7] and *Trade in goods and services*[8].

Business activities

The section of business activities contains statistical information about domestic production whereof two are described below: *Industrial production of goods*[9] and *Basic data for industry, construction and the service sectors.*

Industrial production of goods

The industrial production of goods refers to domestic production in Sweden. The available information concerns industrial companies categorized in the SNI groups 05-33 (which equals the sections B: *Mining and Quarrying* and C: *Manufacturing*) which have more than 20 employees (in some exceptions[10] more than 10 employees and/or at least a turnover of 50 million SEK) (Statistics Sweden,

[7] in Swedish: Näringsverksamhet
[8] in Swedish: Handel med varor och tjänster
[9] in Swedish: Industrins varuproduktion

[10] Exceptions relevant för the following groups: SNI 08, 20.150, 23.5, 23.6, 23.7 och 23.9 (Statistics Sweden, 2010d)

2010d). The information from these companies is collected through surveys, whereas the information from smaller companies is approximated.

The different articles are presented on different CN levels: 4, 6 and 8, but most information is available on a CN8 level, which is the level that has been investigated further. The following information is available on CN8 level on a yearly basis:

- Deliveries (value, thousand SEK): The value of what has been produced and sold, if an article is only produced but not sold it will not be included here (Statistics Sweden, 2011a). But if it has been produced a previous year but sold in the topical year, it will be included.
- Deliveries (quantity, ton): What has been produced and sold, in tons.
- Total production (quantity, ton): The production for the relevant year. In most cases very similar to the value of deliveries.

By performing a review of the CN8 categories 3901xxxx-3914xxxx, it was found to include 124 CN8 groups, all regarding plastics in their primary forms. Of these 124 groups, 43 of them were found to be delivered during one or several of the years 2006-2009. This means that only about a third of all the groups CN8 categories were actively used during this time period. When compared on a CN6 level, it was found that 20 out of 59 of the groups were registered as zero quantity, which means that on this level two thirds of the categories were actively used. This demonstrates that although the systems often may appear to be very rich in information only a few of the groups are actively being used, and the information might not be as complex as it may first seem.

Basic data for industry, construction and the service sectors

The basic data is presented for each SNI code on a national level, containing the following information:

- Number of companies
- Number of employees
- Net turnover (million SEK)
- Value of production (million SEK)

The information as it is presented in the database is presented in Table 11 below. The information for these categories is not published in the database due to secrecy for the particular year 2005 and 2006.

The information is, as all information in the Statistical Database, de-identified meaning it is not possible to see which companies that are hidden between the numbers.

Table 11. *Data as it is presented when extracted from the Statistical Database: Business activities →Basic information*

	2007 / 2008			
SNI	**No. of companies**	**No. of employees**	**Net turnover (MSEK)**	**Value of production (MSEK)**
22.210	277 / 268	4,825 / 4,917	11,721 / 12,408	10,118 / 10,679
22.220	194 / 189	3,068 / 2,458	7,132 / 5,590	6,491 / 5,091
22.230	271 / 261	6,152 / 2,875	6,152 / 6,108	5,636 / 5,223
22.290	614 / 649	9,687 / 6,150	9,687 / 10,139	9,132 / 9,562

Trade in goods and services

Whereas the previous subchapter dealt with domestic production, this subchapter will discuss some relevant information concerning imports and exports that can be found in the Statistical Database.

Imports and exports of goods

One of several presentations of the statistics concerning the foreign trade with goods shows the imports and exports according to SPIN2007, and selected information is presented in Table 12 below.

Table 12. *For SPIN2007, the information is presented in the values of thousand SEK, but for comparison with the SNI values above, it has been rounded off.*

	2007		**2008**	
SPIN2007	**Imports of goods (MSEK)**	**Exports of goods (MSEK)**	**Imports of goods (MSEK)**	**Exports of goods (MSEK)**
22.210	7,069	7,111	7,363	7,355
22.220	3,558	2,982	3,868	3,163
22.230	1,530	3,582	1,668	3,480
22.290	6,620	5,324	6,794	5,470

As previously described (chapter 3.3.1- 3.3.2), SPIN2007 describes the industrial product which is the result of the industrial activity SNI of the equivalent code, meaning that a certain group of products are linked with a group of industrial activities.

Another statistical presentation concerns the imports and exports of goods according to their CN numbers. All CN numbers are listed in the database, and for each CN group the exports and imports is presented, both with respect to quantity in tons and economic value in SEK. The information is presented on a CN6 level. Only data which has passed through the regulations of secrecy will be

published, meaning that some information might be lacking in specific CN groups without any comment about this in the presented data.

Industrial use of purchased goods and services

In the Statistical Database there is also information about the *Industrial use of purchased goods and services*[11]. However, no data is presented since this information is only used for internal purposes at Statistics Sweden in order to calculate the gross domestic product (Statistics Sweden, 2011b). The information concerns the use of raw materials at each company, where different goods are registered together with a value in thousand SEK on a CN4 level (Statistics Sweden, 2009f). Concerning plastic materials, none of the groups 3901-3915 are required to be registered (categorized as chemical products, which will be further processed into a final product), but 3916-3926 should be registered (final products).

Usability of the Statistical Database

The usability of the information will be discussed from two different perspectives; first the usability with respect to CN numbers, and second regarding the SNI categorization.

Information regarding CN numbers

In the Statistical Database, the information concerning the CN categorizations is related to domestic production (amount and value) and exports and imports (amount and value). Even though some of the data has been approximated, it is still possible to get an overview of the net inflow in Sweden (by using eq. 1). The information regarding imports and exports is presented on a CN6 level, whereas the domestic production is presented on a CN8 level. In the case of domestic production, however, a study of the categories 3901xxxx-3914xxxx show that in most cases, there is one category on CN8 level which contributes more than the rest to the CN6 level, as will be described below:

At CN6 level, there are 59 different categories between 3901xx to 3914xx. Of these, 21 are not being domestically produced. Out of the remaining 38 categories, 32 of them only have one subcategory (CN8 level) which is active during the time period (either during the whole period or part of it). This means that there are only 6 remaining CN6 categories, which have a more complex situation where

[11] In Swedish: Industrins förbrukning av inköpta varor (INFI)

several CN8 categories contribute the CN6 category. This is illustrated by an example in Table 13 below. Another aspect that also makes the information complex as that of the 32 substances mentioned above, there are 5 categories which are classified, either partly or to a full extent.

Table 13. *Illustration of an example of the performed investigation regarding the contribution of different CN8 categories to the CN6 category. Of the 38 CN6 categories which were domestically produced in Sweden between 2005-2008, 32 can be illustrated with the example above, where only one of the subcategories (CN8 level) were contributing to the net result of CN6.*

CN6	CN8	2005 (ton)	2006 (ton)	2007 (ton)	2008 (ton)
390190	39019000	0	0	0	0
	39019010	0	0	0	0
	39019020	0	0	0	0
	39019090	243	241.5	250	20,925.9

For the same CN6 group (390190), the data for imports and exports for the same years are presented in Table 14 below.

Table 14. *Illustration of the available information on a CN6 level with respect to trade.*

CN6	2005 (ton)		2006 (ton)		2007 (ton)		2008 (ton)	
390190	Import	Export	Import	Export	Import	Export	Import	Export
	62,248	23,576	62,885	28,696	66,135	24,081	70,509	20,220

By combining the available information from Table 13 and Table 14, it is possible to calculate the net inflow of the group 390190, by using eq. 1. This means that even though the results are shown on different levels of detail with respect to foreign trade and domestic production, it is possible to combine them to some extent. However, if the net inflow is to be calculated according to eq. 1, this can only be done for a CN6 level, since the information of imports and exports is not given on any higher level of detail.

Information regarding SNI

In the same way as for the CN categorization, it is possible to link the values of SNI with the production according to SPIN2007, with respect to monetary terms. The value of production in the different industrial segments (domestic) can be connected to the value of imports and exports, and a net value for each industrial segment is obtained.

An example is illustrated using Table 11 and Table 12 above, for 22.220 which stands for *Manufacture of plastic packaging goods* (SNI) and *Plastic packaging goods* (SPIN2007), respectively. The value of the net inflow can be calculated by combining the information from the two different parameters, for year 2007 the net inflow would be the following (based on eq. 1):

Value of net inflow = 3558 – 2982 + 6491 = 7067 MSEK

In order for this information to be useful, a translation key between the economic value and the content would be required. The possibility of performing this is beyond the scope of this project.

5.2 Information from industry

Besides reviewing the information systems available from authorities, several industrial information systems have also been reviewed and their relevance discussed. The focus in this field has been in available databases, and all of the databases are designed for global use, even though it is sometimes possible to select a region. The following information sources will be discussed: The Plastics web, Matweb, msds.com, Plastics portal and Chemical information search by ICCA.

5.2.1 The Plastics web

The Plastics web is a search engine focusing on plastic materials. It provides general information which aims to be relevant worldwide. At the website there are some different possibilities of searching for information:

1. Plastics – list of different trade names, where each trade name (owned by a specific company) is linked to information related to the MSDS of the chemical product.
2. Generics – lists the families of plastics, such as “Acrylic” and “Polyethylene”, where it is possible to find information about the generic properties of the plastic. If a specific type of plastic is selected, it is also possible to see which manufacturers that produce it globally and under what trade names it can appear.
3. Manufacturers – lists all plastics manufacturers worldwide and which types of plastics that are their specialties.

In order to access the MSDS it is necessary to sign up as a member, but free of charge.

5.2.1.1 Usability of the Plastics web

The audience of the Plastics web is on a global level, meaning it isn’t possible to select information from a region, such as Sweden or the EU. The available information is, however, very specific with respect to material (on a trade name basis), so the Plastics web is valuable if specific materials from a specific producer is of interest. Also, there is a list of product names/manufacturers that no longer exist on the market or that have changed names, which makes it possible to trace production historically.

There are no indications of amounts or contents in different plastic materials, but only information about the properties of different plastics.

5.2.2 Matweb

The construction of Matweb is very similar to the Plastics Web, where the global information is gathered in one place and made searchable through manufacturer or polymer type. Matweb has a wider approach, focusing also on other materials than plastics, e.g. metals. The information which is made available through the searches relates to: Physical properties, Mechanical properties, Electrical properties, Thermal properties and Processing properties. There is also relevant background information about the material, such as producer and trade name.

5.2.2.1 Usability of Matweb

There is very limited use of Matweb when it comes to determining average contents of plastic additives, since this material information isn't available. It can possibly be used to get an overview of which materials that exist.

5.2.3 msds.com

On msds.com, different material safety data sheets (MSDS) are made searchable in a database. Over 3.5 million MSDS are available, concerning all different kinds of chemicals. It is possible to search for MSDS's both with respect to keywords (relating to material or chemical product) and related to a specific manufacturer. In order to access the MSDS it is required to sign up for a membership, which is free of charge. However, this will only give a limited number of free viewings; in order to get unlimited views of the MSDS's this can be purchased for a cost of about $40.

5.2.3.1 Usability of msds.com

The website gathers all relevant information related to MSDS's in one location, which provides a good overview of the available information. The usability of MSDS's in general is, however, quite limited. The information provided in an MSDS usually doesn't reveal the required information regarding what a specific material such as a chemical additive contains. Neither does it describe the distribution of the different components of the material on a sufficient level of detail.

5.2.4 Plastics portal

The Plastics portal is provided by the chemical company BASF. BASF operates worldwide; it provides a wide variety of plastic raw material to different segments of the market.

Two different kinds of information are available: MSDS and documents stating absence of hazardous substance (non content declarations) (BASF, 2011). All documents are specifically made for each material. In the MSDS, only the basic polymer is mentioned by name; the additives are listed as e.g. “additives, fillers” and no additional information.

5.2.4.1 Usability of the Plastics portal

No other information than MSDS and non content declarations are made available, which makes this information no more usable than other similar information systems.

5.2.5 Chemical information search

The International Council of Chemical Associations (ICCA) represents different trade organizations of chemical industries worldwide, such as the Swedish Plastics and Chemicals Federation (ICCA, 2011). On the website a search enginge is provided, with the stated purpose of providing the public with relevant information about chemicals.

It is possible to search for information, e.g. based on CAS numbers, and if a company has uploaded its MSDS this will be possible to view. The available information comes from several sources, such as BASF, DOW Chemicals, and Mitsubishi Chemicals. The trade names and synonyms will also be presented in an easy overview. There are over 1,400 chemicals that are documented in the search engine (UNEP, 2011a). When a search is performed, the information shown in Table 15 is available.

Table 15. *The available information in Chemical information search.*

Information	Description
CAS number	
Safety summary sheets	Redirects to a link on each company’s website, sometimes to the main page for the user to search for it and sometimes linked directly to the safety summary sheet.
MSDS	Linked directly to those documents which have been uploaded by specific companies.
Example of brand/product name	What names the chemical can appear on the market
Example of product category	What products the chemical can be used as

5.2.5.1 Usability of Chemical information search

The search provides information about 1,400 chemicals, which is very little in the context of chemicals. For the performed searches it has been found that some of the most common polymers are not even listed in the database (e.g. Polyethene, CAS: 9002-88-4). Most searches, however, aimed at finding additives which are reported to be used in plastics, where CAS numbers listed in the Commodity Guide were used as an example. However, it was found that very few chemicals are reported in the database, making the available information regarding examples from brand/product name and product category less useful.

5.3 Information from other stakeholders

Besides information available from authorities and industry, two other sources of information have been investigated. First, the website *allabolag.se* which combines different publically available information from e.g. Statistics Sweden and the Swedish Tax Agency Office, will be discussed. Second, the information available from life cycle assessments will be discussed, by discussing the usability of the CPM database.

5.3.1 allabolag.se

The website *allabolag.se* is a service information site, free of charge, about Swedish companies, which contains information about a company's economical activities, their SNI category and contact information. When contacting Statistics Sweden about the SNI categorizations of specific companies, they refer to the website instead of providing the answers (Grabö, 2011).

The information at *allabolag.se* is collected from Swedish Companies Registration Office[12], Tax Agency Office[13], Statistics Sweden and UC, a credit record company (Allabolag.se, n.d.). The information available from Swedish Companies Registration Office concerns the economic status of companies, registrations, etc. and in order to take part of any such information via *allabolag.se* one must pay a fee.

The searches can be performed in several ways, where the most obvious ones are by company or a certain region. However, in this study the searches have focused on searches within the different SNI

[12] In Swedish: Bolagsverket
[13] In Swedish: Skatteverket

categories. A company can perform activities within several SNI categories, but the information at allabolag.se doesn't reveal the relative importance of the different categories. Once a SNI category has been chosen it is possible to further narrow the search by choosing the industry in which the company operates (e.g. Manufacture and industry, Wholesale trade, etc), by choosing the county of specific interest, by choosing a specific size of the company (this is decided by the economic turnover of the company), and by choosing the corporate form (where a joint-stock company is by far the most common form). By doing these selections it is possible to see which kind of companies are the most important in a specific field.

5.3.1.1 Usability of allabolag.se

The searches for different SNI codes relevant in plastics production are presented in Table 16 below. It is possible to get information about each individual company that appears in one of the hits. However, it is not possible to see to what extent each company performs activities within the specific SNI code if it is registered with many SNI codes.

Table 16. *Number of companies that are registered for each SNI category, 29 May 2011.*

SNI	Description	No. of companies
20.160	Industry for plastics in primary forms	66
22.210	Manufacture of plastic plates, sheets, tubes and profiles	311
22.220	Manufacture of plastic packing goods	246
22.230	Manufacture of builders' ware of plastic	321
22.290	Manufacture of other plastic products	807
46.750	Wholesale of chemical products	1,184

Another important limitation is that the information system is dynamic. It shows the information which is presently being collected from the different authorities. This means that there is no historical information being saved, and it is not possible to perform searches for a specific year. The website was visited in March and revisited in May; in the latest search the number of companies had increased for all SNI codes (varying from an increase of 2 to about 20).

The database can be used in order to get an overview of which companies that presently are dominating the industry, but for historical data and changes over time it is necessary to use the data from Statistics Sweden.

5.3.2 CPM database

The possibility of using data published in studies of Life Cycle Assessment (LCA) has been investigated by searching LCA databases, where the CPM database will be described in this report. In the CPM database LCA studies are uploaded and made searchable to the public. Since the methodology for performing an LCA is standardized, and the information in different databases is believed to be somewhat similar, only one database has been evaluated more in detail.

The focus in an LCA is the functional unit, and it is with respect to this that the study is performed. This means that information has not been separated for e.g. different materials in a product[14], but the total lifecycle of the product is in focus. Also, most LCA studies concerning plastic material focus on the cradle-to-gate meaning that the gate is considered as the resin rather than the plastic product. This result is confirmed by studies performed by van Oers et al. (2011).

5.3.2.1 Usability of CPM database

Since the focus of an LCA rather lies on the lifecycle of e.g. a product (here: as defined in the Chemitecs project, see chapter 3.2) it means that the available information has another focus than the one required in this thesis work. The information in these databases can't be connected to specific materials, since it is the production process rather than the materials that are in focus. It is difficult to separate the information in order to find the content of a specific plastic material. The focus is not on the content but rather on the total input and emissions associated with the production process. Thus the available information has another purpose than the one we are trying to obtain. In the cases where a substance has clearly been added to the material, it is not always specified what it is, e.g. "organic compounds" or "toxic chemicals", thus making the information useless when the content on a CAS-level is desired. It is possible that this is due to the fact that a lot of the data is quite old, from the early 1990's, making the focus a bit different than what would have been asked for today. The usability of LCA data in estimating the content in plastic materials is estimated to be low.

[14] Here, product refers to something leaving a production unit. It can be either a chemical product or an article.

6 Results from contacts with industry

The purpose of contacting manufacturing companies within the plastics industry was to see what kind of information that would voluntarily be shared regarding the content of additives in plastic materials. This contact would take place through visiting different company websites and through personal contact. The companies of main interest were those that have production in Sweden, especially compounding and converting companies.

Focus was on the available information from the companies' websites, such as environmental reports, MSDS, or other documents that would give more information about the use of specific chemicals in plastics production. However, environmental reports and MSDS have already been discussed previously in this report, and were found not to be of any significant relevance for the objectives of the study. Thus, these types of documents will not be discussed any further in this chapter. Instead, some relevant information obtained in the contact with some companies in the industry will be presented below.

Contact has been established with *Borealis*, one of the major Swedish polymer manufacturers, but no information what so ever could be given concerning what kind of additives that are used in the processes. In their environmental report it is stated the some additives are used in the polyethylene production and that these are to be "presented orally" (Borealis, 2010a). According to Marie-Louise Johansson (2011), Environmental Specialist at Borealis, the company keeps a list of all chemicals used in any of the processes. The county administrative board is responsible for the surveillance but the information never leaves the company, instead it is presented to the county administrative board in a yearly meeting. All information is regarded as corporate secrets and are not revealed to anyone outside the company.

Another company which has been contacted is *Polykemi*, which is the only Swedish company which distinctively works with compounding. Also in this case, no information could be revealed concerning specific chemicals in their compounds. It was stated that this information is too sensitive and will have a negative impact on the company's economical interests, if revealed. As a matter of fact, a few hundred percentage points of a certain substance can make the difference between two competing companies (Eriksson, 2011). Due to this, Henrik Eriksson, Development manager at *Polykemi,* states that the plastics industry aggressively opposes to revealing information regarding specific ingredients in their recipes. Instead, Eriksson directed to the specialist literature in order to get general information regarding the contents of plastic, namely the following (in decreasing order of relevance):

1. *Plastics Additives Handbook* by H Zweifel
2. *Additives for Polyolefins* by M Tolinski
3. *Additives for Plastics Handbook* by J Murphy

According to the Production Director of *Ineos Compounds*, a compounding company selectively working for the PVC industry, the company doesn't have knowledge about all the contents in their chemical products (Lindgren, 2011). Some compounds are bought premixed, e.g. stabilizers, and mixed further into the compounds at the facility. The information from the suppliers is only provided through MSDS or lists of non content declarations in cases where certain substances are to be avoided. When it comes to the raw material used to produce the compounds, the company knows which kinds of substances they are using, but this kind of information is not shared outside the company.

At *Clariant Masterbatches*, no production is taking place; the mixing is only taking place in an extruder. As a purchaser of different kinds of chemical products, the company only has knowledge about the content with respect to what is being reported to them. Annika Johansson (2011), Environment and Product Safety, states that the recipes from their suppliers are top secret and Clariant Masterbatches only get information concerning what is being asked for (either through MSDS or declarations of non content), and that the company can never be sure of what is really in their compounds. They simply know what is not intentionally put in there. Since the company has about 25,000 chemical products, a specific agreement has been set with the Product Register. This means that average recipes are being reported for the different plastics, with respect to a handful of the most common colors. Any of the less common mixtures will result in a background noise which will never be reported to the Product Register since it is not made in large enough quantities.

The results of the contacts are pointing in the same direction: no information is desired to be shared. By looking at several web sites from the industry, it is evident that no information is shared in this forum, besides MSDS and similar documents. Several companies which have been contacted have ended up not replying, and above all, been very suspicious.

6.1 Relevance of the information from plastics industry

One aspect that further makes the situation very complex is that many manufacturers, and especially suppliers, are active on the market. As opposed to Figure 1 previously shown in the report, a separation of the industrial activities into polymer manufacturer, compounders, converters and end-users, can rarely be done. Most companies perform several of these activities, e.g. polymer manufacturing and compounding, compounder and converter or converting and production into end-

use. It can be stated that the plastic manufacturing industry has many stakeholders where it sometimes is difficult to draw the line between the different fields of activity. This makes it very difficult to get an overview of the whole field. This made the process difficult in just getting an overview of which companies to take contact with. Not even *The Swedish Plastics and Chemicals Federation*, the trade organization for suppliers and manufacturers of plastic materials, could contribute to this overview, when asked.

The first obstacle was to find information about which companies to contact. The plastics manufacturing industry doesn't display itself publically to a great extent. The only companies which are easy to find information about are the polymer manufacturers, of which there are several that have large production units in Sweden. Borealis and Ineos ChlorVinyls are two major polymer producers and they supply raw material to other plastic producers in Sweden.

However, the greatest obstacle was the lack of information, both in publications, on websites and when contacting companies. No information what so ever will be shared, unless it is already stated in an MSDS or similar, and as stated before there is plenty of room in an MSDS to "hide" substances which are desired to be kept as trade secrets, as long as the substances are not required to be reported due to legislative reasons.

It is also interesting that some companies state not to have full knowledge about the contents themselves. This means that they rely on e.g. lists of non content declarations in order to secure that certain substances don't end up in their products. This also means that only the substances listed in e.g. restriction lists will be the ones that the company will keep an eye on; this implies that there can potentially be a very large amount of chemicals in products that not even the producers themselves are aware of.

Something that should be investigated further is the possibility to use the published information available in literature. Henrik Eriksson at Polykemi states that the literature provides good information about what is generally being used in the industry. The literature might not be as specific with regard to a certain plastic material, as would be the outcome if a producer's recipe was to be known, but on the other hand that recipe might be very different from another producer's. Since the goal is to estimate average contents, it is possible that the literature could provide information at about the same level of detail.

7 Possible combinations

Based on the previous discussions some of the information systems have been found to possibly be of greater interest and have a larger usability than the rest. Some of these information systems will be further examined below, and attempts to combine some different sources of information will be made. The selections have been made on decisions on what information systems are found to be most relevant, and the combinations have been made due to the logic of the combination. The following combinations will be attempted and discussed:

1. The Commodity Guide and the Product Register
2. KemI-stat and SPIN database
3. Product Register and statistical information
4. SNI, SPIN2007 and Combined Nomenclature

7.1 The Commodity Guide and the Product Register

As previously mentioned, the Commodity Guide provides an example of what a commodity or a material could possibly contain. The Product Register contains information about chemical products that are being registered in Sweden. In the study, the information in the Commodity Guide and the Product Register were compared, by doing a case study for ABS plastic (acrylnitrile butadiene styrene). ABS was chosen as one of 15 plastic materials in the Commodity Guide. For the different plastic materials in the Commodity Guide, which represent the most common materials, the range of chemical content varied a great deal. For 8 of the materials, over 140 chemicals were listed as potential ingredients, while for 4 materials it was below 50 ingredients. For the case of ABS, the content was 85 possible chemicals, and it was chosen since it had a quite high content of chemicals, but that it would still be feasible to go through the different chemicals in the Product Register.

7.1.1 Case study: ABS plastic

In the Commodity Guide, 85 CAS numbers are listed as possible ingredients in the material ABS. These CAS numbers are both organic and inorganic substances. After the comparison with the Product Register for the years 2006-2008, 16 of the substances were found not to be registered in the Product Register and 10 substances were registered to a value of 0 tons and 0 products. This most probably means that these substances have not been used in plastic production in Sweden during that time period (over the limit of what is required to be reported to the Product Register, 100 kg/year and

company). After the exclusion of chemicals which have no reported use during the time period, a simplification could thus be made where 59 substances remain as potential ingredients in ABS.

Another 7 CAS numbers were found to be used in only 1-3 products, with a total use of less than 100 kg yearly[15]. Since these substances were only registered for a few chemical products, the information is classified and it doesn't reveal any information about which industry fields that the products are used in. But it can be stated that a very small amount is used in any part of industry, and in a first step these could be excluded, leaving 52 CAS numbers on the ingredient list of ABS.

There are also 14 chemicals which are registered as inorganic substances. This will of course contribute to the total content of the plastic material, but if an average content of organic additives is to be done, this information will not be required. This exclusion results in 38 remaining organic additives.

Finally, there is one chemical which is being registered as being used almost exclusively in the textile industry, and not in the plastics industry.

This means that there are 37 remaining chemicals to be evaluated, and that a total of 48 chemical substances can be excluded due to the above reasons. However, it is important to remember that this is a simplification and the assumptions are only valid for ABS produced in Sweden. The remaining chemicals can be studied in further detail, with respect to type of use (SNI description) and type of product (functional code). The information for one of the chemicals is presented in Table 17.

Table 17. *The information for year 2006 for the substance 1-hydroxy-4-[(4-methylphenyl)amino]-9,10-anthracenedione (CAS: 81-48-1), according to available information in KemI-stat.*

CAS	Chemical name		Description	Tons	No. of products
81-48-1	*1-hydroxy-4-[(4-methylphenyl)amino]-9,10-anthracenedione*	Total use		6.4	11
		Product type	Coloring agent, other	0.1	4
		Industry	Industry for plastic products	2.8	8

As can be seen in Table 17, the information is not very transparent since the specifications don't add up to the total use. The total use is 6.4 tons and the available information regarding which industry it is related to only show 2.8 tons, leaving another 3.6 tons undeclared. There is also no logical connection

[15] One exception was the substance *14H-Benz[4,5]isoquino[2,1-a]perimidin-14-one* (CAS: 6829-22-7), which was registered for 3 products and 1,1 tons in year 2008, but 0 tons in the remaining years.

between the “Product type” and “Industry”; it is unclear whether the “Coloring agent, other” is a product within “Industry for plastic products”, or if they are unrelated. Since so much information is lacking, it is very difficult to draw any further conclusion from this. It is apparent, however, that the information is available at the Swedish Chemicals Agency.

7.1.2 Relevance of the combination

This study only aimed at trying to see which substances that were listed in the Commodity Guide that could be excluded given the information available in the Product Register. However, the Commodity Guide only provides an example of what a material can possibly contain, which means that other substances than those listed might be used. The net result was that 48 chemicals were excluded, but no new chemicals were added.

The relevance of using the information available in the Commodity Guide regarding chemical content in materials should be discussed. Since the Commodity Guide will only list possible ingredients, resulting in a net content much higher than 100 %, which will highly limit the potential of the Commodity Guide.

The process was only performed for one selected material, ABS plastic. It could be interesting to see whether different plastic materials would yield about the same results where several chemicals listed in the Commodity Guide can be excluded after comparison with the Product Register.

The system boundaries for the information in the Commodity Guide are not clearly defined, but the data used has been for Danish products and general information in the literature. This means that this is not specified with respect to content in domestically produced materials in Sweden. The Product Register, on the other hand, will only account for the use of chemical products within Sweden, meaning that the system boundaries of the two different cases are very different. It is not unlikely that an ABS plastic produced in China might contain different additives than that produced in Sweden, but if a Chinese plastic material is sold to the Swedish market it is not defined as a chemical product, but as an article and the contents will be unknown. Therefore, the exclusion of 26 chemical substances due to their lack of presence in the Product Register could maybe be justified if only domestic production is being considered, but not otherwise.

7.2 KemI-stat and SPIN

Both KemI-stat and the SPIN database are based on information from the Product Register. However, the same information is not always presented in the two databases. By doing a comparison with the two databases, the differences in information have been attempted to be clarified. The comparison will be represented by two of the substances listed as possible ingredients in ABS plastic according to the Commodity Guide: *chlorinated [29H,31H-phthalocyaninato(2-)-N29,N30,N31,N32]-copper* (CAS: 68987-63-3) and *2-(2´-Hydroxy-5´-methylphenyl)-benzotriazole* (CAS: 2440-22-4).

The first comparison, of the substance *chlorinated [29H,31H-phthalocyaninato(2-)-N29,N30,N31,N32]-copper* (CAS: 68987-63-3) is presented in Table 18 and Table 19 below.

Table 18. *The information from the Product Register as it is presented in KemI-stat, for the chemical substance chlorinated [29H,31H-phthalocyaninato(2-)-N29,N30,N31,N32]-copper (CAS: 68987-63-3).*

KemI-stat	**Year 2006**			**Year 2007**			**Year 2008**		
	Description	**Ton**	**# prod**	**Description**	**Ton**	**# prod**	**Description**	**Ton**	**# prod**
Total		34.1	19		120.7	18		1.5	10
Product type	Coloring agents, other	0.8	5	Coloring agents, other	0.9	5	*Secrecy*		
Industry	Export	20.4	9	Export	63.4	6	*Secrecy*		
	Publishing, printing and reproduction of recorded media	0.0	3	Publishing, printing and reproduction of recorded media	0.0	3			

Table 19. *The information from the Product Register as it is presented in SPIN, for the chemical substance chlorinated [29H,31H-phthalocyaninato(2-)-N29,N30,N31,N32]-copper (CAS: 68987-63-3).*

SPIN	Year 2006			Year 2007			Year 2008		
	Description	Ton	# prod	Description	Ton	# prod	Description	Ton	# prod
Total		14	19		57	18		1	10
Product type	Other coloring agents	1	5	Other coloring agents	1	5	Other coloring agents	1	5
Industry (NACE-code)	Manufacture of rubber and plastic products (25)	14	4	Manufacture of rubber and plastic products (25)	57	5	n.d.		
	Publishing, printing and reproduction of recorded media (22)	0	3	Publishing, printing and reproduction of recorded media (22)	0	3			
	Sale, maintenance and repair of motor vehicles and motorcycles (50)	0	3	Sale, maintenance and repair of motor vehicles and motorcycles (30)	0	3			
Industry (national code)	Publishers and printers; other industry for recorded media (D22)	0	3	Publishers and printers; other industry for recorded media (D22)	0	3	n.d.		

In KemI-stat, the product type is stated to be confidential for year 2008, but in SPIN it is being registered for the same year. By only looking at the information in KemI-stat, it would be assumed that for 2008 the chemical would only be used in a maximum of three products. However, through the information in SPIN, it is shown to be used in five products.

The total number of tons differs between the two databases, due to the fact that the amount of the exported products is being subtracted from SPIN but presented in KemI-stat. The overall information given from SPIN is better in this case, where the use of the chemical substance is described in further detail. As an example, the category “Manufacture of rubber and plastic products (25)” is not at all listed in KemI-stat, which means that only by looking at KemI-stat it would not be clear that the substance is being used in plastics production.

The second comparison, of the substance *2-(2´-Hydroxy-5´-methylphenyl)-benzotriazole* (CAS: 2440-22-4) is presented in Table 20 and Table 21 below. Due to a change in the descriptions and codes of NACE between 2007 and 2008, the descriptions are not the same (Eurostat, 2008).

Table 20. *The information from the Product Register as it is presented in KemI-stat, for the chemical substance 2-(2´-Hydroxy-5´-methylphenyl)-benzotriazole (CAS: 2440-22-4).*

KemI-stat	Year 2006			Year 2007			Year 2008		
	Description	Ton	# prod	Description	Ton	# prod	Description	Ton	# prod
Total		15.2	22		18.1	33		21.7	33
Product type	Raw materials for production of plastics	6.3	3	Raw materials for production of plastics	8.8	3	Raw materials for production of plastics	7.5	3
Industry	Export	6.4	6	Export	6.3	5	Manufacture of plastic products	6.4	5
				Manufacture of plastic products	3.2	3	Export	4.4	7

Table 21. *The information from the Product Register as it is presented in SPIN, for the chemical substance 2-(2´-Hydroxy-5´-methylphenyl)-benzotriazole (CAS: 2440-22-4).*

SPIN	Year 2006			Year 2007			Year 2008		
	Description	Ton	# prod	Description	Ton	# prod	Description	Ton	# prod
Total		9	24		12	34		17	33
Product type	Raw materials for production of plastics	6	3	Raw materials for production of plastics	9	3	Raw materials for production of plastics	6	3
Industry (NACE)	Manufacture of chemicals and chemical products (24)	6	5	Manufacture of chemicals and chemical products (24)	8	6	Manufacture of rubber and plastic products (C22)	9	7
	Manufacture of rubber and plastic products (25)	3	4	Manufacture of rubber and plastic products (25)	3	5	Manufacture of chemicals and chemical products (C20)	8	5
Industry (national)	n.d.			Industry for plastic products (D25.2)	3	3	Manufacture of plastic products (NC22.2)	6	5
							Manufacture for export (NEXP)	0	7

As in the first case the exports have been discounted in SPIN, resulting in a lower total amount of chemical product in SPIN than in KemI-stat. Unlike the first case, the total number of products is not the same in the two databases. The system is not transparent enough to explain this in itself.

In SPIN, the NACE level provides an overview of where the substance ends up. Comparing the sum of tons at NACE level with the total amount for each year, this shows that almost all the weight is accounted for. However, this is not true for the number of products, where 15, 23, and 21 products are unaccounted for in the years 2006, 2007, and 2008, respectively. The conclusion that can be drawn is

that the products which are not shown in the table are of small scale use, since they can't contribute to the total weight to any significant level.

7.2.1 Relevance of the combination

By combining the two sets of information, more information is available than is presented in any of the two databases separately can be obtained in some cases. However, since the presentation is not transparent enough, it is difficult to draw conclusions for the specific chemicals. The data is still on a very general level, where it is unclear how the substance is really being used. What is certain is that without any inside information from the Swedish Chemicals Agency, it is not possible to sort out the differences between the two systems due to the lack of transparency of which information is being presented and how it is being simplified.

7.3 Product Register and statistical information

It is possible to make a request to the Product Register in order to make an information withdrawal, giving more or other information than that presented in the open databases KemI-stat or SPIN. The data from the Product Register contains information regarding the CN category, but it is not possible to connect a certain CN number with different chemicals in any of the two databases. The available information, as it is being presented in KemI-stat, only refers to either the total amount (in tons) or the number of products for a CN number.

Therefore, a request was sent to the Swedish Chemicals Agency regarding three chosen CN categories which all contain plastic additives in some way, and are being registered in the Product Register. The selected CN categories were: 3812[16], 3902[17], and 3915[18] (Taric, 2011). The request regarded the content of each CN category, where it was desired to get a list of the CAS numbers registered in each CN group for the years 2006-2009. The information was compiled by Carl-Henrik Eriksson (2011).

Since the information is registered in the Product Register on a CN6 level, the information was requested at this level if this could be allowed due to the secrecy. In the group 3812, the CN6 group which was of primary interest was 381220[19] and 381230[20] which refers to compounds ready to use in

[16] 3812: Prepared rubber accelerators; compound plasticisers for rubber or plastics, not elsewhere specified or included; anti-oxidising preparations and other compound stabilisers for rubber or plastics
[17] 3902: Polymers of propylene or of other olefins, in primary forms
[18] 3915: Waste, parings and scrap, of plastics
[19] 381220: Compound plasticisers for rubber or plastics

plastics and rubber production, e.g. masterbatches. The result revealed that the category 381220 has 112 registered substances on a CAS level which are being used. However, only two of these were allowed to be presented in text due to the strict instructions of secrecy. For the category 381230, a total of 421 substances were registered. In this case, 63 chemical substances were described on a CAS level. Out of these substances, 15 were lacking information for two years or more due to secrecy, making it difficult to draw any conclusions on the use of those substances.

For the CN category 3902, this refers to propylene plastic in its primary form. There are 207 chemical substances listed in the group on a CN4 level, but only 23 of these are presented by name and amounts. Most of the chemicals listed are related to the polymer rather than additives.

The CN group 3915 only contained two substances, which implied that no information could be presented.

Additional information about the function of the chemicals was also given, where the major groups in each CN6 group were presented in terms of the functional codes. However, the information is only listed in a range of falling amounts, and no information regarding the quantity of each functional code.

Table 22. *Information from the Statistical Database and request to the Product Register.*

	2006			From the Product Register		
CN6	**Domestic production (ton)**	**Import (ton)**	**Export (ton)**	**No. of products**	**No. of substances**	**% of chemicals that are presented**
390210	19,495	113,396	25,860	208	36	25 %
390220	0	2,120	97	43	26	8 %
390230	0	87,878	8,099	63	43	12 %
390290	6,350	6,298	8,096	68	102	7 %

The information on CN 3902 was also compared with the statistical data provided by the Statistical Database, with respect to information regarding domestic production and imports/exports for the CN6 categories, as seen in Table 22. The table also shows the result from the Product Register, as described above.

7.3.1 Relevance of the combination

If the restriction of secrecy didn't exist, it would be possible to obtain the contents of chemicals (CAS numbers) for all CN6 categories which are required to be reported to the Product Register. This kind of request is probably the way to get the most possible information out of the Product Register, given

[20] 381230: Anti-oxidising preparations

that the hindrance of secrecy could be avoided. Since all information in the register is being reported and associated with a CN number from the beginning, this means that the system boundaries will be the same for the Product Register and in the Statistical Database, on a CN6 level. If more information could be achieved from the Product Register, it would thus be possible to calculate the net inflow for all CN6 categories which are required to be reported to the Product Register, by using the information from the Statistical Database as shown in Table 22 above, and eq. 1.

7.4 SNI, SPIN2007 and statistical information

Sörme and Brolinson (2010) present the possibility of obtaining information based on the *Industrial use of purchased goods and services*. Since companies report their use of different goods on a CN4 level, this can be connected to the SNI category to which the company belongs. However, the information is strictly kept under secrecy (Statistics Sweden, 2009f), and its relevance will not be discussed any further since the information has not been possible to evaluate.

Table 23. *Combination of CN8 (in the category CN4: 3903, Polymers of styrene, in primary forms) and CPA as presented in Eurostat (Eurostat, n.d.).*

	CN8 (2010)	**CPA (2008)**
Code	3903 11 00	20.16.20
Description	Polystyrene: Expansible	Polymers of styrene, in primary forms
Code	3903 19 00	20.16.20
Description	Polystyrene: Other	Polymers of styrene, in primary forms
Code	3903 20 00	20.16.20
Description	Styrene-acrylonitrile (SAN) copolymers	Polymers of styrene, in primary forms
Code	3903 30 00	20.16.20
Description	Acrylonitrile-butadiene-styrene (ABS) copolymers	Polymers of styrene, in primary forms
Code	3903 90 10	20.16.20
Description	Other: Copolymer, solely of styrene with allyl alcohol, of an acetyl value of 175 or more	Polymers of styrene, in primary forms
Code	3903 90 20	20.16.20
Description	Other: Brominated polystyrene, containing by weight 58 % or more but not more than 71 % of bromine, in one of the forms mentioned in note 6(b) to this chapter	Polymers of styrene, in primary forms
Code	3903 90 90	20.16.20
Description	Other: Other	Polymers of styrene, in primary forms

By using translation tables from Eurostat, it is possible to link a certain CN number together with a CPA code (Eurostat, n.d) . This can in turn be used to translate into a SNI code since CPA/SPIN2007 (product classification) is linked to SNI (industry classification), which was illustrated in chapter 5.1.3.2. This means that it could be possible to connect a specific CN8 category with a SNI and SPIN2007 group. The CN and CPA conversion is showed in Table 23.

7.4.1 Relevance of the combination

Due to the fact that the categorization of industrial activities are much more general than the classification of different goods according to the CN structure, much information gets lost if there is a connection made between the two. As can be seen in Table 23, all the different CN groups will end up in the same CPA category. This will also imply the same SPIN2007 category for all CN8 categories, namely *Polymers of styrene, in primary forms* (20.160.02), and the SNI category would then be *Manufacture of plastics in primary forms* (20.160). By grouping the different CN groups in order to convert it into CN, a lot of information would get lost; initially there is information regarding the specific properties of the polystyrene polymer, and at the end there is only information regarding plastics manufacturing. This also shows that if one is to go the opposite way, there is too little information to translate SNI into CN.

This means that it is always possible to categorize a specific CN8 group into a SPIN2007 category, but moving the opposite way would only allow for categorizing the SPIN2007 into the CN4 group: 3903, *Polymers of styrene, in primary forms*.

As mentioned in chapter 5.1.3.2 it is also necessary to have a translational key or model in order to convert the SNI and SPIN2007 values from monetary terms into an amount, in order for this information to be valuable.

8 Discussion

Based on the previous discussions on the results from existing information systems, relevant information from industry and the attempts to combine different sources of information, a general discussion will take place, focusing on the accessibility to and transparency of data and the levels of detail which the different sources of information are presented on.

8.1 Transparency

In the research work, several of the information systems have been found to be lacking in transparency when it comes to the cut off levels, system boundaries and choices of concepts. If different sources of information are to be combined, the background information needs to be very transparent. The system boundaries are often different in different projects, and this will have to be considered when comparisons are made between them. This was shown in e.g. the comparison between SPIN database and KemI-stat, where different information was presented due to different restrictions in secrecy. Another example is the combination of the Product Register and statistical data, where the system boundaries differ, and also the collection of data is performed in different ways, where the self registration is used in both cases but the statistical data is also complemented with additional estimations where data is lacking.

One example regarding choice of word is the term “product” which is not always clearly defined and has sometimes caused confusion, as has been discussed previously in the report. When information is being requested, it is important that we know what kind of information we are asking for and during what circumstances it should apply.

8.2 Accessibility to data

The largest limitation in performing this kind of research is the scarcity of data, mainly due to secrecy. For someone outside the Swedish authorities, it is not possible to access the kind of information which they get through their statistical information gathering. On the other hand, the very point of statistical information is that it should be general and show trends, not to pinpoint specific companies or industries and reveal all information about them, which is also why the information is not dispensed from the Swedish authorities.

The studies have shown that if the information regarding chemical content in plastic material is desired to be known, the most relevant information system is the Product Register, which will show

the information regarding the content in the groups CN 3901-3915 (chemical products). Concerning plastic articles (3916-3926) the information available concerns the economic value rather than the chemical content (in the *Industrial use of purchased goods and service*), since this is the major focus in the Swedish statistics.

8.3 Loss of information in the supply chain

By looking at what kind of information is available from companies regarding contents in the materials, these usually focus on MSDSs and non content declarations. It was also stated in discussions with industry representatives that they don't always know the content in their own products, but rather keep track of certain substances that are not supposed to be in there. When a specific raw material is purchased, it is not a mixture of different CAS numbers that are requested, but rather a certain function which is desired in the final product. This means that it is not always enough to find information from one supplier regarding the contents, but also to track substances further down the product chain.

8.4 Focus of the information

Another interesting aspect is what kind of information is being published and where the focus lies. As stated, many companies provide non content declarations, mostly based on chemicals that have previously been experienced to be toxic or in other ways harmful. If the information is based only on current knowledge, it is likely that other chemicals whose effects might not be known are missed out on.

8.5 Information on different levels of detail

The classification of goods can be done in different levels of detail (CN2 to CN8) and as was seen in one of the attempted combinations, information was lost when information about the SNI was attained. Because different systems have different purposes, going from one system to another will not always enable all of the information to follow. Due to the complexity of several of the systems, it is difficult to penetrate the information without much previous knowledge regarding statistics and insight in how the information is being compiled.

9 Conclusion

After the completion of this thesis work, it can be concluded that no similar work has been found, with the purpose of estimating organic chemicals in materials. The current information systems which have been investigated vary a lot in their potential usability, the two most interesting data sources seem to be the Product Register and the Commodity Guide, with respect to contents in chemical products and materials, respectively. With respect to industrial activities, information regarding domestic production and trade is available from Statistics Sweden, but this only provides information regarding the societal flows, meaning it will not reveal any information regarding the material contents of certain products (here: defined according to the Chemitecs' definition). Some different attempts to combine different information systems have been made, but due to lack in transparency of the different sources, and that the system boundaries differ, it is a complex process.

Besides the information gathered about chemical products in the Product Register, there is no authority which gathers information on the chemical contents in different products or commodities available on the market (Swedish Chemicals Agency, 2010a). Given that there is no information collected, it can't be published either. This means that this data has to be estimated in some way, either through industrial requests or literature searches. The industrial information which has been evaluated shows that the focus rather lies on environmental impact or safety, than the emissions from specific articles in their use phase. Another result was that some companies don't have full knowledge about the chemicals in their products, but rather on what they don't contain. Attempts to contact producers have not resulted in any further information. There have been indications that literature values would result in approximately the same results as answers from industry.

A joint discussion with industry has been discussed (Rydberg, 2011), where different companies in the industry gather to contribute with their knowledge about additives in plastics, resulting in lists of mean contents for different types of plastic materials. This would, like for the case of the Product Register, only provide information regarding Swedish manufacturing. It has not been estimated how this information would possibly differ from any literature values.

The Product Register will only provide information regarding the content of chemical products in Sweden. It is possible that the information could be extrapolated to be valid also for other polymers and their additives that are being imported. Even though the information is available in the Product Register, it is still important to remember that this will only be what the companies are actually reporting, not what the real use is, due to the limit for reporting or lack of knowledge.

The use of the Commodity Guide suits the purpose well, but it is not a projection of the real use of chemicals, rather a possibility and sometimes a worst-case scenario. Improvements in the data should be done if it is to be used any further, e.g. by complementing it with further literature values or comparison with real use in the Product Register.

To conclude, based on the current available information in publically available information systems, no way of fully estimating average contents have been found, even though improvements to the current standards can be made. The information needs to be further penetrated, preferably by people with skills and knowledge in the subject. It is possible, at least for chemical products in Sweden, to find further information and present the average contents on a CN6 level. The companies which produce both polymers and plastic additives will register their information in the Product Register, and this strongly proposes a continued and improved use of the Product Register.

10 Recommendations for future work

This thesis work has shown that much information is available through the Product Register, the question is rather how to take part of it. Possible ways for extracting more information from the register should be discussed with the Swedish Chemicals Agency, and ways of getting past the requirement of secrecy should be investigated. One possible approach is to let someone at the Swedish Chemicals Agency can extract the information of interest and perform the emission calculations, and simply revealing the results of the emissions.

Another important source of information is the Commodity Guide, which can further be complemented with more recent data, especially regarding new materials. Since much of the previous data in the Commodity Guide is based on literature values, the addition of more detailed literature data should be a valid approach.

In order to be able to use the information regarding SNI and SPIN2007, which are in monetary terms, it would be required to develop a model for converting these monetary terms into an amount. Whether or not this is possible to perform should be examined, and the relevance of this kind of model should be evaluated.

The possibility of getting additional information from stakeholders in the plastics and additives through a joint discussion could also be investigated. In case of success, this information could also be incorporated in the Commodity Guide. This would give more directions on what is actually being used, rather than what is potentially being used, as is the case with the current Commodity Guide.

Appendix I

The following information systems have been used in the project.

BASTA, available at: <www.bastaonline.se>

Varuguiden, available at: <https://webapps.kemi.se/varuguiden/>

KemI-stat, available at: http://apps.kemi.se/kemistat/

SPIN, available at: <http://195.215.251.229/DotNetNuke/default.aspx>, or from <http://www.kemi.se>

Swedish Environmental Report Portal, available at: <https://smp2.naturvardsverket.se/>

Statistical database, available at: <http://www.ssd.scb.se/databaser/dbinfo.asp>

Substance flow charts, available at: <https://apps.kemi.se/flodessok/floden/flodessok.cfm>

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