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PACKAGING OPERATIONS WITHIN
THE GREEK LOGISTIC INDUSTRY.
EVALUATING AND REDESIGNING PAPER PACKAGING
IN COMPLIANCE WITH ENVIRONMENTAL REGULATIONS.

Georgakoudis Elias

A thesis submitted to the University of Huddersfield in partial
fulfilment of the requirements for
the degree of Doctor of Philosophy

The University of Huddersfield

May 2014

*Dedicated to my family for all the
support and understanding shown
all these years of effort*

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ABSTRACT

Packaging occupies an indispensable part of everyday life. Even though packaging is meant to ensure that products arrive in excellent condition, so as to satisfy required needs, more often than not, consumers, as well as industrial users are more interested in the product itself than its packaging. However, if the packaging fails, the product is potentially unfit to serve its purpose. In order to meet the demands of industry, the packaging industry in Greece has evolved, mainly through new investment. This investing has boosted the market by adding quality to the products and affects corporate efficiency in a positive way. Industrial operations are subject to environmental legislation, such as the 94/62 EU Packaging and Packaging Waste Directive, which aims at optimising the various methods used in re-processing the packaging materials after their having been used.

The literature review enables comprehension of particular issues pertinent to the discussion on packaging, since it draws attention to various kinds of paper packaging. This research explores the role and importance of paper packaging in the supply chain and in proposing improvements that may ameliorate current packaging practices.

This research project explores packaging operations, as well as the issues related to the packaging supply chain, with respect to the Greek market. Moreover, it seeks to identify the occurrence of impediments, which arise as a result of inner operating discrepancies between the European Union countries, regarding the implementation of Directives such as the Packaging and Packaging Waste Directive (94/62/EC).

Key issues related to packaging are thoroughly scrutinised in this research. Among them, the relation between packaging and the environment is investigated, the overpackaging issue, along with packaging redesign, are examined, as they are all interrelated facets of the research, regarding the endeavour to enhance packaging performance. Therefore, packaging performance is examined in relation to some major aspects such as warehousing, storage, and transportation, as well as how to improve packaging expenditure. From this point of view, the issues examined are subsequently connected to the analysis of the current environmental problems and the ways to minimise them.

This study includes not only a survey of both the market and the supply chain but also of the participants in them. A detailed case study of multiple respondents' categories was developed for this reason. The data, which were collected through a specially designed questionnaire adjusted to the various categories of the respondents, were treated and analysed in order to assist the conclusions.

Following the above, this research delves deeply into issues of paramount significance, such as overpackaging and packaging redesign, approaching them with laboratory methods. The research applies both theoretical methods, based on the literature, and common industrial practices. Originating from industrial sources, the data give evidence to the reliability of the results, adding insight into the issues investigated.

Furthermore, this research points out the potential to significantly ameliorate a company's packaging performance through analysing and conducting crucial modifications to packaging design. Problems such as the packaging legislation and the discrepancies related to it among countries, not only of the EU but also of those not belonging to it, are thoroughly investigated, showing the unstable market circumstances created due to the rivalry among countries, which stems from inadequate legislation.

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CHAPTER 1 – INTRODUCTION

1.1. The research context

This research examines an essential yet sometimes overlooked aspect of supply chain management, namely that of packaging. Consumers especially but also industrial users are invariably more interested in the products they are purchasing than the packaging which is there to ensure products arrive in good condition in order to meet identifiable needs. If the packaging fails, then the product is invariably not fit for purpose.

The production of packaging materials though involves the use of scarce renewable and non-renewable resources. Whereas not so long ago, recycling and reconfiguration would not have been considered, this is not the case at the present time. An increasing rate of awareness among conscientious producers and customers has resulted in their being overcritical with respect to issues such as over-packaging, along with the factors prohibiting the achievement of low cost opportunities of recycling and reclamation. Moreover, the over packaging issue keeps puzzling society worldwide. According to the Asia News Monitor (2013), China's Central Television promotes a movement encouraging consumers not to buy over packaged or heavily wrapped up products. In 2010 in the UK, Sainsbury's was accused of using excessive packaging for some products (fresh joint of beef) by the Lincolnshire's council (Smithers, 2010). Furthermore, according to Saxena (2010), although it is common practice to use over packaging for many kinds of products, due to their demanding transportation conditions, plenty of optimisation, such as cube utilization and minimization of vibrations and crashes during transportation, can be achieved through logistical improvements, thus avoiding unnecessary over packaging.

The aim of this research is to explore the packaging operations and issues that occur in the packaging supply chain with specific reference to the Greek market. In addition, it seeks to determine the various obstacles, which occur due to endemic operating differences between the various countries of the European Union, hampering the implementation of Directives such as the Packaging and Packaging Waste Directive (94/62/EC). Furthermore the present research seeks to determine the main issues that occur in the Greek packaging supply chain while providing a deep understanding of its peculiar characteristics. The thesis provides to any concerned party (i.e. industry, government, researcher etc) valuable evidence

concerning the severity of the overpackaging issue in a company's supply chain. It further underlines the importance of the packaging redesigning process and the potential benefits that can be derived from such an action for both the environment and the community.

The Greek market is special in so far as the effects caused by a number of measures formulated by the European Union generate discrepancies compared with the remaining member states, partly due to the geographical position of Greece and the distance from the central European market.

In addition, the surrounding countries (Turkey, Former Yugoslav Republic of Macedonia, Albania) consist of important competitors for the internal market of Greece, partly due to their lower labour costs. Furthermore, since these countries do not belong to the European Union, they are not obliged to implement the European Union's directives, resulting in keeping their costs at a lower level (e.g. since their domestic industries, are not forced to maintain particular infrastructures), thus increasing their competitive advantages compared to Greece.

The role and importance of paper packaging in the supply chain is one of the main issues explored in this investigation. Various forms and uses of paper packaging in the market are presented and analysed and the way in which the paper packaging materials impact on the environment is also examined and discussed in this research.

The Greek Packaging Market

Greece, as a member-state of the European Union, experienced an impressive growth during the 1980's and 1990's. This growth was partly the result of its participation in the European Community and the multiple financial packages received from the European Commission (First: 1987, Second: 1992 etc).

During these two decades the economic conditions in general availed Greece, despite the recessions of 1982-1983 and 1992-1993 that wounded the industrialised countries. Siebert (1999, pp.71) believed that this phenomenon is not unusual since the economic cycles are not always synchronised in the world economy. He also describes that while a region of the world may be in a recession, others could experience economic growth. In general terms it seems that during this period Greece followed the economic growth of the other European countries and its industry eventually blossomed.

As shown in Figure 1.1, based on the data from Eurostat, the annual Industry Production Index in Greece for the period 1995-2011, followed the general average trend of the European Union. Still, the year 2009 is the period where Greece enters a recession and the Greek index shows a big decline compared to other European countries (see Figure 1.2). Although it is difficult to tell when exactly and how recessions begin, a recession is described by a slowdown of the rate of growth of an economy followed by falling incomes and high unemployment (Cleaver, 2004 and Mankiw, 2004). Industrial development in Greece is further testified in Figure 1.3. where, as shown, the Industry Turnover Index of Greece follows the same average trend as all other member states. If we further look at Figure 1.4. (available data starts from year 2000) the value of exported goods and services is increasing, supporting the previous statement for economic growth in Greece in recent decades.

The packaging industry in Greece has evolved as a result of industrial development.¹ As shown in Figure 1.5. packaging waste generated in Greece between 1997 and 2010, followed by an increase in trend as a result of the industry's development analysed above. At the same time, serious progress seems to occur to the packaging waste recycled, showing an increase in the overall recycled volume of packaging. New investment in the packaging industry advances the market not only by enhancing the quality of products but also by positively affecting the efficiency of companies.

There are some issues to be discussed that are relevant to the paper industry. Although there are some paper recycling centres operating in the country, it is possible that a big amount of the woodpulp used in the recycling process is imported from foreign countries. However, if this is true, it is not surprising, due to a lack of primary resources. Still, most of the paper packaging used, is produced domestically while there are some types of paper packaging that are also imported (see Figure 1.6.). It should be noted that it is assumed that the surrounding countries such as Turkey and Bulgaria provide the Greek market with raw packaging materials, mainly because of their competitive prices as a result of their lower labour costs.

¹ Due to difficulties into finding relevant data concerning packaging industry for the specific member state, the analysis is based on data provided by Eurostat.

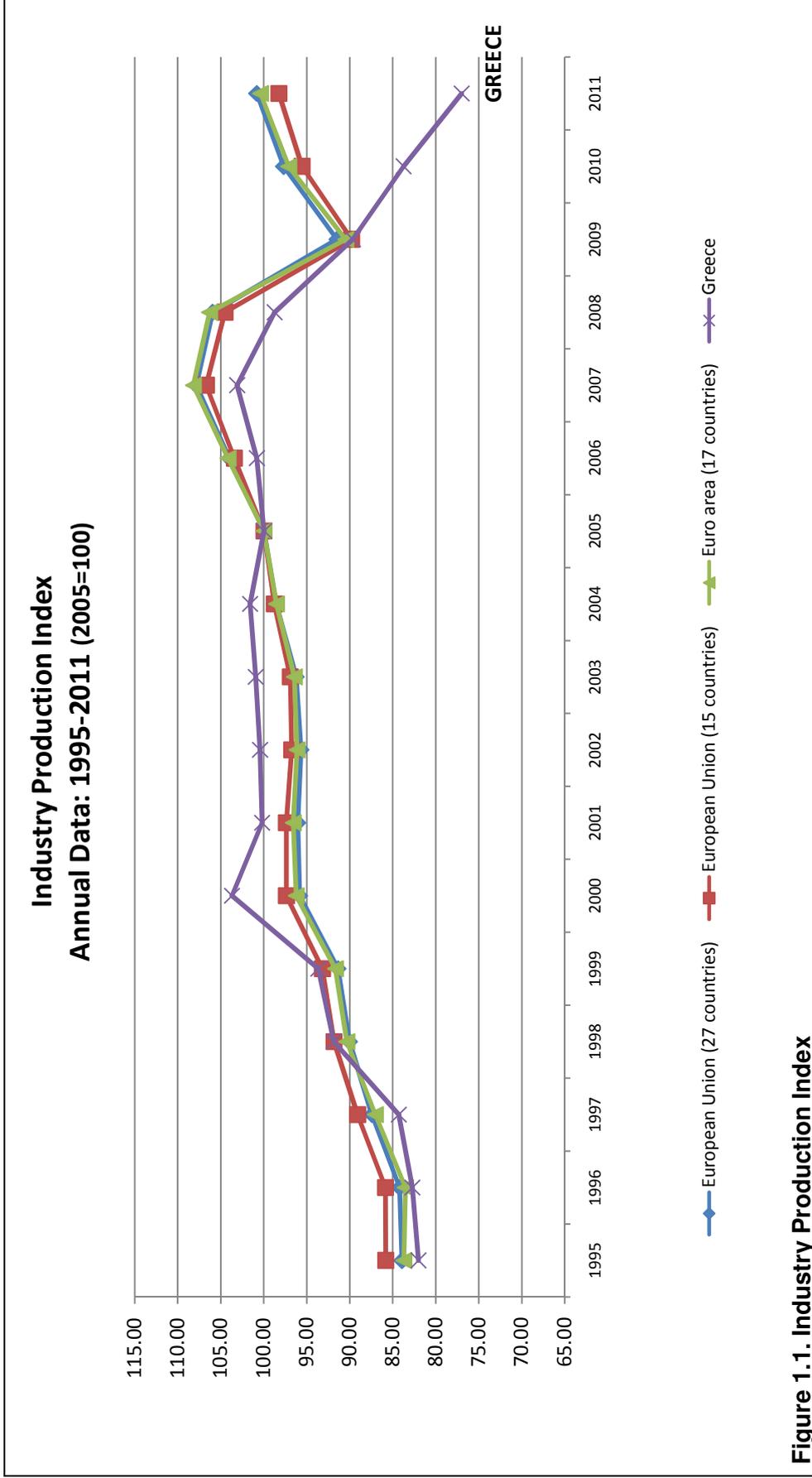


Figure 1.1. Industry Production Index

Source: Eurostat, [online] Available at: < <http://appsso.eurostat.ec.europa.eu/nui/show.do>> [Accessed 26th January 2013]

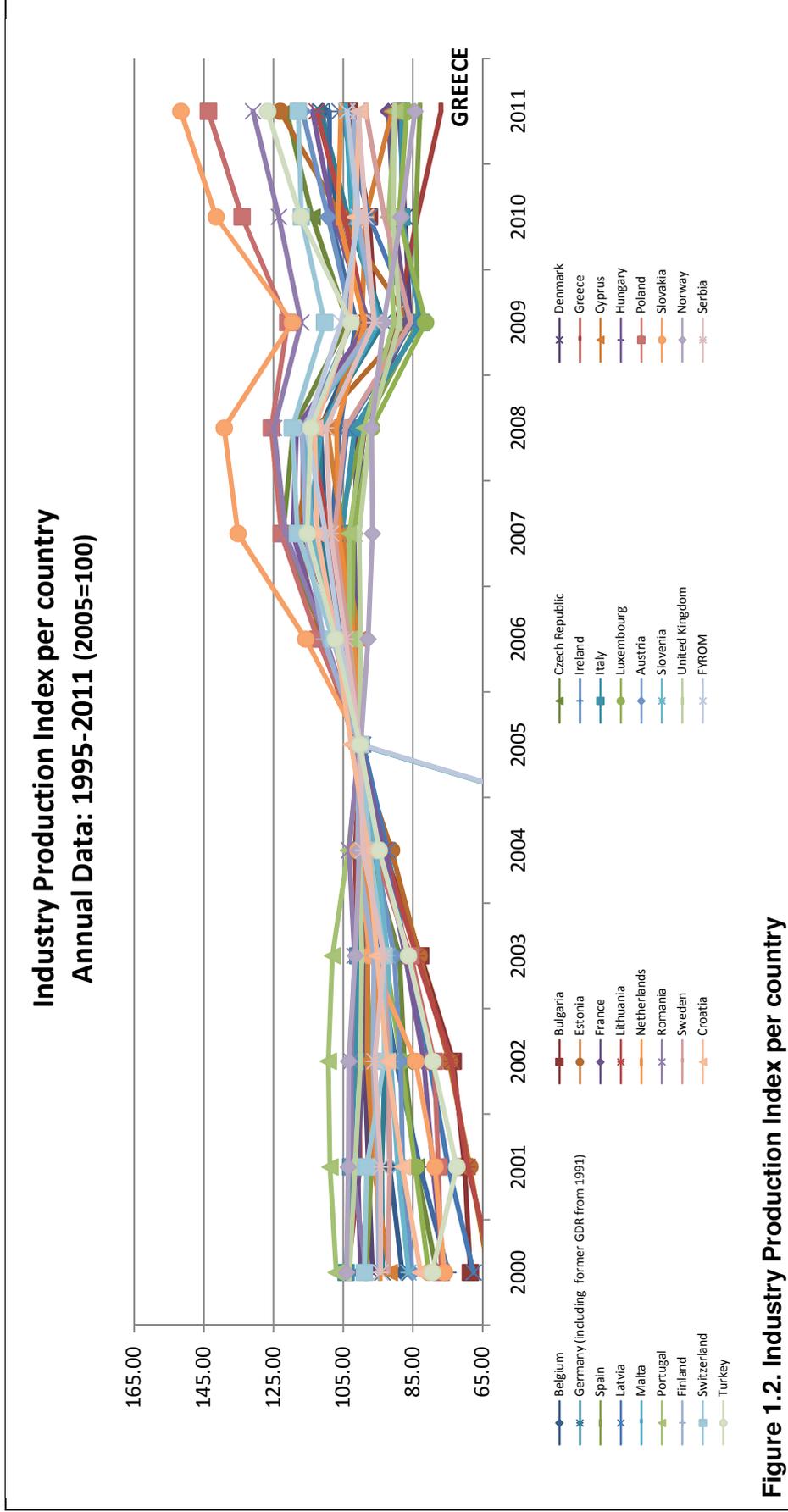


Figure 1.2. Industry Production Index per country

Source: Eurostat, [online] Available at: < <http://appsso.eurostat.ec.europa.eu/nui/show.do> > [Accessed 26th January 2013]

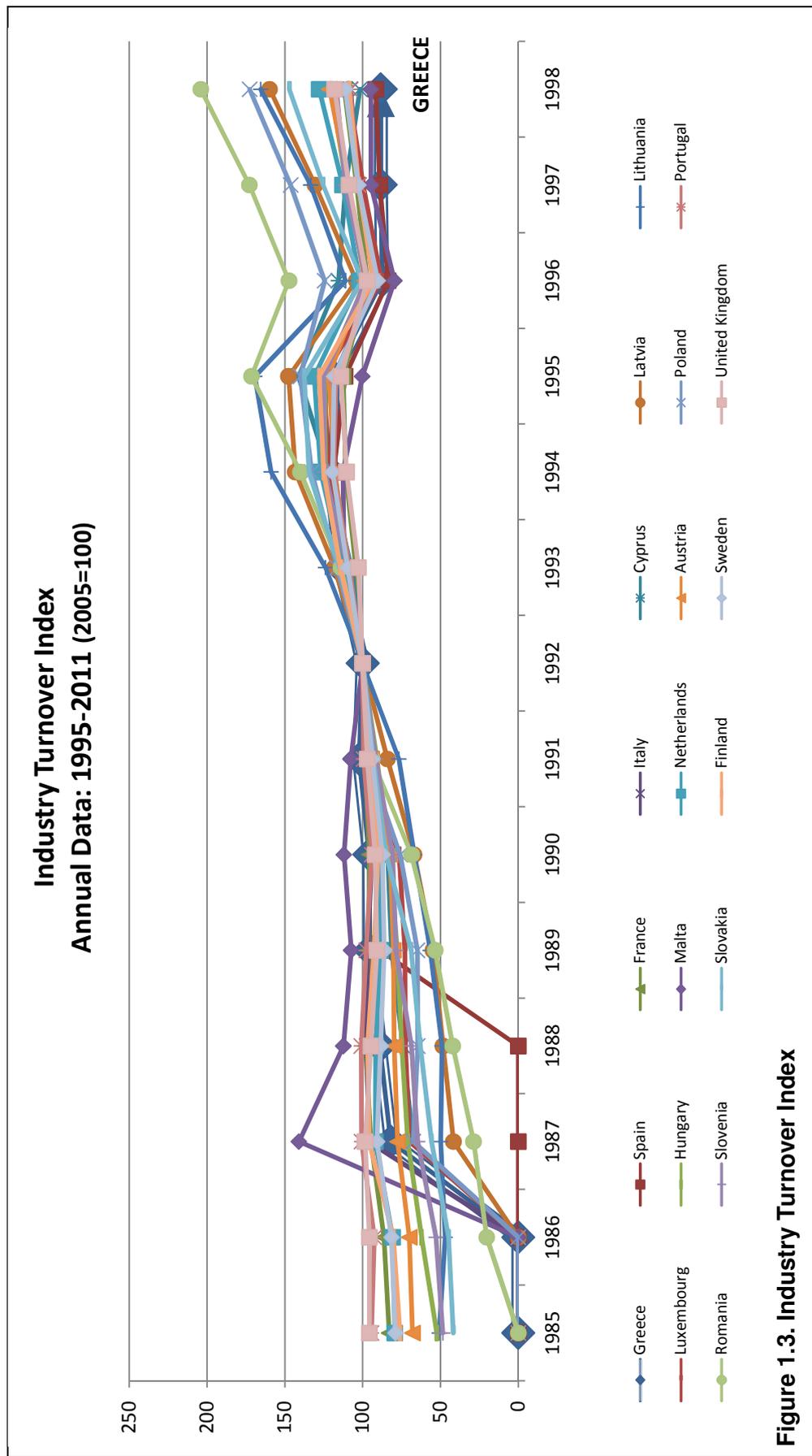


Figure 1.3. Industry Turnover Index

Source: Eurostat, [online] Available at: < <http://appsso.eurostat.ec.europa.eu/nui/show.do>> [Accessed 26th January 2013]

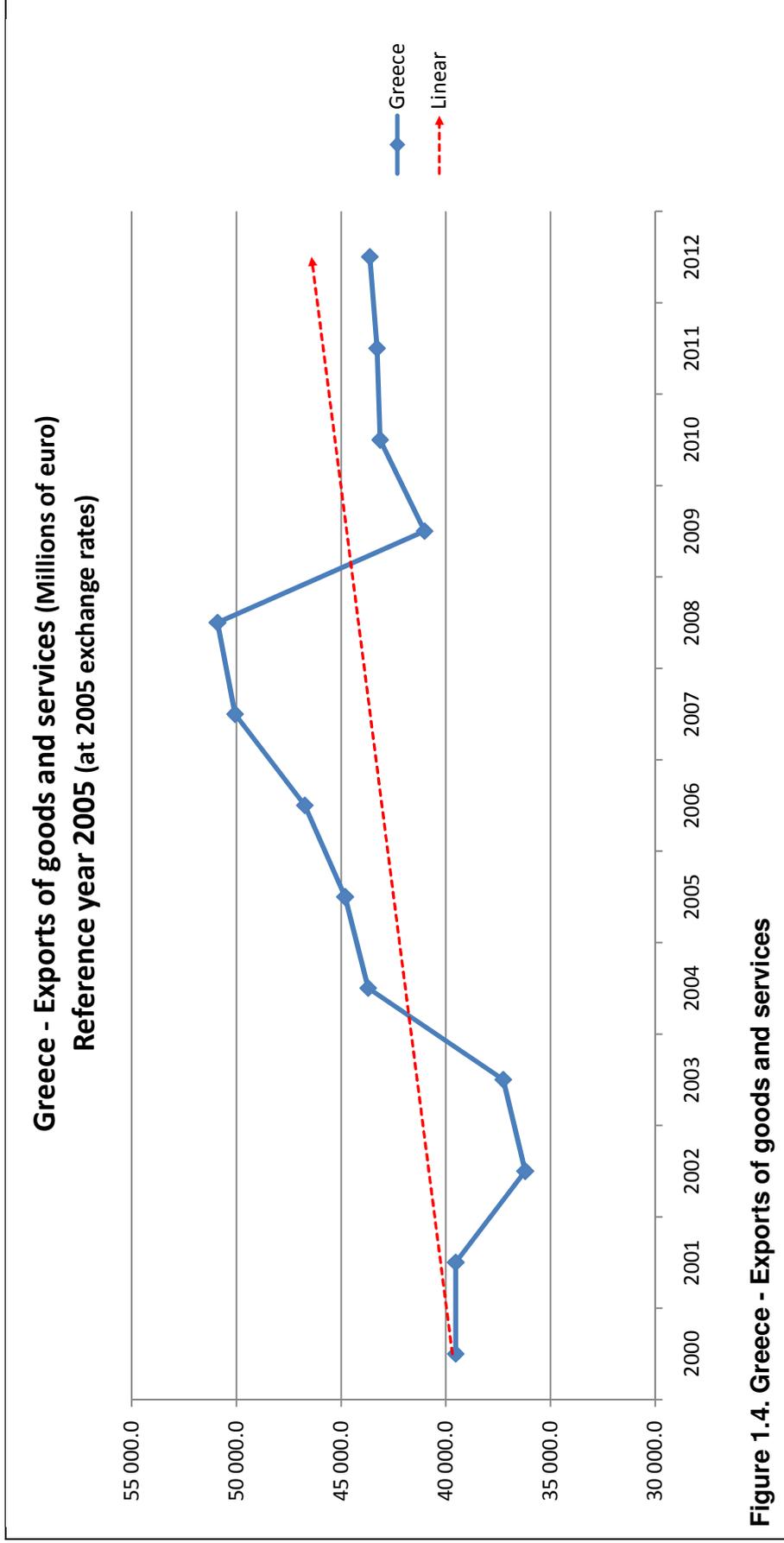


Figure 1.4. Greece - Exports of goods and services

Source: Eurostat, [online] Available at: < <http://appsso.eurostat.ec.europa.eu/nui/show.do>> [Accessed 26th January 2013]

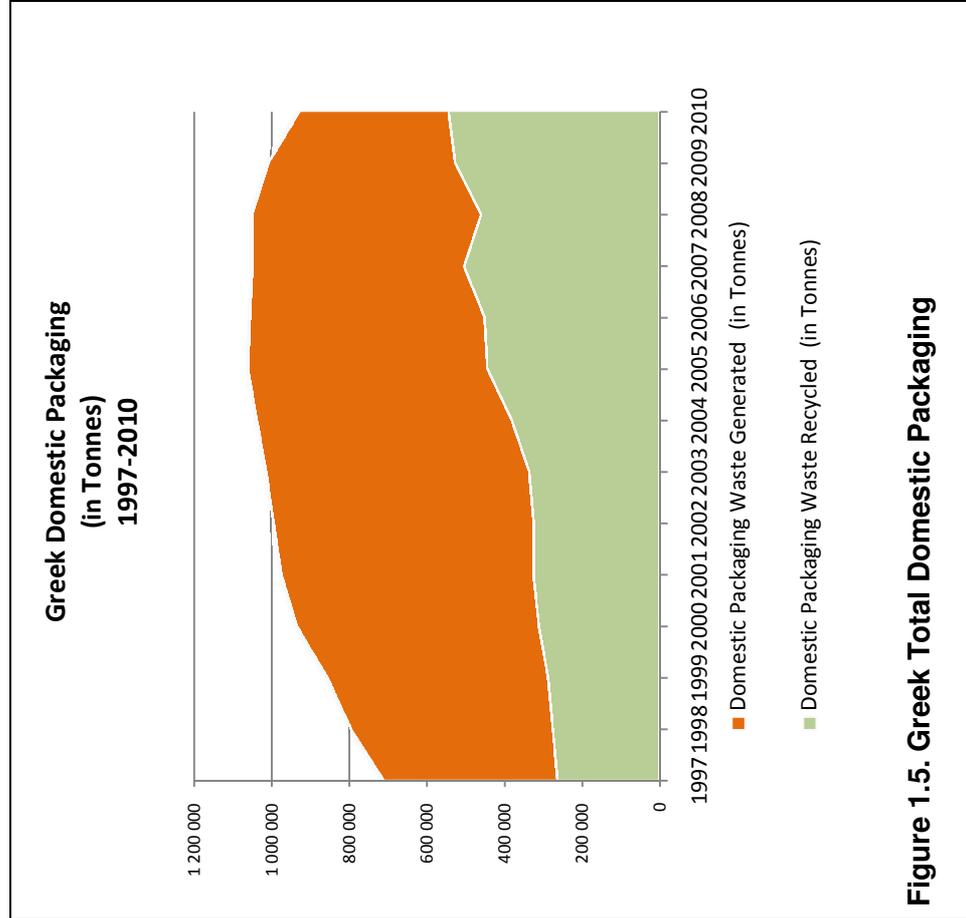


Figure 1.5. Greek Total Domestic Packaging

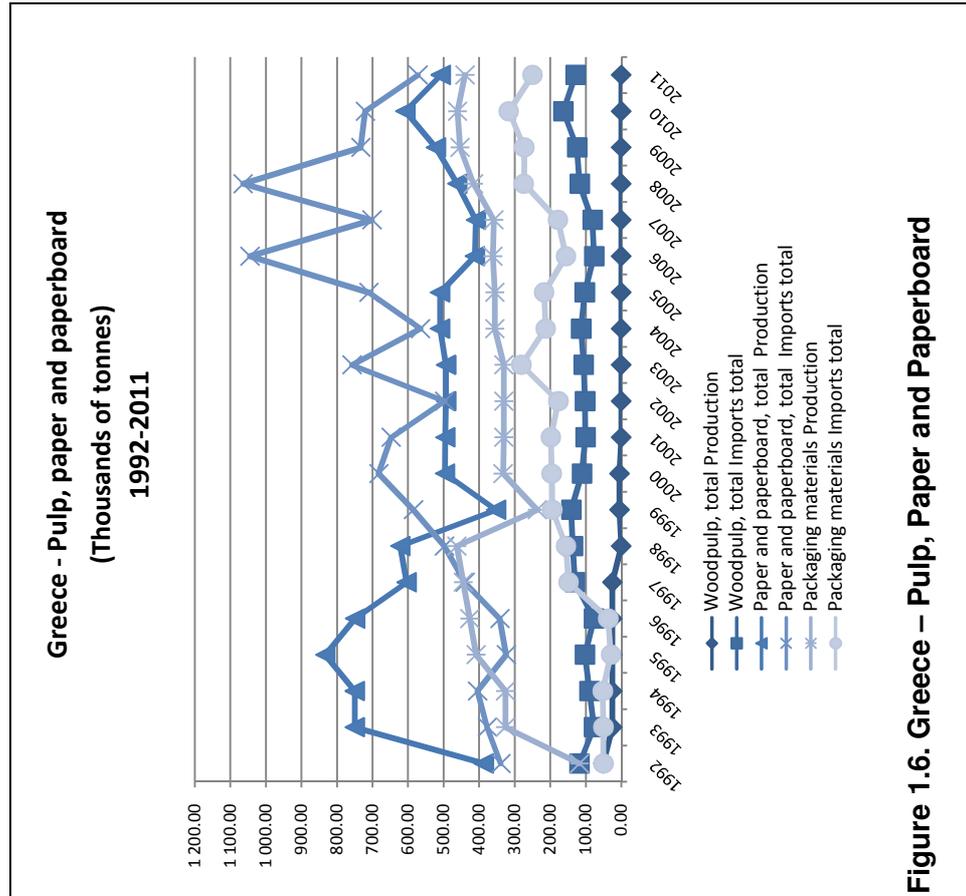
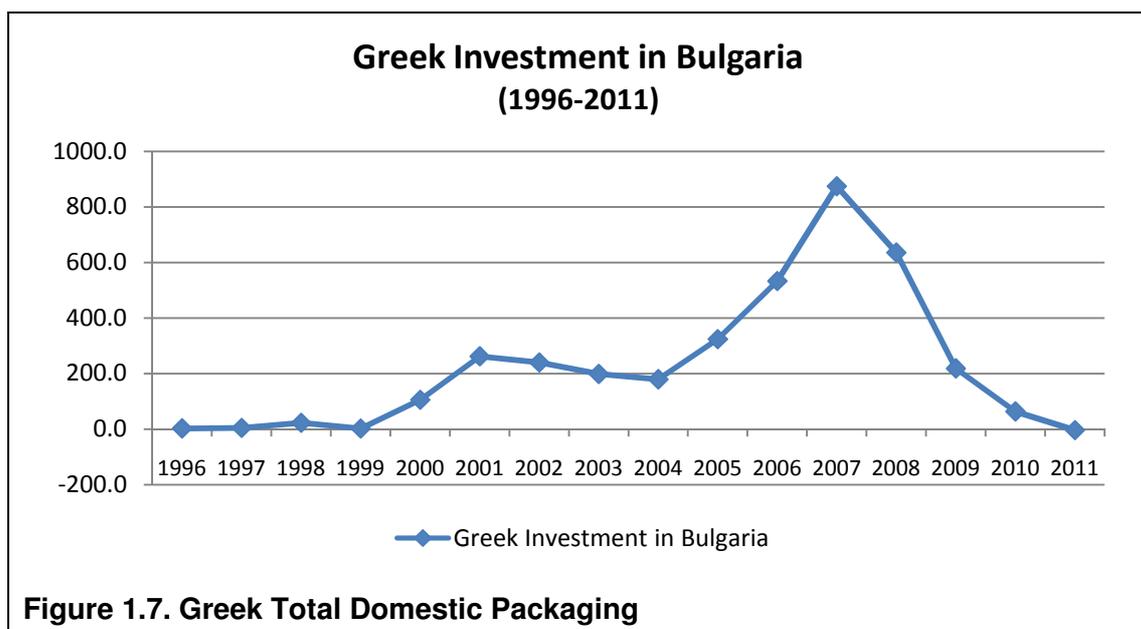


Figure 1.6. Greece – Pulp, Paper and Paperboard

Source: Eurostat, [online] Available at: < <http://appsso.eurostat.ec.europa.eu/nui/show.do> > [Accessed 26th January 2013]

It should also be noted that the Greek market especially from the beginning of 2000, is facing huge challenges for what is relevant to its competitive characteristics compared to the surrounding countries. As cited by Katsikis et al. (2012) discussing the above issue and investigating the conditions between Greece and Bulgaria, despite the fact that both countries are members of the European Union, they are very different from a social and economic perspective. Katsikis et al. (2012) also states that Greek registered companies with various commercial activity participation, ranging from 5% to 100%, almost numbered 4100 by October 2012 while employing approximately 82,000 people in Bulgaria.

It is interesting though that at the same time that Greece is facing recessionary effects and despite the fact that Greek investment in Bulgaria has fallen especially after 2009, four of the biggest investors in Bulgaria for the year 2012 are Greek companies (Invest Bulgaria Agency, 2012). Figure 1.7. clearly shows the evolution of Greek investment in Bulgaria for the period 1996-2011.



Source: Invest Bulgaria Agency, (2012), Available at: <http://investbg.government.bg/en/pages/latest-data-about-investments-in-bulgaria-211.html> [Accessed 27th January 2013]

It seems that low taxes on the one hand and the very low administrative requirements for the new established companies posed by the Bulgarian authorities on the other, are the two most important reasons for this phenomenon (Katsikis, 2012).

Although information for countries surrounding Greece was difficult to obtain, the above analysis clearly describes the current conditions that Greece is called to

face. Financial drain to foreign countries and low capital investment that are the result of bad governmental decisions and high taxes, affects a number of factors such as the unemployment level, industry stability and viability. This in turn strengthens the economic recession effects into a self-provisioning loop (OECD, 2013, Pappas, 2013, Athanassiou, 2009).

On the other hand, the packaging industry is firmly connected principally to domestic industry. Low domestic product consumption, weak exports and an unstable market, further weakens the packaging industry since it is inseparably integrated with consumption. It is indisputable that the higher the consumption is, either domestic or external, the wider the need for packaging consumption becomes. Environmentalism seems to be less important in such a difficult market situation.

The role and performance of paper packaging is being examined in depth by using a focused case study (see Figure 1.8.). A supply chain has been identified and studied, focusing on paper packaging. Different participants are going to provide the researcher with substantial feedback which –at a second stage- are to be analysed and commented on, in detail. The Greek companies which participate in the research will provide important information and valuable insight into the issue, in order to enable the researcher to examine different aspects of it, through a wider view on the topic.

The primary data obtained from the participants in the supply chain will be used to discuss the need for the establishment of a reverse channel for a paper packaging manufacturer. Since the investigation is focused on the paper packaging industry it is a great opportunity to analyse the specific issue and discuss the current circumstances for the reverse transport of paper materials back to the recycling centres in Greece. The specific issue will prove to be of utmost importance, since the main idea, covering the environmental directives and especially the 94/62 EU Packaging and Packaging Waste Directive, is the optimisation of the various methods with respect to the processing of packaging materials after their use.

In the same manner, the investigation means to include an evaluation of the extent to which the packaging regulations affect the prices of packaged products. Based on the data obtained from the participants of the supply chain, the intentions of the market concerning price increases, in case of environmental taxes posed by the government, are to be analysed and discussed, as well.

Another issue that is to be investigated is the demand for environmental friendly packaging, viewed from a final consumer's perspective. More specifically, it

will be examined whether among the leading and most decisive factors influencing the agents' preferences, when buying goods, are the environmental friendliness of the product, the price and the place of origin. It is conjectured that the more informed the customers are, the more their consuming decisions would be based chiefly on the environmental friendliness of a product.

Using an individual case study, in which an industrial customer provides relevant information concerning the type and quantities of packaging used, alternative scenarios will be set, speculated and analysed. The main target of this analysis is to suggest and evaluate the use of lighter paper packaging (compared with the current packaging used by the company) and present the advantages and the disadvantages of the alternative suggestions. This research is to be conducted from a technical perspective, providing the methodology that could be applied to any kind of corrugated paper packaging (single or double layer, full kraft, recycled or other kinds of paper).

At a second stage the research aims to provide alternative suggestions for a more sustainable Packaging Supply Chain. Initially the overpackaging issue is investigated in an attempt to reveal weaknesses, problems or failures that if treated effectively could potentially offer multiple advantages to the user. Using a case study, in which an exemplary industrial customer provides all the necessary information, the analysis will apply the feedback from the overall packaging study, used in the packaging enterprise. Moreover, the analysis is going to include packaging strength tests that were conducted in a laboratory, giving a complete overview of the issue.

Finally, the research will extend to the point of giving solid proof that the redesign of paper corrugated packaging may have cost benefits. In addition, the case study aims to provide evidence that the redesigning process could further offer weight and transportation benefits, provide better environmental performance and finally offer better protection to the packaged products.

1.2. Research Aims and Objectives

This research considers the following aims:

Aim 1: To provide an evaluation of the paper packaging issues in relation to the barriers generated by the implementation of the Packaging and Packaging Waste Directive (94/62/EC).

Aim 2: To provide alternative suggestions for a more sustainable Packaging Supply Chain.

To evaluate **Aim 1**, the following objectives will be applied:

- a. Through an extended supply chain case study based on the Greek market, to provide an in-depth analysis of the role of paper packaging.
- b. To evaluate the extent to which the packaging regulations affect the prices of the packaged products to various EU-27 countries. (Especially in the case of Greece).

In addition, to evaluate **Aim 2**, the following objectives will be addressed.

- a. To investigate the overpackaging issue to reveal weaknesses, problems or failures that if addressed effectively could offer multiple advantages to the user.
- b. To prove that the redesign of corrugated packaging may:
 - Have cost benefits in the cost of packaging.
 - Weight benefits.
 - Transportation benefits.
 - Environmental benefits from the combination of weight and transportation benefits.
 - Overall protection benefits.

1.3. Outline of the Research Methodology

1.3.1. Type of Research

In order to answer the research aims, an evaluation was necessary between existing theoretical elements and reality (including operations, methods and knowledge). Yin (1984) cited that one of the most important factors in research is the combination of theory and real life and the way that the researcher finally succeeds to formulate theory, based on findings and results.

For all the above, case study research of a general packaging supply chain (Figure 1.8.) was preferred, since this method has enabled a more schematic and clear approach, allowing for a more in depth analysis and understanding of the research object (Yin, 1994, Miles and Huberman, 1994). In addition, according to

Saunders et al. (2003), a case study approach is very useful in most research, since it is likely to answer important questions such as what was the case, as well as what was the reason and what happened in a very specific situation.

The main idea covering the Case Study is the investigation of a specific paper packaging supply chain. The 6 major links of this Supply Chain are examined one by one. In the beginning, **Suppliers** are those who undertake to supply the next link, which is **Packaging Manufacturers** with paper raw materials. **Suppliers** are supposed to collect and recycle these used packaging materials from the market. On completing the above procedure, they supply **Packaging Manufacturers** with these raw materials in order to produce paper packaging to use in the supply chain. The paper packaging produced at this stage is further carried to the **Industrial Customers** using them in their packaging operations. The packaged products are then carried from the **Industrial Customers** to **Wholesalers and Retailers** who undertake to unpack these products (although some of these products are sold along with this kind of packaging) and sell them to the **Final Consumers**. At this point, where upon products are unpacked, the reverse flow starts and the packaging materials are circulated following a reverse direction either for landfilling or back to the **Suppliers** for recycling. The case study is graphically illustrated in Figure 1.8.

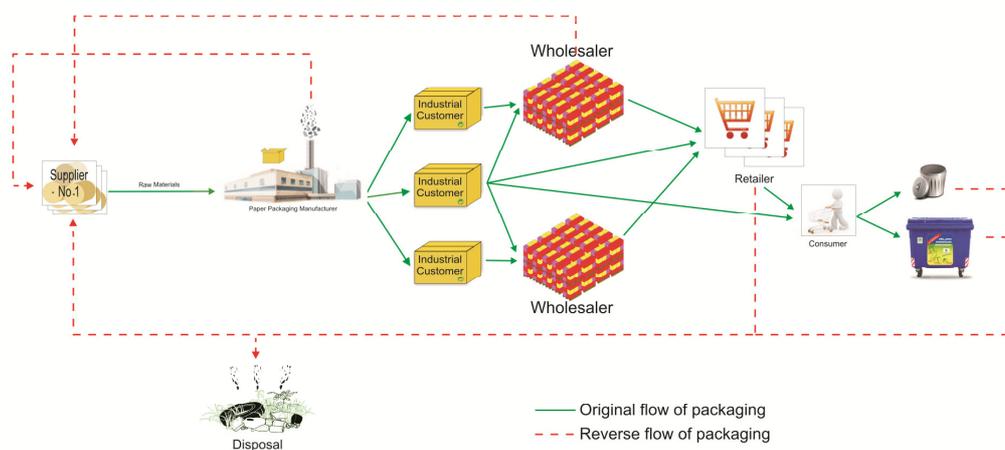


Figure 1.8. The packaging Supply Chain

1.3.2. The Data Gathering Process

Aim 1: The processes used to gather data for Aim 1 in this research, are presented below (see Figure 1.9.):

1. To identify the effectiveness of current European Packaging Regulations.
2. To investigate the role of paper packaging in the supply chain.

3. To further investigate the environmental impact of paper packaging.
4. To analyse the other packaging materials in the market: plastic, metal and glass.
5. To formulate a case study where a specific packaging supply chain is being analysed.
6. To carry out a survey of the supply chain participants (suppliers, packaging manufacturers, industrial customers, wholesalers-retailers, final consumers) using a written questionnaire to collect original data from the Greek market.
7. Using all the data collected from the supply chain:
 - a. To discuss the need for the establishment of a reverse channel of a paper packaging manufacturer.
 - b. To evaluate the extent to which the packaging regulations, affect or might affect the prices of the packaged products (the case of Greece).
 - c. To analyse the current situation in packaging and products damaging and make a prediction in case of packaging quality downgrading.
8. Evaluate the typicality of a Greek supply chain in the European market from an environmental point of view.

Aim 2: The processes used to gather data for Aim 2 in this research, are presented below (see Figure 1.10.):

1. Investigation of two different products in two individual Case Studies with relevance to the redesigning issue.
2. Evaluation of each Case Study separately.
3. Investigation of the secondary packaging used in the packaging operations of an existing company. The investigation of the Case Study includes an analysis of the packaging and multiple lab tests. The analysis is structured with relevance to the overpackaging issue.
4. Evaluation of the Case Study.
5. Discussion of the potential benefits concerning packaging redesign in terms of weight, cost, protection, environment, transportation.

The research methodology is explained in more detail in Chapter 4 – Research Methodology.

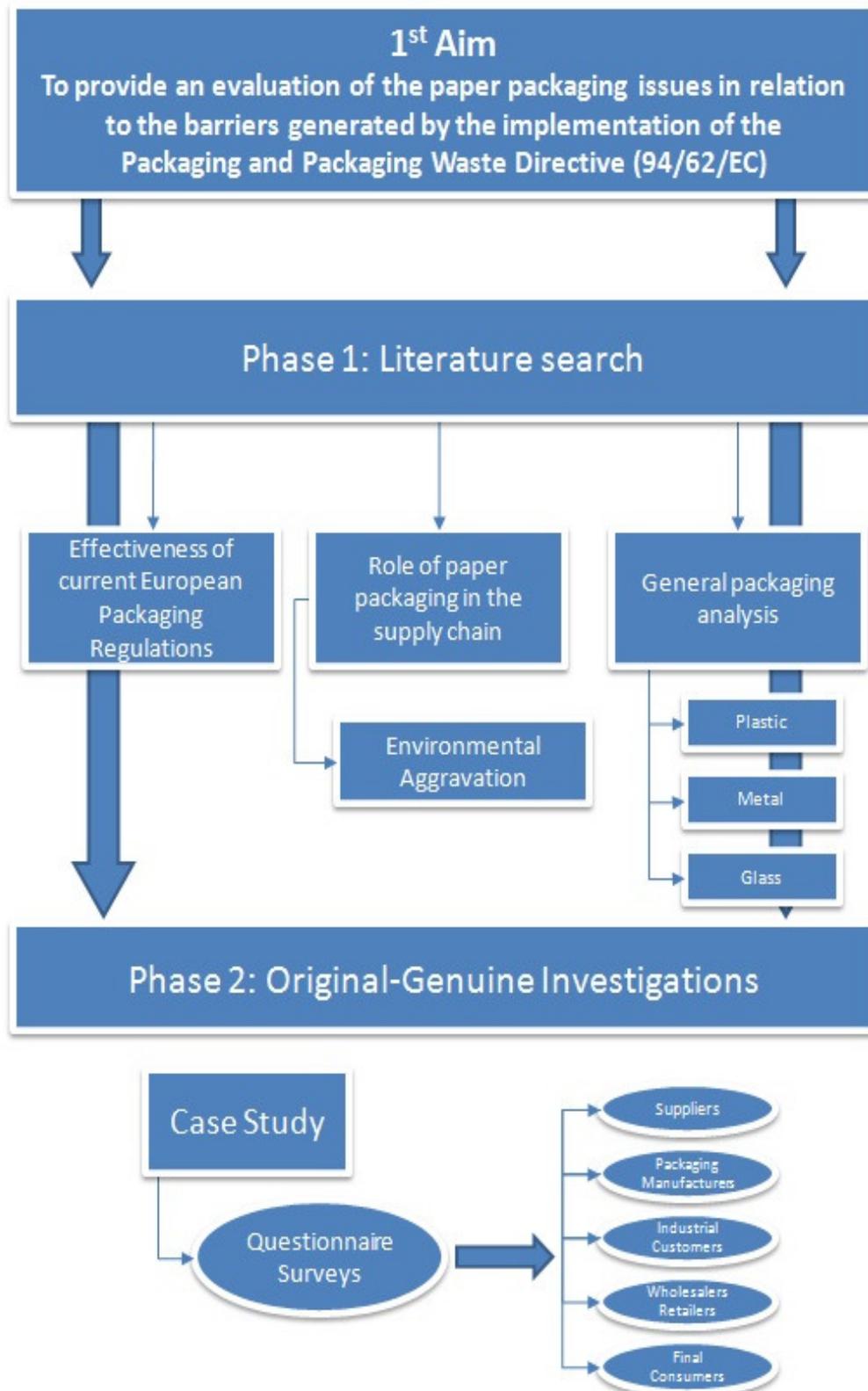


Figure 1.9. Aim 1. The Data Gathering Process

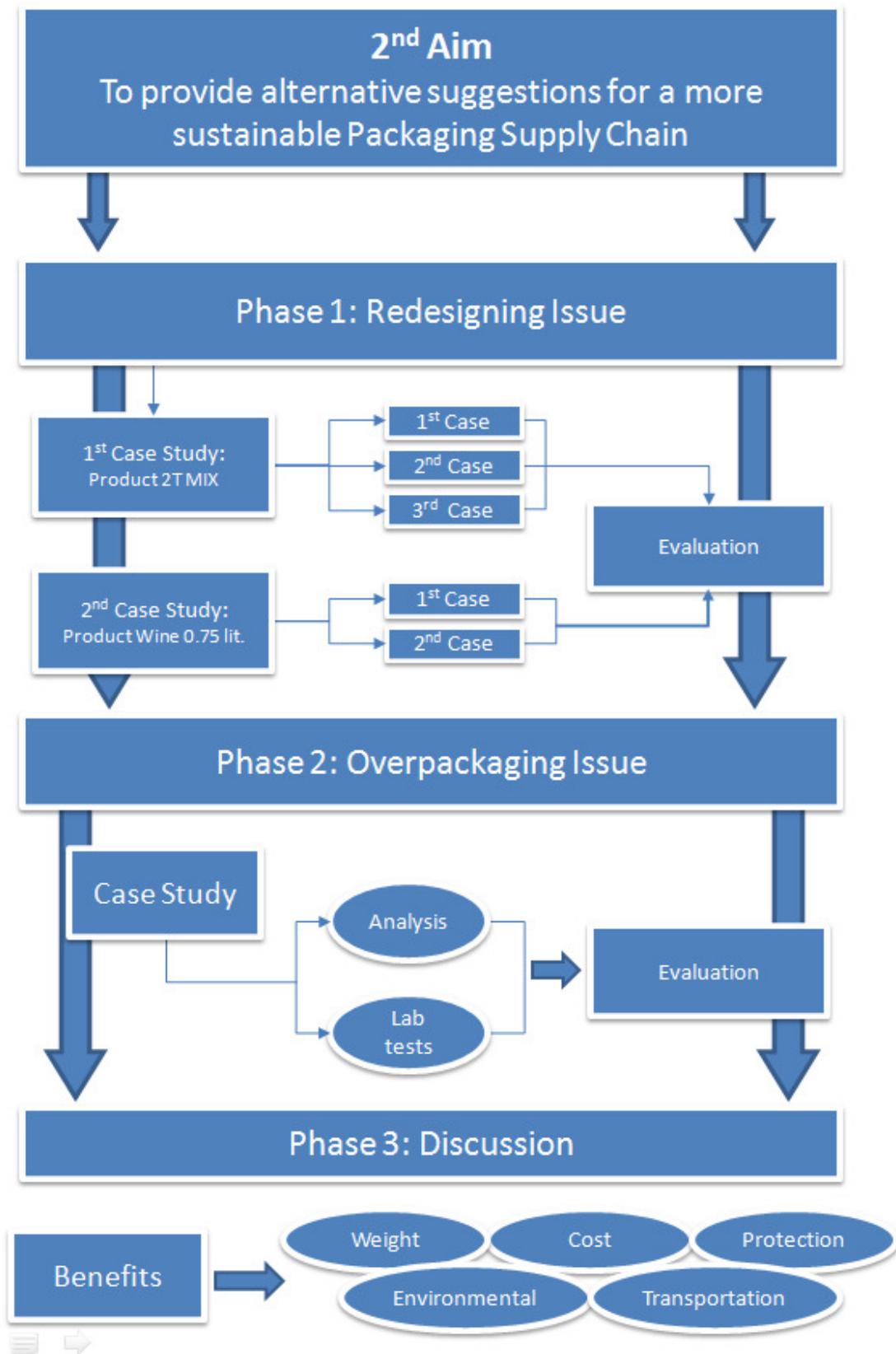


Figure 1.10. Aim 2. The Data Gathering Process

1.4. The Relationship Between the Research Aims and the Structure of the Project

Table 1.1. below, shows the structure of the thesis, presenting the relation of the Research Aims and Objectives with the chapters of the project and the elements of the scientific method used.

Table 1.1. Aims and objectives of the research

Aim number	Research aim		
1.	To provide an evaluation of the paper packaging issues in relation to the barriers generated by the implementation of the Packaging and Packaging Waste Directive (94/62/EU).		
Objectives			
Objective number	Description	Methodology	Chapter
i.	Through an extended supply chain case study based on the Greek market, to provide an in-depth analysis of the role of paper packaging.	Analyse this by using primary data obtained by the participants of the supply chain.	5th “Analysis & Discussion”
ii.	To evaluate the extent to which the packaging regulations, affect the prices of the packaged products to various EU-25 countries. (Especially in the case of Greece).	Investigate this using primary data obtained by the participants of the supply chain presenting the market intentions for price increases in case of implementation of an environmental legislation.	5th “Analysis & Discussion”

Aim number	Research aim	Methodology	Chapter
2.	To provide alternative suggestions for a more sustainable Packaging Supply Chain.	Evaluate this by using 2 different case studies investigating the full packaging analysis and giving alternative suggestions.	6th "Discussion"
Objective number	Description	Methodology	Chapter
i.	To investigate the overpackaging issue to reveal weaknesses, problems or failures that if addressed effectively could offer multiple advantages to the user.	Investigate this by using a case study and making an analysis of the entire packaging (primary, secondary, transportation) that an industrial consumer uses in its packaging operations.	6th "Discussion"
ii.	To prove that the redesign of corrugated packaging may: 1. Have cost benefits in the cost of packaging 2. Weight benefits 3. Transportation benefits 4. Environmental benefits from the combination of weight and transportation benefits 5. Overall protection benefits		6th "Discussion" & 7th Conclusions & Further Work

1.5. Research Originality

This research focuses on the packaging sector and the individual problems or barriers caused in the market by important external factors such as legislation and directives. A strong motive for the investigation of the packaging issue and several other individual issues in the field, was the evidence for problematic situations and trade barriers caused by the so-called German refill quota. The specific law which was introduced in Germany in 1991, was an effort to limit the use of non-refillable containers pushing the beverage industry to use refillable containers for at least 72% of its products (Golding, 1998, pp.77). The main idea behind this legislation was that since the volume of one-way beverage containers sold was increasing as a result of increasing beverage consumption, the market should be driven to the consumption of

refillable containers (glass or plastic) in an effort to protect the environment (Fishbein, 1994).

However, very soon after its implementation the law was found to have weaknesses and generate trade barriers². Other countries argued that the specific system that resulted in extra costs for the non-reusable containers was unfair for the foreign companies. This argument was based on the fact that the foreign industries were compelled not only to change their bottles into refillable but also to organise reverse, longer and expensive channels of transportation (compared with the domestic manufacturers) in order to collect the empty bottles (UKEN Archive, 2001).

A few years later due to emerging environmental problems, the European Union adopted the Packaging and Packaging Waste Directive (94/62/EU). This directive aimed to harmonize national packaging waste management measures, in order to reduce its impact on the environment and at the same time ensure that packaging laws did not create any obstacles to trade or restrictions to competition within the Community (The European Organization for Packaging and the Environment, 2000 and EUROPA, European Commission, Environment, 2005).

Despite the fact that the main purpose of the Directive is the environmental protection in Europe, the present research seeks and investigates problems, failures and obstacles generated by the European legislation. Geographic regions far away from the European core appear to have different characteristics, insufficient infrastructures and very often a lack of governmental management and sometimes absence of a will for change (Sklias, 2008). After conducting preliminary literature research it was clear that the paper packaging issue had never been investigated from the point that the researcher intended to conduct it. In addition, the researcher organized his research with special focus to the Greek market where there was still a lack of research on the specific field. The purpose is to provide a strong theoretical base concerning the peculiarities of Greece as a member-state, on the ease of compliance with the European orders on Directives such as the 94/62/EC. At a second stage, the same methodology could also be used to investigate the progress of other member-states on the same or similar field and make useful comparisons.

Although the researcher discovered academic research in the field, this research was not focused on the specific field and furthermore was targeted to specific packaging problems in other countries or geographic territories. The

² According to the Institute for Local Self-Reliance (n.d.) the beverage industry in Germany failed to meet the quota for two consecutive years (1997-1998). For this reason the government in Germany started seeking alternative solutions in order to stop the decline of refilling.

researcher decided to evaluate the paper packaging issues in relation to the barriers generated by the implementation of the Packaging and Packaging Waste Directive (94/62/EC). At a second stage issues such as the need for the establishment of a reverse channel for a paper packaging manufacturer, the extent to which the packaging regulations affect the prices of the packaged products to the Greek market or the main factor affecting the buying decisions of the final consumers were also investigated. In addition issues such as the use of lighter packaging and its implications, the redesigning of packaging or the investigation of the overpackaging issue were issues of great importance addressed in detail in this research.

Except for the above contribution to knowledge the present research further enhances industrial knowledge by putting the outcomes to use. The methodological processes developed and analysed in the following chapters can be adjusted to the packaging needs of any company who needs to ameliorate its packaging processes.

The European Union that acts as a single entity should always consider the special needs and characteristics of its member states before proceeding with legislation. This investigation provides strong evidence on the specific field. Factors such as the current economic conditions, the financial standing of the residents, the infrastructure, the geographic position, special local problems, demographics, industrial level and many more should always be considered. For example, the findings in Greece revealed that the price of the product is among others (origin, environmental friendliness etc) the most important factor influencing the buying decisions of the consumers. This finding should be considered in relevant legislation that in turn should be fitted to the needs of each country since the financial standing of the residents is not the same in all countries. In addition, a similar investigation in other member-states may reveal that environmental friendliness is maybe more important in a country and the origin of a product could be decisive for another country.

However the investigation was extended to other packaging fields as well. In an effort to provide alternative suggestions for a more sustainable Packaging Supply Chain two issues were analysed in detail: the overpackaging issue and the redesigning of packaging. Due to the wide ranging nature of the subject, both approaches are focused on the secondary paper corrugated packaging.

Concerning the over-packaging issue the investigation has provided a practical framework and a detailed methodology, based on which, the substitution of a corrugated packaging quality could be successful if lab strength tests and detailed

calculations are applied. The investigation is based on a real case study. A company (who until recently was not a Multi Pack's customer) addressed Multi Pack and assigned the company to seek and ameliorate the corrugated packaging used in its packaging operations. The investigation revealed a number of issues for more than one of the corrugated boxes the company was using in its packaging operations. The solutions were finally suggested to the company who provided the details and the basis of the case study. The method could easily be applied to other types of packaging as well (primary, transportation etc), provided that the researcher holds sufficient data (concerning packaging, supply chain, modes of transport, storage time etc.) and physical access to the product.

For the redesigning issue, the investigation provides a detailed analysis of how simple changes to the shape or dimension of the secondary paper corrugated packaging could offer important advantages to the user. These advantages include a better utilization of vehicle space during transportation and cost reductions that could be achieved by an increase of the volume of products carried per vehicle in combination with a lower total packaging cost.

In order to achieve a better overview of the redesigning issue and its advantageous outcomes, the investigation included the analysis of two different products in two separate case studies. These are a product called 2TMIX³ 200gr. with an average retail price of 2.50€/piece and a bottle of wine 0.75lit. with an average retail price of 8.50€ per unit. The two products used i.e. the bottle of 2TMIX and the Wine Bottles were selected randomly among the five products that appear to have the highest volume/demand of packaging⁴. These five products were: a) 2T MIX or similar product, b) Wine Bottles, c) Olive Oil metallic cans, d) Marmalade Jars and e) Sponge or similar products. In order to increase the validity of the results the investigation included the analysis of two of the above products instead of investigating just one of them.

The alternative packaging suggestions made in the research refer, once again, to the secondary paper corrugated packaging since the objective was to show the value of the process. The analysis is detailed and from a practical scope, provides the researcher with a tool on how to estimate, present and compare different packaging approaches. In any case, the industry could be inspired and take ideas on how to analyse its special packaging needs. On the other hand, the

³ 2TMIX is an oil product used for the lubrication of two-stroke engines. The oil must be mixed with the fuel to lubricate the engine and avoid any damages due to overheating.

⁴ The selection was based on relevant data provided by Multi Pack S.A.

research provides the tools for a packaging designer, on how to estimate, analyse, redesign and compare different approaches, finding the way to a more sustainable packaging supply chain.

1.6. The role of the researcher / Bias

The role of the researcher is dual through being the conductor of this research at the same time as an employee of the company i.e. Multi Pack S.A. The company –as described in the following chapters- has provided valuable information (data and methodology) for the completion of this research.

This double role of the researcher does influence the researcher's decision since his role in the company as a packaging designer affects his performance as a researcher. Except for the necessary technical knowledge on the issues under examination a relation of this kind with the company and the packaging sector, in general, involves personal experience that might affect the outcomes or specific decisions on issues such as the methodology adopted for the completion of the investigation. Another bias that may come as a result of the above special circumstances is the discussion of the outcomes that may be affected by the former experience of the researcher in the packaging field.

1.7. Structure of the Thesis

Chapter 1: Introduces the subject matter and defines the research aims and objectives. It also covers an overview of the research methodology and tools used in this research. This chapter also elaborates the structure of the thesis and its relationship with the research aims.

Chapter 2: Develops the research context through a review of the literature which relates to environmental matters related to packaging, logistics concept, and thorough analysis of the various packaging materials with emphasis to paper packaging and presentation of packaging production, consumption, recycling or reusing etc., in numbers.

Chapter 3: Deals with the review of the literature and the general packaging concept. It defines packaging and reverse logistics while it associates packaging and the environment. It further presents and describes the main packaging recovery methods i.e. recycle, reuse and incineration.

Chapter 4: Deals with survey design and the methodologies used in the questionnaires sent to the different links of the packaging supply chain.

Chapter 5: Discusses the original data collected by the different links of the supply chain. The results are collated and analysed per link and some conclusions are drawn.

Chapter 6: Discusses the results of the analysis of the data obtained from the supply chain. Furthermore alternative suggestions for a more sustainable packaging supply chain are also presented and analysed. In addition, the overpackaging issue is discussed in detail by using a Case Study.

Chapter 7: The overall conclusions with reference to the research aims and objectives, limitations of the research and recommendations for further research are presented in this chapter.

1.8. Summary

Chapter one has provided an introduction to the research topic. It has defined and analysed the aims and objectives of the thesis providing an overview of the research. The research methodology, the main case study used and the data gathering process are also discussed and commented.

In addition, the structure of the thesis and the individual chapters followed by a brief summary are presented in this chapter as an introduction to the research topic. Finally the association of the research aims and objectives with the chapters of the project and the individual methodology used for each separated objective are also outlined.

CHAPTER 2 – THE PACKAGING CONTEXT

2.1. Introduction

In this chapter the main packaging materials, types and categories are presented and described. Particular emphasis is given to the different paper packaging types since the overall research mainly focuses on the paper packaging sector. This analysis is going to help to understand the packaging issue, its special characteristics and the way in which packaging develops, in order to be able to continue in the further investigation of the reverse flow of packaging (after the accomplishment of its main objective, e.g. the protection of the product), for the purpose of recycling, reusing or disposing. Despite the fact that new trends and legislation (especially in the internal market of the European Union) dictate that the development of a better organised system of reverse flow of packaging is necessary for every country, for the time being, there seems to exist a number of difficulties hindering its implementation.

2.2. A brief History of Packaging

Packaging as we know it today has a long history parallel to human's life. In our world packaging is thought to be something normal, a material that encloses the goods in order to preserve freshness, prevent contamination or protect from damage. According to Emblem (2000) the range of products that do not require any packaging is limited. And as Coughlin (2000) supports almost any commodity is contained in some sort of packaging. But this was not always the situation.

In the prehistoric days, food was consumed where it was found. The first organized societies were self – sufficient, producing, chasing, fishing and cultivating what they used (Hook and Heimlich, n.d.). When containers were needed in order to preserve food (fruits, meat, etc.) for any future food shortage, nature provided leaves, shells, gourds, etc. (Berger, 2002). They also discovered other materials good for preservation such as animal skins and terracotta vessels.

Nowadays, packaging is a more sophisticated issue, since the new market conditions and the needs of both companies and consumers are totally different compared to the past, and particular combinations between marketing and logistics are required. According to Denison and Cawthray (1999) except from its original purpose to contain and protect the products throughout the supply chain, the new

role that packaging is called to play, “is partly the result of the pressures of the modern retailing system and the opportunities that have arisen as a result of the way we now choose to live”. In addition, compared to the past, new issues arise. As cited by Halling (2011) nowadays packaging security is another issue in the global economy and many countries are taking measures in order to solve counterfeiting and reimbursement problems.

Through the ages both the materials and the techniques of packaging have changed considerably, thus affecting the quality of our lives via the prevalence of the most expedient ones. The following summary of the various packaging developments is based mostly on the analysis made by Hook and Heimlich: “A history of packaging” (n.d.).

2.2.1. Paper and Paper Products

History

During the First or Second century B.C. the Chinese pioneered creating the first sheet of paper by using sheets of mulberry, old rags and hemp waste in order to use it as a packaging material for food wrapping.

However, the paper as we know it today was developed around 1867 where paper originating from wood pulp was created and the procedure was patented in the United States. It was Carl Dahi who in 1884 invented sulfate (kraft) pulp. The first decade of the 20th century also signals the most dynamic starting point of the paper industry with the invention of machinery for the automatic production of in - line printed paper bags and boxes (Encyclopaedia Britannica Online, 2013, Berger, 2002).

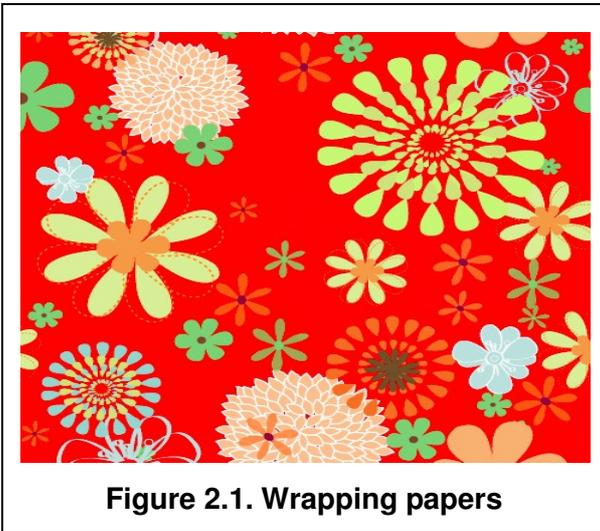
Kellogg brothers were the first to use cereal cartons, protecting and advertising in this way their products and establishing paper as a well promised packaging material for the future (Berger, 2002).

Paper Packaging Categories

Wrapping papers, multiwall paper sacks, folding box-board cartons, rigid boxes, solid and corrugated fibreboard cases, fibre drums and moulded pulp containers, are all part of the paper packaging category.

Wrapping Papers

The wrapping operation could be described as the covering of an object or a group of objects in a uniform package. The aim of this kind of packaging is to contain and protect the products and at the same time to provide ease of use and communicate various messages, images or information to the user.



Source: The author

Many types of wrapping materials are available in the market:

Many types of wrapping materials are available in the market:

- **Kraft paper** – a very strong type of paper. It is naturally brown but can be bleached to white as well.

It is very resistant to moisture.

- **Stretchable paper** – a type of paper that can be stressed under certain circumstances while maintaining its physical characteristics. It is frequently used in cases where extra strength is required.
- **Wet – strength paper** – special type of paper, containing Kraft pulp that is very resistant to water. It is mostly used in cases where particular transportation or storage conditions occur e.g. outside packaging, cold storage etc.
- **Imitation Kraft** – a type of paper that is usually dyed to resemble Kraft. Alternatively it could be recycled paper containing some proportion of Kraft pulp. In general it is used as a lower quality substitute to Kraft paper.
- **Sulphite paper** – machine glazed paper that its glossy surface is suitable for logos and images reproduction. It could be used for wrapping food, small items etc.
- **Greaseproof paper** - paper covered with a protective barrier, most commonly wax and paraffin, that resists grease and oil. It is frequently used in cooking.
- **Glassine** – under special manufacturing process, greaseproof paper can be transformed into glassine. This type of paper is used in special

circumstances, since it provides barrier properties to gases, odours and water vapour.

- **Vegetable parchment paper** – water, grease, fat and oil resistant paper. Used for wrapping baked goods, butter, margarine, cheese, fish, meat etc.
- **Tissue Paper** – low weight soft and thin paper. It is mostly used in cases where the surface of the product is susceptible to abrasion, such as jewelry but can be also used in cases where a lower cost tissue is needed.
- **Coated paper** – paper which has been coated with multiple layers to one or both sides. Coating is a necessary process, especially when specific requirements should be met by the paper substrate. Such requirements could be the desired oxygen and moisture barrier, adhesion, prevention of static-caused defects, printability and durability (Wagner, 2010, Kirwan, 2005).



Figure 2.2. Open mouth multiwall paper sack

Source: Commercial Packaging, viewed 24 November 2010, <http://www.commercial-bag.com/products/multi_wall_packaging>

Paper Sacks

Paper sacks are made from several thicknesses of paper, nested inside one another (Paine, 1991). These concentric paper tubes, differ mainly in the design of the end-closure, that distinguishes the sacks into: open mouth sacks and valve sacks (Kirwan, 2005).

It is the multiple layers of paper rather than the thicknesses of the papers used in the manufacturing process, which give the multiwall sack its strength and flexibility.

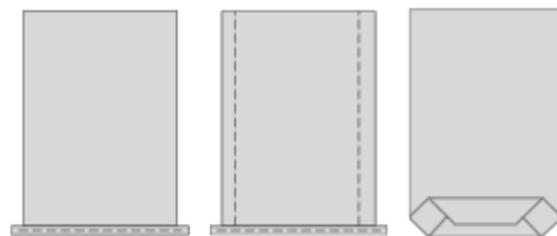
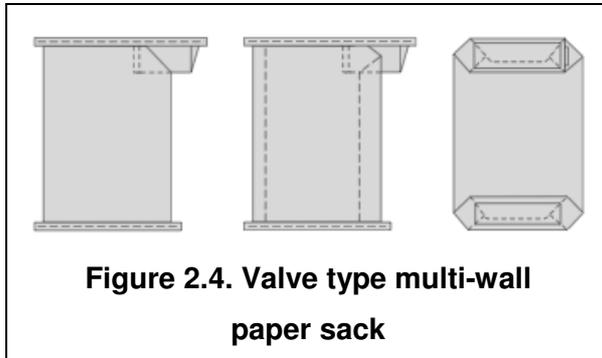


Figure 2.3. Open mouth multiwall paper sack

Source: Kirwan, M.J. (2005) *Paper and Paperboard Packaging Technology*. Blackwell Publishing Ltd.: UK

Although in the past, multiwall paper sacks were mostly used to contain powdered materials e.g. cement, flour etc. today the uses of paper sacks have broadened. Kirwan (2005), states that nowadays, -because of its strong advantages,



such as easy bulk palletisation, stacking and handling- a paper sack is used for the containment - packaging of over 2000 products. The following table presents the European end - uses of Paper Sacks for 2008.

Source: Kirwan, M.J. (2005) *Paper and Paperboard Packaging Technology*. Blackwell Publishing Ltd.: UK

Table 2.1. European end - uses of paper sacks for 2008

Product end - use	Quantity used in 2008 (in million units)	%
Building Materials	3.250.343	63,23
Mineral Products	155.196	3,02
Food Products	605.551	11,78
Animal Feed	410.419	7,98
Chemicals	383.864	7,47
Seeds	107.263	2,09
Miscellaneous	228.117	4,44
Total	5.140.753	100

Source: EUROSAC – European Federation of Multiwall Paper Sack Manufacturers
 'Analysis of EUROSAC Memberfirms Answers', [online] Available at: <www.eurosac.org>
 [Accessed 21st November 2010]

The following types of paper are the most common materials used in multiwall paper sacks:

- Kraft paper.
- Low-stretch crepe Kraft (LSCK) – Kraft paper to which crepe has been applied during the manufacturing process, before it is fully dried. This kind of paper is resistant to moisture for short period of times.
- Extensible Kraft (EK) – Kraft paper (usually uncreped), which as the result of a special treatment has a high, controlled degree of stretch.

All the above kinds of paper can be transformed into wet-strength surfaces, by resins added to the paper stock after heating.

According to Hanlon et al. (1998), the main advantages of the paper sacks are:

- Low unit cost comparing to any other kind of paper packaging,
- Fit perfect around the products they contain,
- When empty, they occupy the least amount of space, in the warehouse (before their use) or in the disposal bins (after their use).

On the other hand compared to other kinds of paper packaging, paper sacks do not stand very elegantly on the store shelves and from a marketing



Figure 2.5. Low-stretch crepe Kraft (LSCK)
Source: Martell's of Sutton Ltd., viewed 23 November 2010,



Figure 2.6. Extensible Kraft
Source: Samuel Grant Group, viewed 23 November 2010, <<http://www.samuelgrant.co.uk/prodpage.asp?productid=19>>
<http://www.martells.co.uk/catalog/index.php/removal-equipment-paper-products-c-21_35>

perspective cannot communicate the messages to the consumer because of the wrinkles and folds on their surfaces. Another main disadvantage is thought to be the stacking problems during storage or transportation, which is mainly the result of their vague shapes.

Folding Box-board Cartons

Folding box-board cartons are thought to be of the most popular rigid packages, since they are used as a retail pack in the distribution of a wide range of products such as food stuffs, decoration, confectionery, toiletry, tobacco, electronic equipment, pharmaceuticals etc.

For the production of this type of packaging, several types of paper can be used that in combination (e.g. mechanical pulp for the inner layers and bleached chemical pulp for the outer layers) can provide a very strong and stiff paperboard (Kirwan, 2005). Specific needs, requirements and attributes about the packaging

posed by the industrial customer, determine the type of paper that is going to be used for the production of a folding box.

Usually box-board packaging destined for use in frozen food products or in cases where a high resistant paper is required, is mainly manufactured by virgin materials (chemical pulp) with higher cost compared with the recycled materials. However, although the cost of paper materials corresponds to their quality⁴, the strength and resistance of the virgin materials to special conditions such as moisture or grease, make possible the use of lighter paper combinations, “around 10 percent less in thickness, than that of a filled board of equivalent strength” (Hanlon et.al, 1998, p.157).



Figure 2.7. Folding box-board cartons

Source: European Paper & Packaging Industries, viewed 25 November 2010, <<http://www.paperonline.org/paper-uses/packaging-material-products>>

However, the cost is not always the main factor in what to use, since the use of a cheap kind of paper of lower quality, may result in waste or product losses throughout the supply chain, which again can increase the cost of the user and aggravate further the environment. Additionally, for some products such as food, beverage, medical, hygienic (sanitary napkins or baby diapers) etc. the contact with packaging produced by recycled materials of unknown source should be avoided, in order to avoid potential infections or contaminations. Furthermore, from a marketing perspective, the quality of the packaging



Figure 2.8. Folding box-board cartons

Source: Grassidesign, viewed 25 November 2010, <<http://www.grassidesign.com/pages/packaging-design.html>>

itself, its gloss and weight, affect in a way the buying decisions of the consumers, especially for high priced products, such as jewelry or cosmetics. However, the development of sustainable reverse channels of distribution for used packaging materials, recycling evolution and new technological approaches, have given paper manufacturers the ability to produce almost any kind of paper at the desired quality,

⁴ Paper materials of higher quality are more expensive in the market, because of the virgin pulp they contain and their special manufacturing process. In general, recycled paper is cheaper than paper made by virgin pulp.

strength, colour, stiffness, resistance and gloss, fulfilling any needs or requirements of the market.

The main advantages of the folding cartons appear to be:

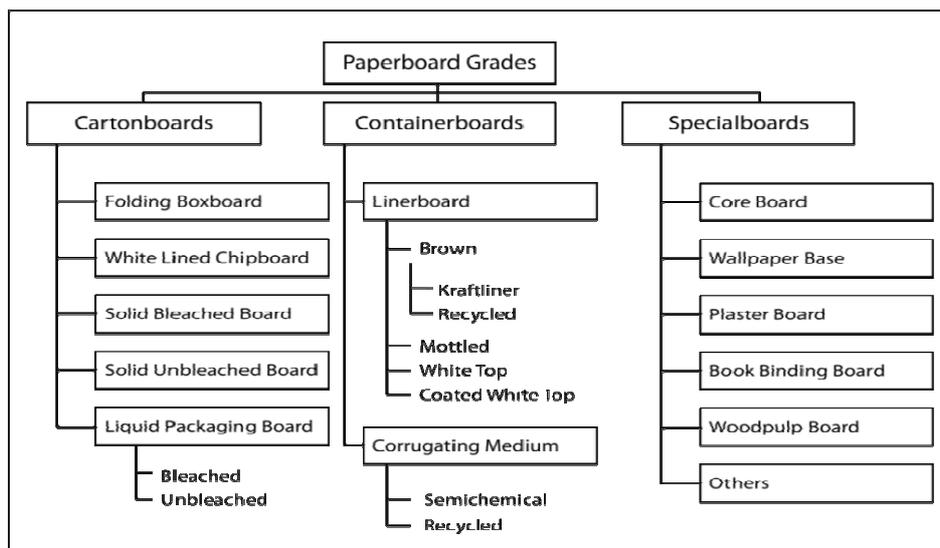
- Low cost,
- Good strength properties,
- Excellent appearance on the retail shelf, since they can be printed by offset and gravure techniques,
- Take up a minimum of space because the cartons are shipped and stored in collapsed form,
- Can be manufactured in various shapes, sizes and styles, and
- Can provide product differentiation and brand identification.

(Hanlon et al., 1998, Ameripak Industries Inc⁵, 2007)

On the other hand, the main disadvantage of folding cartons is that they appear limited in strength and can carry products of no more than a few kilos, compared for example to corrugated containers.

The following graphic, presents the general classification of Paperboard Grades, as cited by Holik (2006):

Table 2.2. Classification of Paperboard Grades



Source: Holik, H. (2006) *Handbook of Paper and Board*. WILEY-VCH Verlag GmbH & Co. KGaA: GERMANY

⁵ Ameripak Industries Inc. is a company providing packaging services including design, manufacturing, and assembly.

Rigid Boxes

The demand for rigid - paperboard boxes, also known as “setup” boxes, has



Figure 2.9. Rigid Cardboard box

Source: Zooly Box Source , viewed 08 December 2010, <<http://www.zooly.org>>

grown steadily during the past decades. The main reason for this increase is the industrial need for the existence of a stable packaging of greater endurance and strength, for use in many kinds of products. However, according to Kirwan (2005), in recent years there has been a steep decline in the demand of rigid boxes, mainly due to the dramatic increase in the demand for similar paper packaging, such as cartons and corrugated cases.

Rigid boxes are used for packaging of a great range of products such as tableware, footwear, small tools, perfumes, cosmetics, jewelry and watches, electronics, chocolates etc.

According to Lynch and Anderson (2009), the following primary materials are needed for manufacturing a rigid box:

- Chipboard (for the rough box),
- Stay paper (to hold the sides of the box together),
- Glue (to hold the outer wrap to the box), and
- Outer wraps (for the decorative appearance).

Concerning chipboard, the four most common types used in the manufacturing process are the following:

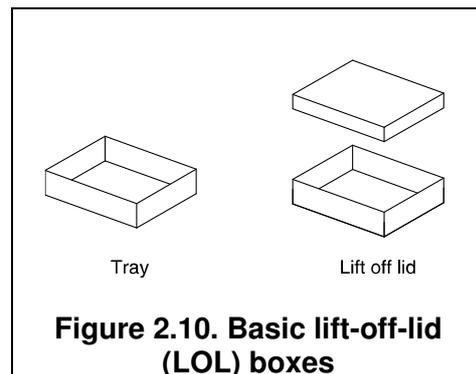
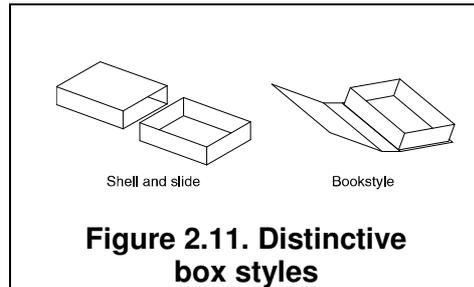


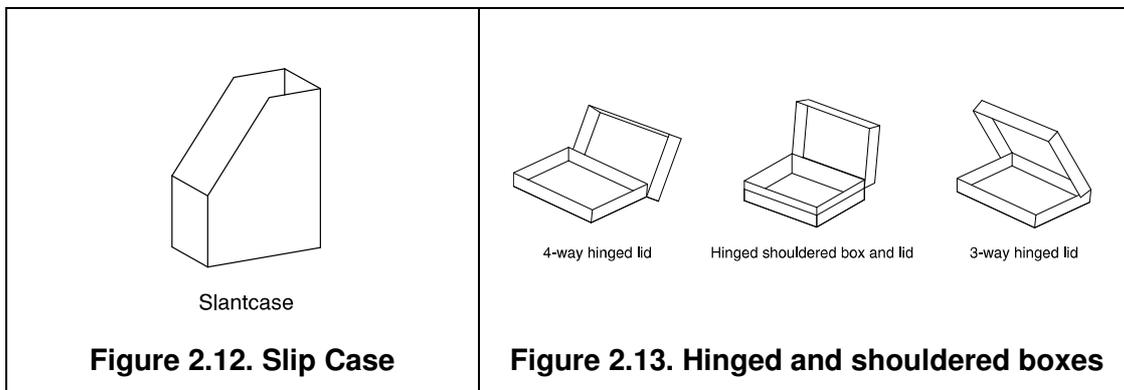
Figure 2.10. Basic lift-off-lid (LOL) boxes

Source: Kirwan, M.J. (2005) *Paper and Paperboard Packaging Technology*. Blackwell Publishing Ltd.: UK

- Plain chipboard – made entirely of waste paper,
- Vat-lined chipboard – made using a liner of low-grade white waste paper,
- Book line chipboard – made with a liner of book or litho paper, applied to one or both external sides of the board,
- “Solid – news” chipboard – made mostly from newspaper waste that has been de-inked.



Source: Kirwan, M.J. (2005) *Paper and Paperboard Packaging Technology*. Blackwell Publishing Ltd.: UK



Source: Kirwan, M.J. (2005) *Paper and Paperboard Packaging Technology*. Blackwell Publishing Ltd.: UK

Source: Kirwan, M.J. (2005) *Paper and Paperboard Packaging Technology*. Blackwell Publishing Ltd.: UK

The outer wraps, used mostly to give a good appearance to the final packaging, can be paper, foil or cloth materials, that when applied and through good printing and artwork, can give a very good and unique aesthetic result.

The main advantages of rigid paperboard boxes are the following:

- An infinite number of results, since the combination of different materials – papers, can give to rigid boxes the desired characteristics, with regard to various elements such as strength, appearance etc.
- A huge number of design possibilities, as a result of the particular manufacturing process of rigid boxes, compared to a folding carton. In addition, these individual custom designs can be produced without expensive investment in special tools or dies.
- High structural strength and durability, offering great protection to its contents, nearly always greater than that provided by folding cartons.

- From a marketing perspective, rigid boxes can be easily customized to provide product identity.
- Ability for the smaller manufacturer to make “small quantity” production runs, since the initial costs of rigid boxes are very low, compared to printed cartons.
- Ability to use it in an alternative way when empty.
- High recyclability, since typically more than 80% of the materials used in the manufacturing process, can be recycled.
- It can be displayed on the shelf with the lid open, increasing the sale appeal of its contents.



Figure 2.14. Rigid boxes can be easily customized to provide product identity

Source: Burt Rigid Box, Inc., viewed 03 January 2011, <http://burtbox.com/rigid_box_news.html>

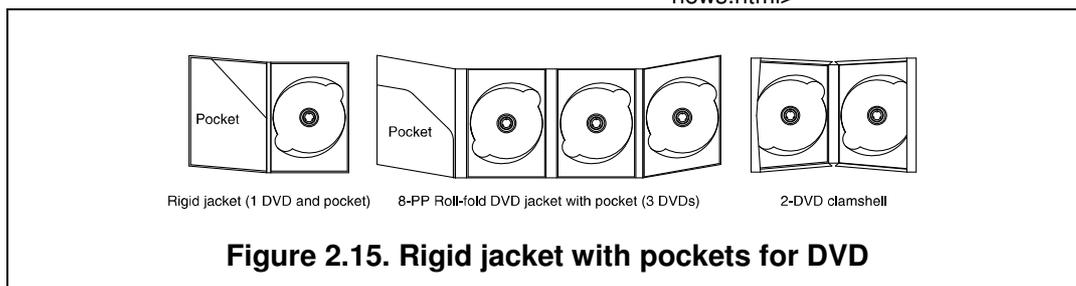


Figure 2.15. Rigid jacket with pockets for DVD

Source: Kirwan, M.J. (2005) *Paper and Paperboard Packaging Technology*. Blackwell Publishing Ltd.: UK

On the other hand, the main disadvantages of a rigid box are the following:

- High transport costs because of its large “empty” size.
- High storage cost because of the same reason.
- Relatively high cost compared with folding cartons, mainly due to the higher labour content of the rigid box.
- Volume restrictions:
 - Slow rate of production.
 - Storage problems because of its size.
- Unsuitability for automated processing in high volume applications.

Kirwan, (2005), Paine, (1977), Lynch & Anderson, (2009)

Solid and Corrugated Fibreboard Cases

A solid fibreboard container, which was first introduced in the market, around 1902, “is a rigid, puncture-resistant and water-resistant material” composed of paperboard, where kraft or similar papers have been applied, to one or both sides (Kirwan, 2005).

Solid fibreboard containers are used in a wide range of packaging applications, such as:

- Horticultural produce, meat and poultry, fish,
- Beverage cans and beer bottles as a wrap-around packaging,
- Shoe - box packaging,
- Secondary packaging of food (e.g. yoghurts),
- Divisions to create cells in a corrugated case or box where other packaged products can be placed (e.g. bottles),
- Point of sale displays,
- Furniture and mirror backing,
- Heavy products for shift avoidance during transportation. (Quinn, 2009).

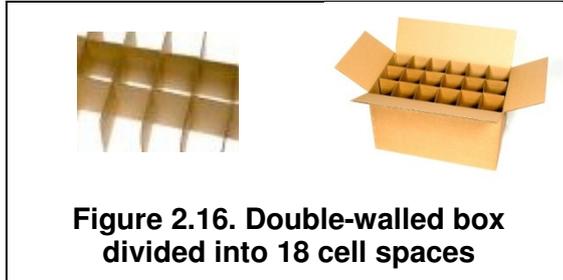


Figure 2.16. Double-walled box divided into 18 cell spaces

Source: BOX Express, viewed 17 January 2011, <<http://www.boxexpress.co.uk/product/detail/glass-ware-box-pack>>

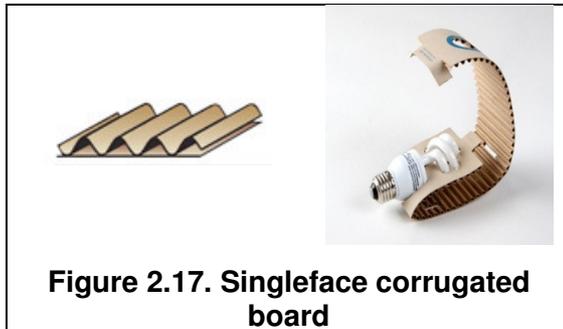


Figure 2.17. Singleface corrugated board

Source: Duropack GmbH, viewed 09 January 2011, <<http://www.wellpappe-verpackung.de/index.php?id=196&L=0>>

Source: IGreenSpot, viewed 09 January 2011, <<http://www.igreenspot.com/cardboard-lamp-packaging-by-audrey-blouin/>>

Solid board is made by pasting one or more layers of paper or paperboard together. These multiple layers provide the packaging with additional strength and resistance to water. For specific uses, additional materials such as sheets of polyethylene (PE), may be applied to one or both sides, in order to provide the desired features. (Kirwan, 2005).

Quinn (2009) states, that “solid fiber containers are used almost exclusively for applications in which container return and reuse are desirable and where return can be controlled by the distributor”. The main reason for this is that although the fiber containers can be used 10-15 times before they are removed from the market, they are in general two to three times more costly than corrugated containers of the same size, so their use is advantageous only if they are to be returned.

On the other hand, corrugated fiberboard packaging, is one of the most popular packaging categories. According to Kirwan (2005): “*Corrugated fiberboard packaging is, in terms of tonnage, by far the commonest type of paper and paperboard-based packaging.*”

This kind of packaging is composed of:

- One or more flat parallel sheets of paperboard, called liners.
- One or more central fluted or corrugated sheet, placed between the liners, called corrugating medium.
- Special adhesive applied to the crests of the fluted sheet, to hold liners and corrugating medium together. (Paine, 1977)

Different types of paper are used for the production of a corrugated board – box. The most common of them, are cited below (Holik, 2006):

Liners

- Kraft Liner – made of at least 80% kraft pulp, bleached or unbleached, ranging from 115 gr/m² to 440 gr/m².
- Kraft-faced liner. This kind of paper, does not have a specified stock composition, but its strength properties are guaranteed.
- Two – layer covering paper.

Corrugating Medium

- Semicemical paper – a corrugated paper, “made by treating wood chips with chemicals to achieve pulp of the desired properties” (Paine, 1977).
- Fluting or corrugating medium – ranging from 80 gr/m² to 200 gr/m².

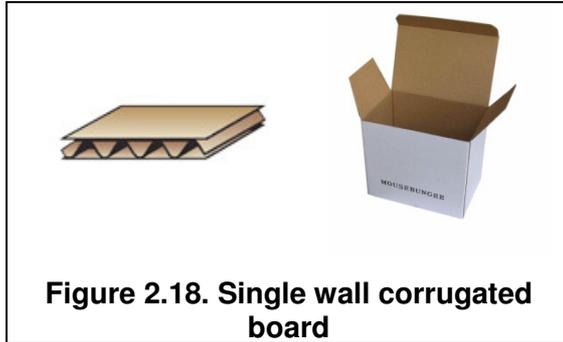


Figure 2.18. Single wall corrugated board

Source: Duropack GmbH, viewed 09 January 2011, <<http://www.wellpappe-verpackung.de/index.php?id=196&L=0>>

Source: China Trade Online, viewed 09 January 2011, <<http://www.gd-wholesale.com/whole-sale-dir/a56c/e2699f/box-case-corrugated-s-1.html>>

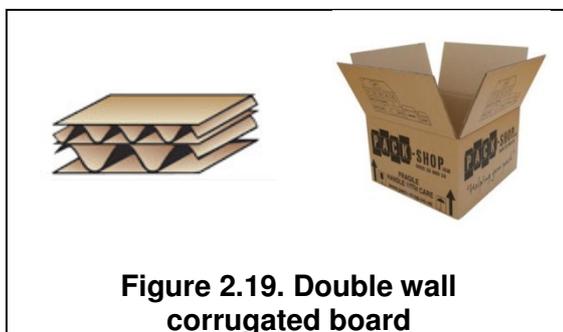


Figure 2.19. Double wall corrugated board

Source: Duropack GmbH, viewed 09 January 2011, <<http://www.wellpappe-verpackung.de/index.php?id=196&L=0>>

Source: Wanna Pack, viewed 09 January 2011, <<http://www.wannapack.co.uk/cardboard-boxes/packing-boxes/>>

- Depending on the number of paper layers they are composed of, there are different categories of corrugated containers. The most common types of



Figure 2.20. Triple wall corrugated board

Source: Duropack GmbH, viewed 09 January 2011, <<http://www.wellpappe-verpackung.de/index.php?id=196&L=0>>

Source: OXBOX, viewed 09 January 2011, <http://www.oxbox.com/custom_corrugated.html>

corrugated fiberboard packaging are the following:

- Singleface corrugated board (consisted of two paper layers: a corrugating medium glued with a flat liner),
- Single wall corrugated board (consisted of 3 different paper layers: two flat liners and a corrugating medium glued between these two liners),

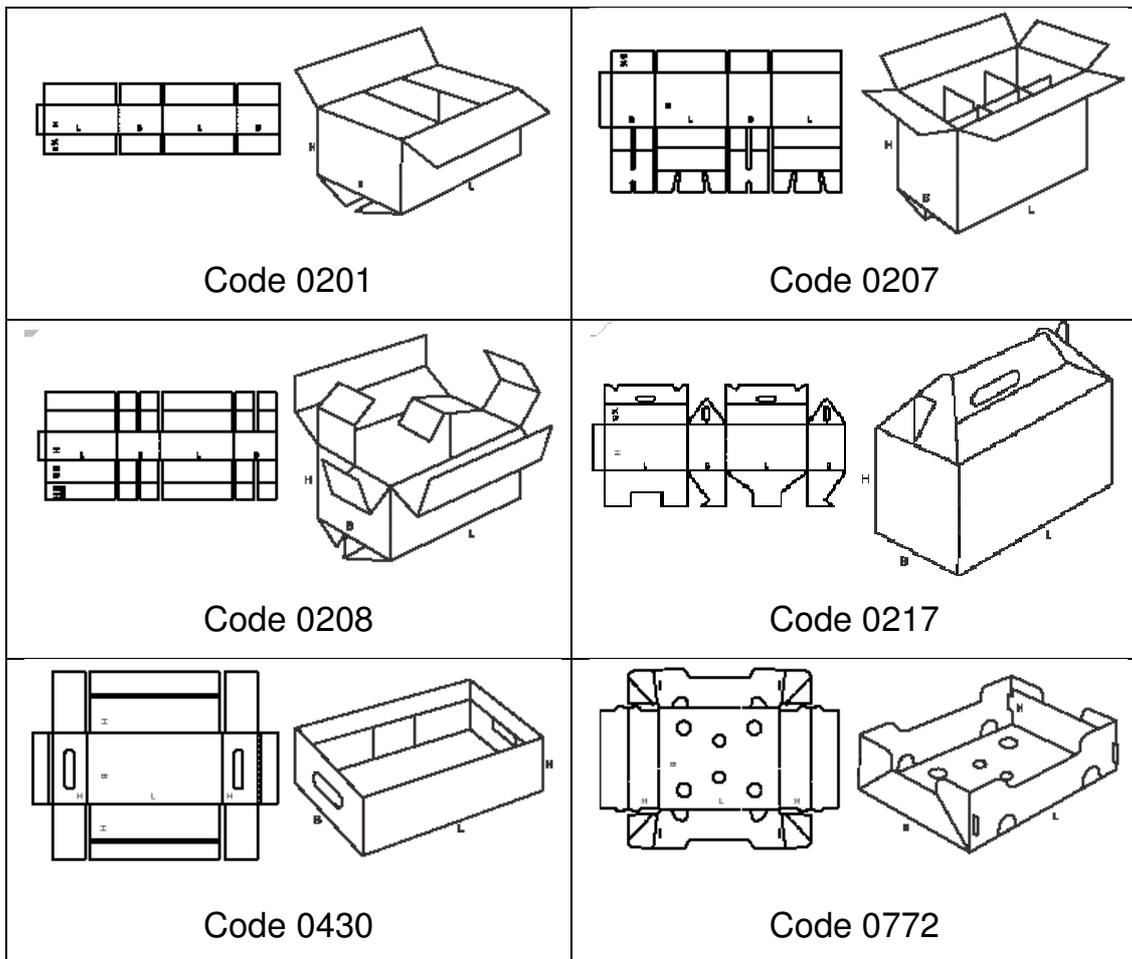


Figure 2.21. A list of designs adopted by FEFCO & ESBO - International fibreboard case code

Source: FEFCO, European Federation of Corrugated Board Manufacturers (2007), "International fibreboard case code", 11th Edition

- Double wall corrugated board (consisted of 5 different paper layers: two layers of corrugating medium framed by three flat liners), and
- Triple wall board (consisted of seven different paper layers: three layers of corrugating medium framed by four flat liners).

Corrugated paper boxes are used in a wide range of packaging applications. According to Holik (2006), “Containerboards (corrugated boxes) are used in many packaging applications starting from simple transportation containers and ending with multicolor printed display containers for stores.”

Some types of fibreboard cases, based on FEFCO’s and ESBO’s Code⁶ are presented above (Figure 2.21).

Table 2.3. Main differences between the solid fibreboard and the corrugated fibreboard containers

	Solid Fibreboard Containers	Corrugated Fibreboard Containers
More resistant to puncturing	✓	
More resistant to wet or damp conditions	✓	
Reusable	✓	
Better protection to high density products	✓	
Better rigidity		✓
Cheaper		✓
Better packaging for lighter products		✓

Source: Paine, F.A. (1977) *The Packaging Media*. Blackie & Son Ltd.: Great Britain

Based on the above analysis, either solid or corrugated fibreboard containers, can be used in almost any packaging case. However, two main factors: i) the relative higher cost of solid fibreboard containers and ii) the type of the supply chain, can affect the decision of the user, among these two different types.

⁶ The “International Fibreboard Case Code” has been developed by FEFCO and ESBO as an official system to substitute long and complicated verbal descriptions of fibreboard case and packaging constructions with simple symbols internationally understood by all, regardless of language and other differences. Cited in: FEFCO, European Federation of Corrugated Board Manufacturers (2007), “International fibreboard case code”, 11th Edition

The main differences between the solid fibreboard containers and the corrugated fibreboard containers, are presented in Table 2.3 (Paine, 1977).

Fibre Drums

According to Kirwan (2005), “a fibre drum is a cylindrical container with a sidewall made of paper or paperboard having ends and components made of similar or other materials such as metal, plastics, plywood or composite materials”.

Fibre drums are used in a wide range of packaging applications, such as: food, pharmaceutical products, chemicals, solid products, granulars, powders, semi-liquid and liquid products and furthermore for the protection of textiles, films, adhesive tapes etc. They can also be used as a core for wire, cables, metal foils etc. (Kirwan (2005), Fibre Drums Ltd.)



Figure 2.22. Lock-Rim Fiber Drums

Source: GHC Specialty Brands, LLC., viewed 27 February 2011, <http://www.labsafety.com/Lock-Rim-Fiber-Drums_24535011/>



Figure 2.23. Kraft Tape with fibre drum core

Source: KITA (Korea International Trade Association), viewed 27 February 2011, <http://www.tradekorea.com/products/kraft_tape.html>



Figure 2.24. Aluminium Foil with fibre drum core

Source: Adams UK Packaging Materials, viewed 27 February 2011, <<http://www.adams-packaging.com/blog/index.php/aluminium-foil-or-plastic-wrap-which-is-better-for-the-environment/>>

Nowadays, in many cases, fibre drums have replaced even wooden barrels (Sweeney, 2009).

The sidewall of drums, is manufactured by the convolute winding, of several layers of paper of different grades, while the outer ply may be water resistant. The number of paper layers is determined by the stacking strength needs of the users and varies from 4 plies for the lighter drums used in lighter products, to 11 plies for the larger drums, intended to be used in heavy loads. (Gerald, 2009).

An important characteristic of this kind of packaging, is that fibre drums can be customised and manufactured based on specific needs and qualifications, required by the customer. In general, virgin unbleached kraft or recycled paper of around 280 gr/m² are used as raw materials, while the number of plies determine the strength of the drum. The addition of several materials, such as aluminium foil,



Source: 123-mpomponieres.gr, viewed 27 February 2011, <<http://www.123-mpomponieres.gr/p.TOPI-DICHTY-KOD-TL-30400-FOT-YLIKA-GIA-GAMO-VAPTISI.167741.html>>

polyethylene or paraffin wax, or the use of alternative group of materials, including silicones, alginates and polyvinyl acetate emulsions (Paine, 1977), both internally or externally of the plies, can add specific advantages to the drum, such as moisture barrier. (Kirwan, 2005)

The paper synthesis of fibre drums and the relative durability as a packaging mean have several advantages for this kind of packaging. Fibre drums can be reused several times and finally “the component materials recovered and recycled, or disposed of in energy-to-waste systems”. (Kirwan, 2005)

Summarizing, fibre drums:

- Have a low cost compared with metal alternatives.
 - Are environmental friendly since they can be reused several times, collected and recycled.
 - Can easily be manufactured with specific attributes, increasing their performance and matching specific requirements.
 - Be water proof, if combined with other materials such as aluminium foil or polyethylene.
 - Are approved for the packing and transportation of hazardous solids.
 - Are widely used by the chemical, pharmaceutical and food industries.
- (Kirwan, 2005)

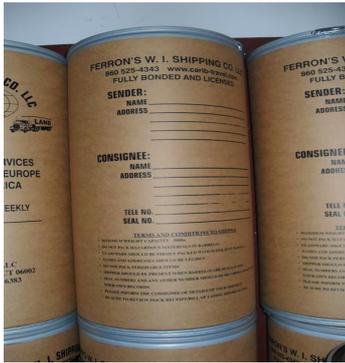


Figure 2.26. Fibre Drums 23x24 inch (585x610 mm)

Source: W.L.Benjamin Associates, Inc., viewed 19 March 2011, <<http://wlbctfs.financial.officelive.com/ProductInformation.aspx>>



Figure 2.27. Fibre Drums

Source: Shanghai Rich Chemicals Co., Ltd, viewed 19 March 2011, <<http://richchemical.com/about.aspx>>

Moulded pulp containers

Moulded pulp packaging is made from pulp formulated into various shapes, designed to provide protection to the products that are going to be packed. This kind of packaging is widely used for the protection of fragile products e.g. eggs, glass bottles, parts, electronics, stabilizing and protecting them from being in contact with other products contained into the same package, or from other factors during transportation that could destroy the product itself, by using special designs and embodied dividers. (Kirwan, 2005)



Figure 2.28. Egg Trays

Source: Rgbstock.com, viewed 19 March 2011, <<http://www.rgbstock.com/photo/mswS7BY/eggs-stack-ly>>



Figure 2.29. Fruit Tray

Source: Primapack SAE, Ltd, viewed 19 March 2011, <<http://www.primapack.com/fruit-packaging.php>>

This packaging category includes:

- Trays – used for the protection of fragile products e.g. eggs, fruits, glass ampoules etc. Figures 2.28 – 2.29.
- Clam-shell-style containers – used in cases where the products should be enclosed and totally protected. Figure 2.30.
- Corner or edge protectors – used for the protection of ceramics, furniture or electric appliances. Figures 2.31-2.32.



Figure 2.30. Clam-shell-style containers

Source: Best-B2B.com, viewed 19 March 2011, <http://www.best-b2b.com/Products/764/799-1/paper-wine-tray_339980.html>

Source: EC21 Inc., Ltd, viewed 19 March 2011, <http://xzp200229.en.ec21.com/Light_Packaging_Glass_Packaging_Pulp-1858968-1859242.html>

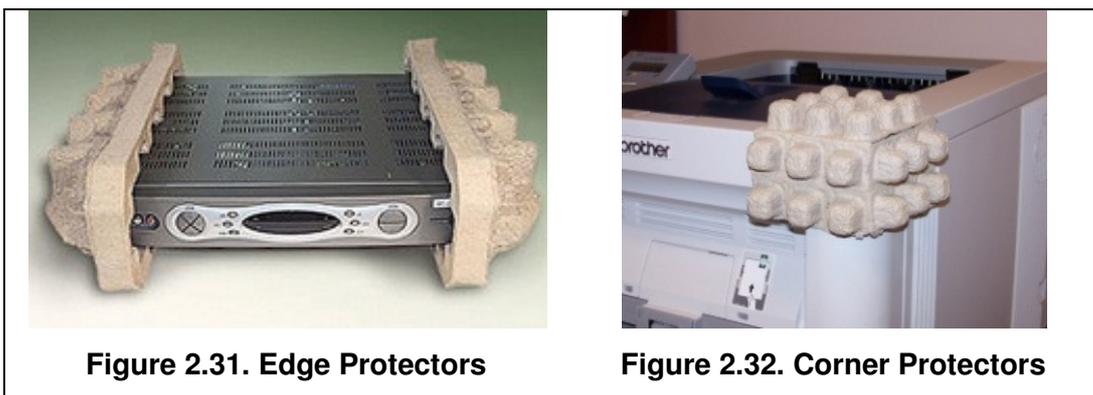


Figure 2.31. Edge Protectors



Figure 2.32. Corner Protectors

Source: Packaging Digest, viewed 19 March 2011, <http://www.packagingdigest.com/article/341383-The_search_for_sustainability_Paper.php>

Source: Salazar Packaging, Inc., viewed 19 March 2011, <<http://blog.salazarpackaging.com/sustainable-products/new-green-packaging-product-%E2%80%93-globe>>

Summarizing, moulded pulp containers are widely used in:

- Food and drink industry (e.g. eggs, fruits, wine bottles).
- Chemicals (e.g. medicines, ampoules).
- Electronic equipment (e.g. printers, DVD players).
- Furniture.
- Ceramics.

This kind of packaging is in general a cost-effective packaging solution and in many cases it is supplementary to the total packaging of a product. It is fully customisable to the shape of the product itself and hence it provides high protection with very low cost, facilitating handling operations of fragile items or products with irregular shape. (Kirwan, 2005)

2.2.2. Glass

Made from base materials such as: limestone, soda, sand and silica, glass making was first industrialised in Egypt in 1500 B.C. although there is archaeological evidence that it began in 5000 B.C. as an offshoot of pottery. According to the Roman historian Pliny (cited by Courtesy of PPG Industries, Inc., 1999), the discovery of glass happened by accident: *“Phoenician sailors feasting on a beach near Belus in Asia Minor, could find no stones on which to place their cooking pots; therefore, they set them on blocks of soda carried by their ship as cargo. As the fire's heat increased, the sand and soda turned to molten glass.”*

Since then, the ingredients and the mixing process have changed very little but there was tremendous progress in molding techniques especially during the 19th century. The 1870's was an important period for the glass sector, since the invention of a semi – automatic bottle machine allowed the mass production of bottles and introduced glass as a common, daily object (Courtesy of PPG Industries, Inc., 1999).

After 1890, manufacturing developments and glass uses had a rapid expansion, since its techniques became much better understood. Finally, in the late 1950's, Sir Alastair Pilkington introduced a new method of glass production – float glass production – that even today is the most common (by 90%) flat glass manufacturing method (Visual Communications S.r.l., 2003).

Here again the evolution of plastics at the end of 1970's, affected and weakened glass packaging. Nowadays, as a type of rigid packaging, glass still continues to give solutions to industry.

According to Berger (2002), *“for products that have a high quality image and a desire for high flavour or aroma protection, glass is an effective packaging material.”*

2.2.3. Metals

Various metals (copper, iron, gold, silver etc) were discovered by humans. However, golden shrines, boxes, cups made from silver etc. were too valuable for common use.

The process of tin – plating was stolen from Bavarians (who had developed the technique since the 14th century) and spread in Europe around 1600 A.D.

However, the idea for food preservation into metallic containers was realised in France in the early 1800's. A Parisian chef found that food placed in tin containers and sterilized by boiling could be preserved for long periods.

Despite of the fact that aluminium particles were first extracted from bauxite ore in 1825, the first aluminium can, appeared no earlier than 1959, nine years after the design of the first aluminium foil containers. Since 1960, food manufacturers have widely used tin cans in their processes, although in many cases they have replaced aluminium with cheaper plastic.

2.2.4. Plastics

Although plastic is the youngest packaging material compared to paper, glass and metal, it has found a lot of uses during the last decades. In today's world we cannot even imagine our lives without the use of plastic (American Plastics Council, 2005).

Despite of the fact that the first man - made plastic was created on 1862 by Alexander Parkes (Bellis, 2005), it was not until the mid of the 20th century that plastic was broadly used as a packaging material, especially for food sector.

Cellulose acetate was first derived from wood pulp in 1900 and cellophane (a close relative of celluloid) was first manufactured in 1924 in New York. *“The 1920's witnessed a “plastics craze” as the use of cellophane spread throughout the world”* (American Plastics Council, 2005). Hair in toothbrushes was replaced by fibre and especially after 1939, this new material was broadly used for stocking production replacing silk and experiencing a great public acceptance.

Polyethylene Terephthalate (PET) although discovered in 1941 (Bellis, 2005), was used for beverage containers the last quarter of the 20th century, reducing the use of glass in this sector and changing the market globally.

Since the 1950's, plastics:

- a) have been used in the production of many goods and have gained an important market share, and
- b) have revealed new opportunities for the substitution of natural materials that affect all of our lives.

The American Plastics Council (2005) stated that *“since 1976, plastic has been the most used material in the world and was voted one of the top 100 news events of the century”*. However, the use of plastic has raised serious environmental concerns especially if we consider that it is a material that does not degrade into its base materials (comparing to natural substances) and so *“the plastic cup someone threw away in 1955 still exists today, sitting in a landfill somewhere”* (BookRags, Inc., 2005).

Nowadays, despite the low cost of plastic, packaging designers, considering the environmental concerns, are beginning to use recyclable and recycled plastics in their creations.

The Timeline of Plastics can be seen in Appendix 3.

2.3. Sustainability

The notion of Sustainability has steadily evolved and changed through the years. While it was first used to prescribe the use of forests in a proper manner over time⁷ nowadays it has a broader view since it deals with a number of economic, industrial and environmental issues. As described in the Dictionary of Human Geography (2009) the “three pillars” of sustainability are economic (connected with financial issues), social (relevant to social oriented issues) and environmental. On the same issue Miller (2010) states that for a company being sustainable means to commit to people, planet and profits.

According to Lowe (2002) sustainable development is “the use of resources and the environment in a judicious manner so as to preserve their availability and

⁷ As cited in ‘Sustainability’ (Scoones, 2007) the term was invented in 1712 by Hans Carl von Carlowitz, who used it in his publication called “Sylvicultura Oeconomica”.

quality for the use and enjoyment of future generations”. According to the same source every aspect of the supply chain may be seen from a sustainable aspect. In this way transportation is firmly tied with the use of “*low energy and mass transit systems*”. As described in the Dictionary of Environment and Conservation (Park and Allaby, 2013) sustainability is “*a concept that is used to describe community and economic development in terms of meeting the needs of the present without compromising the ability of future generations to meet their needs*”.

As described by Fernie & Sparks (2009) except for the concern on the effectiveness of the channels of distribution and supply chains, there is also an environmental trend affecting the operations in supply chains. The pressures are either internally or externally driven. From an external point of view the companies have to comply with governmental directives or legislation. On the contrary, according to the same source, from an internal point of view the companies have realised that sometimes by enhancing their operations in order to be environmentally friendly may prove to be efficient and effective. Fernie & Sparks (2009) further explain that according to some critics it is necessary to invest in long-term sustainability that is firmly connected to a low-carbon way of doing business. However, in this extreme scenario, the societies must be sufficed to what is produced locally.

Miller (2010) states that consumers are most likely to be attracted by companies that appear to be attached to sustainable operations, since these companies appear to be not only responsible for but also conscious of their operations. As Garbowsky and Rahman (2013) state due to the emerged environmental problems (global climate change, water contamination, depletion of rain forests, scarcity of natural resources and so on) there is an increasing trend for environmental friendliness. The world is changing. Consumers are changing by demanding environmental friendly products (e.g. organic food), people are willing to buy less packaged goods, the demand for less polluting cars is rising and recycling is increasing.

As described by Al Plamann⁸ in “Sustainability Is 'a Way of Thinking'”, (Zwiebach, 2011) being green is totally different to developing sustainability since “green” activities are easy to be measured and their success can be evaluated. On the other hand sustainability is a whole philosophy of doing business, in order to achieve long-term (environmental) benefits. According to Montabon et al. (2007)

⁸ Al Plamann is a chief executive officer of Unified Grocers Los Angeles.

environmental management practices concerning the sustainability efforts, which can ameliorate a company's performance, include all those techniques, policies and various procedures a company implements in order to monitor and control the impact caused on the environment by its operations.

Many companies are making steps towards improved sustainability. As described by Kroger CEO (Orgel, 2011) effective sustainability needs strong efforts and collaboration with the suppliers in fields such as effective transportation of the products to the market with minimum environmental cost (less truck miles), the use of less packaging or packaging materials. Additionally, Soyka (2012) comments that sustainability is the chance every company needs in order to create lasting value.

In a same manner a manager of environmental services at Publix Super Markets (Hamstra, 2011) described that the company decided to invest in training its managers in an effort to seek and find opportunities in that specific area to collaborate with the suppliers and make improvements in areas such as waste reduction.

Moreover other similar efforts include that of Procter & Gamble (Angrisani, 2011) which is promoting the shift of laundry from hot/warm water to cold water by using suitably developed products. The company has already introduced concentrated laundry powder detergents meaning that the same portion of detergent can be used to clean a higher number of loads compared to regular powders. This innovative product needs less packaging, requires less space to be warehoused and transported and eventually results in reduced carbon emissions sustaining its environmental friendly notion.

According to Brezinski (2009), sustainability should not be accused of being economically prohibitive for the companies since it can help in improving product quality or contribute in cost reduction. Brezinski further states that sustainable companies will eventually survive and evolve by incorporating sustainable practices.

2.4. Sustainable Packaging

Although sustainability as already mentioned is a relatively old concept and its existence follows a parallel path to human history, it is not easy to distinguish between its special characteristics and the way it is perceived and acknowledged by different cultures or even social structures throughout different eras (Redclift, 1999). Moreover, sustainability has come to be used in environmentalism although, as cited

by Holling (2000), as a philosophy it may also be comprised of economic, political, cultural and sociological features.

Regarding packaging, sustainability plays an important role mainly because packaging is versatile. Nonetheless it is not unusual for the different segments of the packaging community to have different perceptions of the sustainability notion.

As cited by Jedlička (2009), although according to the classical notion the main target of packaging is to protect the product, one should bear in mind that eco-packaging should gather different attributes, rendering it not only proper but also sustaining its environmentally – friendly aspect, while at the same time serving its fundamental purpose. However, despite the fact that both governments and consumers keep asking for more “green” packaging, what an industrial customer needs is an enticing packaging for the products.

In addition, consumers require that the product should be properly packaged and marketing departments request that packaging should be luxurious and alluring enough to promote. The dilemma is obvious for companies as they are obliged to combine the conflicting demands, which means that a packaging solution must be found, one that should be “green”, attractive, provide proper protection to the product and strengthen brand image (“Sustainable Packaging”, 2004). As described by Henry Renella⁹ (“Luxury Consumers Prefer Subtle Sustainability Messages on Packaging”, 2011) although a luxury brand should undoubtedly be aligned and use sustainable packaging, the image and impression of the product’s luxury packaging should stay intact.

Another important aspect that should be taken into account is the one described by Williams and Wikström (2011). They argue that although in the past the idea was to use less (packaging) and recycle more, the new environmental trends suggest that the environmental protection that packaging itself offers should be the focus. They also recommend that the industry reconsider its practices and if necessary be ready to increase the environmental impact from the new packaging, should this lead to the reduction of food losses. Given the increasing demand for more products, the idea is to estimate and compare the environmental consequences between more and of better quality packaging and food losses before making the right decisions.

Traditional practices are about to change. As cited by Hildebrandt, (2012) some bottling companies have started packing wine in aluminium cans in order to

⁹ Senior vice president of New York-based Estee Lauder’s Global Packaging development.

assist portability. In addition, the use of aseptic packaging in beverage applications is increasing since this type of packaging allows the perishable and sensitive beverages (e.g. coconut water, exotic tropical fruit juices) to be transported by common transportation methods and be stored at ambient temperatures. Moreover, according to the same study nearly 2/3 of the aluminium cans in circulation are recycled while this material appears to be lighter (less weight per shipment → less fuel use → less CO₂ emissions → reduced cost). At the same time the production of recycled aluminium cans requires 95% less energy compared to those produced using virgin materials.

On the other hand, what consumers expect should seriously be taken into account. Lucas (2013) explains that consumers keep asking for more “green” products yet they also expect that the cost should be absorbed by the industry. In addition Goodrich (2012) supports the view that sustainability is a priority for consumers, which strongly affects their consuming habits, aiding environmental protection. However, he also adds that the citizen’s active participation in various environmental activities is of the utmost importance at this point, since it ensures that well-informed citizens will seek and find ways to support sustainability.

It should be stressed that the industry is currently making real progress on the packaging field. In 2013 NewPage Corp. earned the Sustainability Award in the Ameristar 2013 competition for its “*LittleFoot 100% Compostable Packaging Barrier Product*”. The above packaging is fully compostable and manufactured by combining paper and metalized cellophane, which makes it possible to avoid the use of foil or other polymers. Its composition ensures high protection from oxygen and moisture for the product while offering a notable printing surface and distinct appearance.

Further announcements made by big companies clearly show the way towards packaging sustainability. A remarkable example is that of Sainsbury which announced that the company plans to increase the use of recycled and recyclable packaging materials and at the same time make it easier for its UK customers to recycle. The company also announced that one of its main aims is to reduce the use of packaging by half for its store brand products (“J Sainsbury Plans to Reduce Store Brand Packaging”, 2011).

In the same manner, the US retailing giant Walmart decided to engage in packaging sustainability. One of its main objectives was to redesign the shoe boxes used throughout its US shops. According to Kalkowski (2012) the new design economised on paper by 692 tons approximately, within the first 10 months in 2011.

Furthermore, the company decided to ask its toy suppliers to replace the wire ties used to prevent the toy from moving in the box with ties made by natural fibres. In this way, in 2 years' time approximately, the Walmart products managed to save up to 1.6 billion feet of wire.

It should not be overlooked that the above packaging innovations would not have materialised if accomplishment in two other fields had not preceded: packaging machinery and packaging materials. As commented by Brulz (2013) the invention of biopolymers was not adequate since the industry would have to make the proper changes or additions in machinery so as to ensure that the materials would be fully operational, would not hinder the manufacturing process itself or generate printing failures.

Lastly, it should also be considered that more often than not packaging cannot be substituted and that in many cases companies cannot use lighter, bio-degradable or packaging made from recycled materials. It may be easy to find new innovative and sustainable ways to pack shoes, for example, or use new wrapping materials and lighter corrugated boxes to protect electronic equipment and detergents, for instance, but is not always easy to substitute primary packaging for food (e.g. biscuits, rice, flour etc) (Kalkowski, 2012). The above can be further advocated if legislation such as that of Food Standards Agency in the UK is taken into consideration:

“...it is necessary for all materials being used to have been manufactured in such a way that they comply with the Framework Regulation (EC) No 1935/2004 for materials and articles in contact with food, that is, that they should not transfer their constituents to food in quantities that could endanger health, bring about an unacceptable change in the composition of the food or bring about a deterioration in the organoleptic properties of the food.”

2.5. Summary

This chapter has included an analysis of the main packaging materials, placing emphasis on the different paper packaging categories (wrapping papers, paper sacks, folding boxboard cartons, rigid boxes, corrugated fibreboard cases, fibre drums, and moulded pulp containers). The aim of this analysis is to provide a basic understanding of the packaging categories and introduce the complicated packaging issue that will be examined in the following chapters. It also aims to provide evidence of the special characteristics of each paper packaging category and

the reasons for using each different packaging type in different situations. Finally it deals with the sustainability notion, presenting the main ideas, strengths, advantages and constraints of this approach while listing and describing some practices that have been undertaken by big companies.

CHAPTER 3 – PACKAGING IN THE SUPPLY CHAIN: REVIEW OF THE LITERATURE

3.1. Introduction

The 20th century was a period where the whole world experienced an impressive growth due to the rapid development of new technologies, transportation methods and new international trade opportunities. However, this growth has not been without serious environmental implications. Pollution of air and water, depletion of the ozone layer, rapid disappearance of rain forests, scarcity of landfills are the most important of them (Wu and Dunn, 1994).

After the 1980's land filling has become a major problem especially in countries where land is scarce. At the same time land filling creates other problems such as waste disposal, increased transport costs, tipping fees and public opposition (Chan, 1996).

In the late 1980's the environment emerged as an important factor. With the attention of the media and the efforts of various environmental groups, consumers began to give more attention to this subject and forced companies to improve their environmental performance and meet consumer concerns. At the same time the environment became an increasingly important political issue (Livingstone and Sparks, 1994). It was in this period that phrases such as: "environmentalism", "environmental friendly", "greenhouse effect", "ozone layer", "pollution" etc. started to be widely used (Milton, 1991). Many countries considering the significance of the problem tried to create a framework in an attempt to obligate companies to operate in a more ecological way and protect the environment.

The European Union as a bloc of different countries has become involved in environmental legislation. However, despite the fact that until the end of the 1980's there were nearly 200 EC/EU directives concerning environmental areas, at least by 1990 more than 50% of these directives had not been implemented (Prendergast and Leyland, 1996).

In this chapter the packaging issue is presented and described in detail. The historical circumstances and the environmental problems that arose during the 1980's and 1990's are presented in an effort to determine the main reasons that led to environmental legislations worldwide, during the same period. Still, special attention is given to the European area and the 94/62 Packaging and Packaging

Waste Directive. Among others, this analysis is going to enhance comprehension of the reasons that call for environmental legislations.

In addition, the packaging notion is being analysed and different aspects concerning packaging are described. Following the above, packaging is presented in relation to logistics and its attributes, which are further examined in connection with the main logistical functions.

Extensive data on Packaging, i.e. Packaging waste generated, used and recycled in the E.U. and the packaging waste per material, are part of the total investigation in an attempt to describe the situation in the packaging field. Furthermore, the literature on issues such as how packaging is chosen by companies, the way that packaging cost forms a reciprocal relation to logistics functions, as well as the process that both of the above elements correlate to the marketing function of packaging are analysed. In addition, special attention is given to improper packaging; along with the needs of the modern way of living that clearly affect the packaging choice (materials and design). Finally, a brief introduction to the overpackaging issue is also part of this chapter, while the main packaging recovery methods are briefly presented.

Before proceeding to the packaging context it is useful to make a brief introduction to the science of Logistics. It is also useful to present the nature of the Closed – Loop Supply Chains since the thesis is based on the examination of case studies focusing on such type of supply chains.

3.1.1. What is logistics?

In any industrialised or non-industrialised society, there is a physical movement of goods between the place they are produced and the place they are consumed (Lambert *et al.*, 1998). As a result, the development of channels is necessary in order to serve the exchanges that take place between producers and consumers. The chain of intermediaries between the point of production and the point of consumption has been called “the supply chain”. According to Ghiani *et al.* (2004) “A supply chain is a complex logistics system in which raw materials are converted into finished products and then distributed to the final users“. As follows, “the supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion and all Logistics Management activities” (Council of Supply Chain Management Professionals, 2013). By the same token, Mentzer, (2001) define a supply chain as “a set of three or more

companies directly linked by one or more of the upstream and downstream flows of products, services, finances and information from a source to a customer". Quinn, (1997) suggests that supply chain management is a matter of great importance since it begins and ends with the customer.

At this point, the term "Logistics" should also be described. As cited in the Dictionary of Human Geography (2013) logistics is defined as "*the organization and management of the movement of goods and services within a system*". Logistics operations integrate a great number of inbound and outbound activities such as: transportation, inventory and warehousing management, integration of information technology and operations management (Grant, 2012).

According the Council of Supply Chain Management Professionals, (2013), "*logistics management is that part of Supply Chain Management that plans, implements and controls the efficient, effective forward and reverse flow and storage of goods, services and related information, between the point of origin and the point of consumption in order to meet customers' requirements.*"

In a same manner the term "reverse logistics" could be used to describe the flow of materials towards the point of origin in an effort to reduce the environmental impact of logistics activities (Rogers and Lembke, 2001).

However, logistics is not fully described in the above definitions. It is furthermore the line of processes which represent the daily function of a company. It could also be the adjustment, the rules and the processes of the warehouse that lead to the faster finding of the right product. It could be the mechanism which leads the storekeeper to take the right decision, or the choice to keep the right volume of the right products in order to be able to serve the demand for a specific period of time, avoiding the urgent order to the supplier and as a result the more expensive transportation (via courier or airplane) of these products. It could also be the reduction in the lead time and lost sales -meaning the quality benefits- making logistics a more important and interesting function (Paraskevas, 2005).

3.1.2. The Importance of Logistics

Logistics and Supply Chain Management tend to be of the most important factors in a company's performance and a key to success in the global economy regardless of company size (Randall, 2000). However, logistics is interrelated with

other sciences as well. As Gudehus and Kotzab (2012) describe modern logistics use the knowledge provided by other sciences and incorporates it into its operations.

The industry is more and more dependent on well-structured logistics. As cited in Gulf News (2012) various weather conditions such as 2011's tsunami in Japan and floods in Thailand caused disruptions the following year in the supply of parts to the car industry. This fact forced the AW Rostamani Automotive Group to invest in new bigger spare parts facilities in Dubai, in order to overcome similar situations in the future. In the same manner, Victoria Kwakwa, World Bank's Country Director for Vietnam supports that serious investment in logistics could be vital for Vietnam in order to face unpredicted weather challenges such as those presented above (tsunami, floods and so on) (The Philippines News Agency, 2014).

According to Giannakenas (2003) in many companies worldwide, the cost of various processes related with Logistics, contribute to the black hole of their profits. Logistics cost is the second biggest cost after marketing and sales costs in a trade company and the third biggest cost after production, marketing and sales cost in an industrial company. Thus there are different types of companies, depending on the effort to reduce the various logistics costs for the purpose of meeting customer requirements.

Logistics management is a measure of the valuation of a company's performance since the processes that are involved impact not only on the company but also on its relations with the various customers and suppliers. According to Kenderdine and Larson (1988, cited by Lambert *et al.*, 1998), successful integrated logistics management combines all different logistics activities in a system and gives them the ability to work simultaneously targeting to the minimisation of total distribution costs and the improvement of customer service levels. Lambert *et al.* already in 1978 cited that the industry was beginning to realise that with the coordination of the various logistics activities, total logistics costs can be reduced and customer service improved.

The function of a supply chain affects most of a company's departments and at the same time its customers and suppliers, since this is the procedure through which raw materials reach the manufacturer and finally the consumer, as a final product ready for use.

Customer service-satisfaction is a really important measure for all companies. According to Birkner (2011) based on customer satisfaction marketers are able to determine if a company is meeting basic customer needs or not. As cited in Oxford

Dictionary of English (Oxford University Press, 2010) customer service is defined as “the assistance and advice provided by a company to those people who buy or use its products or services.” More over the Dictionary of Business and Management (2009) describe that “Customer services cover a wide variety of forms, including after-sales servicing, such as a repair and replacement service, extended guarantees, regular mailings of information, and, more recently, freephone telephone calls in case of complaints.” On the other hand according to Heskett (1994), logistics customer service is “the speed and dependability with which items ordered can be made available...”. He also adds that in many cases customers ask for higher levels of dependability than for faster response to the lead time of the product. In addition, as Bender states (1976, cited by Ballou 1999), the development of a new customer is approximately six times more expensive than it is to keep a current customer, so from a financial point of view, customer service improvement is essential (although customer service is encompassed in the broader concept of customer satisfaction).

The growing demand for innovative and constantly improved products, faster transportation and better quality (both in products and services) and furthermore the development of new technologies, have driven to the shortening of product lifecycles and at the same time to an increase in the range of the goods offered (Iakovou and Xanthopoulos, 2005). For what is relevant to the European Union, various developments were succeeded during the last decade, giving new shape and push to several logistics operations. New conditions and procedures to the customs of the EU's members, the continual economic growth and the demand for more, better and faster movement of products and services boosted the importance of logistics operations and the need for more organised and well stabilised customer – oriented processes. The challenge for the shippers is to serve the European market in the most effective way and at the same time keep the number of warehouses small and the lowest possible inventory (Bowman, 1999).

In recent years most (if not all) of the customers, demand for the lowest cost combined with the quickest possible delivery of the products (Randall, 2000). Thus, producers must organise their businesses in a way that ensures the supply of raw materials, the production of goods and the delivery of products, components or materials at the exact time when an organisation needs them (Lambert *et al.* 1998), driving the market in a more Just In Time way of doing business.

On the other hand the relatively newly arrived environmental concerns put new pressures on the industry globally and the challenges for logistics in particular, become crucial. New laws obligating companies to conform to a more environmental

friendly way of doing business have developed initially in a regional level and afterwards in the EU. Logistics is called to give solutions to a range of problems (procurement of raw materials, design and manufacturing of new products that do not downgrade the environment etc.), finding at the same time methods and ways in a try to avoid increased and hidden costs.

In addition, the new economic conditions and the expansion of individual domestic industries to foreign and bigger markets, creates new problems for logisticians who are now forced to find solutions to new issues such as the kind of the packaging and its individual characteristics (shape, size, color, type) that best fit in a country's culture. The labeling of products is another challenge, since new social conditions which dominate in the EU, require from companies to create products easily identifiable from every EU resident.

3.1.3. Closed – loop supply chains

Guide et al. (2003) state that except for the traditional forward supply chain activities, a close-loop supply chain include further activities connected with the reverse supply chain. These activities include the following: material collection from the end-users, transportation of these materials either for disposing, recycle or reuse, evaluation of the product condition in order to choose the best recovery process and further marketing activities in order to sell the recovered materials to the market.

Well and Seitz (2005) describe that closed loop supply chains are in general a combination of a forward and a reverse supply chain in which the product is collected, remanufactured and finally re-distributed to the market. Sundar et al. (2013) give a general rule concerning this system. They cite that in a closed-loop supply chain the purpose is to collect products or materials in order to be used again and again in the manufacturing process instead of using newly produced raw materials. In addition they state that the newly manufactured products follow in general the forward supply chain while the used products are following the reverse direction i.e. back to the recycling or remanufacturing centres. Quariguasi et al. (2010) state that the main objective of this kind of supply chain is to create the appropriate structures in order to provide economic benefits for the companies involved. These benefits would result from the optimal management of the end-of-use products.

As Flapper et al. (2005) state four major types of closed-loop supply chains are related to the life-cycle of a product i.e. the production phase, the distribution

phase, the user phase and the end-of-life phase. In this very last phase, the product is losing its identity while some of its parts or materials are being transformed or further reused. They further argue that each of the above phases has its own characteristics and the companies are those who decide if they want to create a reverse channel (closed-loop) or not.

Guide and Wassenhove (2009) give a valuable definition:

“Today we define closed-loop supply chain management as the design, control, and operation of a system to maximize value creation over the entire life cycle of a product with dynamic recovery of value from different types and volumes of returns over time.”

In the same manner, according to Gutowski et al. (2011) and Kleindorfer et al. (2005) some activities firmly connected with close-loop supply chains such as that of remanufacturing of some products (e.g. refrigerators or other electrical appliances) except for being environmental friendly are also cost effective for the consumers since the remanufactured products are generally sold at lower prices compared to the brand new products. As Guide and Wassenhove (2009) state, re-manufacturing operations need specific factors to be addressed in order to be economically effective. This means that the products should be available in the right quantities and at the right time while the market should be positive to absorb them after being reprocessed. Kleindorfer et al. (2005) further note that since the collection of materials or products from the supply chain requires human hands, the process may positively affect unemployment by reducing it, especially in the under developed countries.

Savaskan et al. (2004) state that there is an increasing trend where manufacturers are establishing adequate structures in order to collect, remanufacture and distribute these (remanufactured) products in the market in parallel with their usual manufacturing operations. Refurbished or remanufactured products are usually upgraded to a high quality level almost equivalent to that of new products in order to be sold again in the market. As described by Ginsburg (2001) a typical example is that of XEROX which decided to start taking back the damaged copier machines from its customers in order to repair and sell them again to the market or use any spare parts that could be retrieved from them. The same situation applies to other products as well, such as toner cartridges where the companies are willing to pay the shipping charges or even reimburse a small amount for the empties. In the same manner, Guide et al. (2003) clearly cite that in order to operate in a more environmental friendly way, the companies should design and operate their forward

and reverse supply chains in such a way that allows them “to take advantage of all types of product returns”.

However, there is a serious argument concerning the economic effects of remanufacturing. Majumder and Groenevelt (2001) discuss the issue and provide a different approach concerning the comprehension of the strategies of the manufacturers. The main idea of the discussion is what happens in case that the remanufactured product becomes more attractive when compared with the new products. Since the remanufactured item is of equivalent quality but of lower price compared with the new products there is a serious conflict on whether the consumer is going to buy the new or the refurbished item. A major problem is that in many cases very soon after a new product arrives, local remanufacturers appear creating a leak to the closed-loop supply chain, since a big volume of the used products never return to the original manufacturer but instead are being reprocessed by these local stores.

Although closed-loop supply chains include a number of elements that should be included in their optimal design, there are a number of issues that should be considered before proceeding with any changes in the current supply chains. Certainly a closed-loop supply chain include a number of advantages for a company such as its sustainable (environmental friendly) operation. However, on the other hand problems should also be considered since they decisively influence a company’s performance. One of the most important problems appear to be the irregularities that result in the market between the new and the remanufactured products where their equivalence concerning quality and the significantly lower price of the latter. This is a puzzling issue for the competition.

In any case, all partial details should be taken into consideration before proceeding with any changes. At last it should be noted that as Quariguasi et al. (2010) state, by creating a closed-loop supply chain establishing all those actions that are relevant to a reverse flow of products or materials does not necessarily convert a supply chain into one that is sustainable. According to their view, sustainability can only be achieved if the main activities of the supply chain are economic, social and environmentally driven.

A schematic representation of a closed loop supply chain is presented below in Figure 3.1.

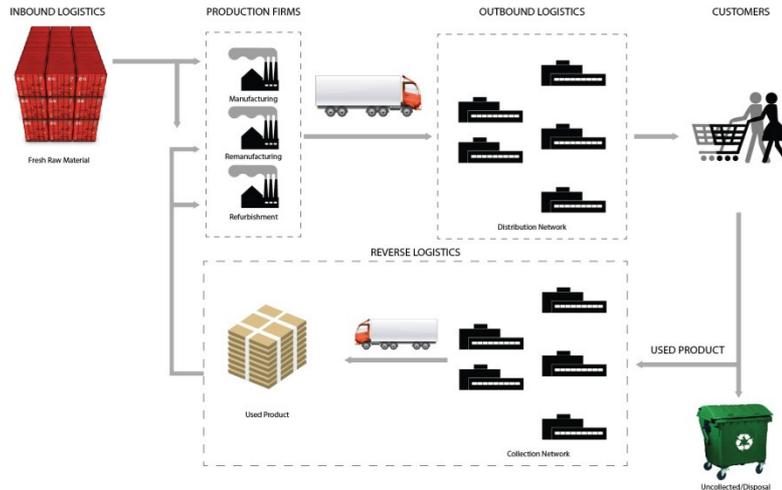


Figure: 3.1. - Representation of traditional and closed loop supply chain. Reproduced by Author. Adopted by: Sundar Raj, T., Lakshminarayanan, S., & Forbes, J. F. (2013). Divide and conquer optimization for closed loop supply chains. *Industrial and Engineering Chemistry Research*, 52(46), 16267-16283. doi:10.1021/ie400742s

3.2. The Packaging Issue

One of environmental campaigners' targets for the confrontation of the various problems in the early 1990's was the packaging issue, partly due to its "*high visibility and its connotations with a throwaway society*" (Livingstone and Sparks, 1994, p.15). This seems to be reasonable since as Mahaffie (2006) describes, the attraction for consumers of a newly designed box with glaring graphics and innovative design is instant as the packaging soon after its purchase becomes a common packaging that should be opened and disposed of after its use. Furthermore, as cited by Qing and Guirong (2012) nowadays the environmental impacts of packaging are so intense because for most products packaging is single-use and turns into waste right after its use.

As we will see in the following chapters, in many cases companies are "accused" of using excessive packaging, using unnecessary raw materials, aggravating in this way the environment by producing extra litter which in many cases could be avoided.

Packaging became a significant issue for the whole Europe since during the last years of the 1980's according the Economist (1990, cited by Livingstone and Sparks, 1994), the European Community was generating approximately 50 million tonnes of packaging every year. Of these only 9 million tons were recycled. For these reasons the introduction of new measures was a necessity.

In 1994 the European Union adopted the Packaging and Packaging Waste Directive (94/62/EU). This directive aimed to harmonize national packaging waste management measures, in order to reduce its impact on the environment and at the same time ensure that packaging laws did not create any obstacles to trade or restrictions to competition within the Community (The European Organization for Packaging and the Environment, 2000 and EUROPA, European Commission, Environment, 2005). This directive impacts not only on the internal market (EU) but on the external market as well, since it puts specific features and details to the products manufactured and imported, from countries outside of the European Union. Further details of the specific directive will follow in the next chapters.

The main aims of the specific Packaging and Packaging Waste Directive and the individual laws enacted by other countries (e.g. Green Dot in Germany – trade mark protected in ~170 countries (Duales System Deutschland AG, 2005)), are:

- to reduce packaging's impact on the environment, and at the same time,
- efface any obstacles to trade or restrictions to competition within the Community,

There are though complaints that these requirements create trade barriers.

For example, groups like the Industry Council for Packaging and the Environment (INCPEN) and Alliance for Beverage Cartons and the Environment (ACE), at the end of the 1990's demanded that the EC take measures against Germany's refill quota, "*which put a 28% ceiling on drinks in single use packaging*" (Packaging Magazine, 1999). Because of the fact that the German system promoted the use of refillable containers, the system of deposits for non-reusable bottles was thought to be unfair for the foreign industries who in order to avoid these extra charges had not only to change their bottles transforming them into refillable but also to organise reverse, longer and expensive channels of transportation (comparing with the local manufacturers) in order to take back the empty bottles (UKEN Archive, 2001). A similar problem arose in 2005 when the Hungarian government decided to introduce a new product fee on beverage containers⁸. As a result Beverage Can Makers Europe (BCME) inquired the EU Commission to investigate the legitimacy of these measures (Business & The Environment With ISO 14000 Updates, 2005).

Moreover, similar efforts appeared in the rest of the world. For example in 2002 Taiwan formulated the Resource Recycling Act in an effort to reduce waste,

⁸According to the legislation certain recovery/recycling target and a minimum refill quota should be reached for single-use containers.

conserve natural resources and provide a framework for recycling and reuse of materials (ROC Environmental Law Library, 2002, Chien-Chung Huang, Hwong-Wen Ma, 2004). Similar efforts include the following:

- Tasmania: Environmental Management and Pollution Control Act (EMPCA) 1994 (Environment Protection Authority (TAS), 1994).
- Australia: Environmental Protection Act 1994 (Government of South Australia, 1993).
- Canada: Canadian Environmental Protection Act 1999 (Government of Canada, 1999).
- Japan: Basic Environment Law 1994 (Government of Japan, 1994).
- India: Environment (Protection) Act, 1986 (Government of India, 1986).
- Egypt: Environmental Protection Law (amended by Law 9/2009) (Egyptian Environmental Affairs Agency) etc.

Nevertheless packaging is not such a simple issue. According to the notion of “ecological modernisation”, economic development and environmental protection can work simultaneously and reinforce each other. New processes and products, in many cases can significantly reduce pollution and transportation (ESRC Global Environmental Change Programme, 2000). On the other hand there is a view that packaging itself reduces wastage by its role in the protection and preservation of products. For example as cited by Marsh and Bugusu (2007), using proper food packaging can extend shelf life by delaying product deterioration, maintain quality and safety of food and at the same time facilitate transportation and storage of the product itself.

The expansion of many companies overseas and to bigger markets (compared with the domestic markets where they used to trade), has increased the distances between the place of production and the point of consumption (Jahre and Hatteland, 2003). Additionally, according to Hellstrom and Nilsson (2011) changes in the consumer habits and the simultaneous increased demand for new products force the companies to find and use new and innovative packaging for their goods. This means that companies seek to redesign or totally change their packages in order to make the transportation, the warehousing and the handling of the products easier and at the same time improve their environmental performance. As cited by Dharmadhikari (2012) while a company’s supply chain needs to operate in order to deliver the right product, to the right place, at the right time and at a reasonable cost for the consumer, at the same time the environmental requirements should also be

fulfilled. Additionally as Lunati (2013) states many companies realise that a better environmental performance is good business practice that in turn strengthens the brand image.

The redesign of packaging in terms of shape and size and many improvements in the ease of handling and opening are some of the recent changes concerning the packaging sector. In many cases (where possible), packaging materials are reduced or substituted with environmental friendly materials such as: recycled glass or paper, use of non – toxic colors, reusable plastic containers etc. A notable example concerns the efforts of Pepsi, Coca-Cola and Nestlé in developing new manufacturing technology for the production of thinner plastic beverage containers that results in less plastic per bottle (White-Sax, 2008).

Environmental friendly – green packaging focuses further on environmental protection through energy and resource saving and waste reduction when designing, manufacturing or using packaging favouring at the same time packaging recycling and reusing operations (Guirong et.al. 2010). In addition the use or recycling of some packaging materials favours the environment by reducing further the use of natural resources. For example as cited by Cattaneo (2008) for every tonne of glass recycled more than 1000kg of natural resources are conserved.

However, according to Billings (2010) packaging sustainability other than for environmental protection is also about marketing. Yet there are serious conflicts between the design and production of “green” packaging and the consumers’ demand for convenience (Packaging Digest, 2011). As cited by Shamash (2009) the industry is pushed by the environmental-conscious shopper to find ways to reduce packaging while at the same time the image of the product should stay intact. In addition, the image of the product is such an important issue that big changes might result in lost or reduced sales since the consumers appear to be loyal to the image of their favorite brands (Kent, 2008).

In other cases such as the food industry, packaging is more essential for the preservation and the avoidance of a part or total spoilage of the product. Jahre and Hatteland (2003) suggest that “*smaller volume of products are required because of changing demographics and the development of self – service concepts, which in turn, leads to more packaging*”⁹. Although the reduction of packaging became one of the most important issues considering the EC’s Packaging and Packaging Waste

⁹ It should be noted that according to Panvalker and Piskolti-Caldwell (2001) smaller volume of products consumed may result in a significant environmental problem since this means more long-distance shopping trips and increased CO₂ emissions.

Directive, the substitution of packaging or generally packaging materials is not always an easy matter, since not all materials are appropriate for some kind of products (e.g. food) and in addition, some products need special treatment and further packaging in order to avoid further waste which might be derived from the destruction of the product itself.

As cited by Emblem (2000), in the past manufacturers were trying to find ways to reduce packaging for cost reasons. Nowadays, environmental legislation forces the market to seek and find ways to reduce the use of packaging materials.

However, according to a survey conducted by Prendergast and Leyland (1996), the above directive and the new procedures that its implementation entailed, was thought by most of the respondents to be financially prohibitive for companies. It is obvious that the packaging issue needs careful treatment since the balance between the implementation of a directive and the corresponding financial problems is fragile.

But what is the singular nature of packaging and its special characteristics that transform it and make it so important for our lives? Or why is its role so important for a product for both logistics and marketing?

Back in 1998, Lambert *et al.* citing six packaging functions given by Robertson (1990), condensed them into two core functions: i) logistically related and ii) marketing related.

Nowadays the above statements are more than valid. From a marketing perspective Kemp (2011) describes that packaging protects the brand by protecting the product from damage, pilferage and counterfeiting. As Meyers and Gerstman (2005) state, the package design is so important that most of the time it drives the purchase decisions of the customer. They also add that packaging is the ultimate element contributing as a major decision maker. Aligned with the above, Dannis Lee¹⁰ states in the South China Morning Post (AISEE@SCMP.COM, 2004) that for what is relevant to cigarette packaging in China it has been observed that the design is many times more important than the quality of the contained product. In addition, as cited by Rundh, (2009) the package design plays a vital role in the communication between retailer and consumer helping the consumer to find, select and pick the product from the shelf. Furthermore as cited in Design Week (2010) packaging is more powerful than advertising in promoting a product. This aspect is based on the

¹⁰ Dannis Lee is Chief Financial Officer at cigarette package printer Vision Grande Group Holdings.

fact that while advertising has just one chance to attract a consumer's attention, packaging is more effective since the brand and other information and messages are constantly displayed on the product's packaging.

In the same manner, packaging provides information about the product including the need for special treatment, preservation conditions, ingredients, expiration dates and other important elements, acting actually as an adviser for the consumer. In recent years plenty of packaging innovations have contributed to the improvement of modern life. An important example is the information concerning product name and strength that all medicines should bear in Braille as a result of the EU's Falsified Medicines Directive (Kemp, 2011).

From a logistics perspective the packaging function aims to organise, gather and protect products, components and materials during storage and transport (Lambert *et al.*, 1998). According to Prendergast and Leyland (1996), packaging undertakes the protection of the product from damage that may be caused during transportation or handling of the product, spoilage or loss from various reasons (e.g. theft, misplace).

Packaging can be classified into two major types: consumer and logistical. It is clear that packaging is related to logistical activities: transportation, storage, inventory control, purchasing, and handling. Not to mention the customer service undertaken by packaging in the protection or the easiness in unpacking and discarding the useless –once opened- packing materials (Robeson and Copacino, 1994). So from a manufacturer perspective, a well designed packaging, including the shape, the colour, the materials, the strength, the weight or other characteristics is essential. As a result, since the basic axes for manufacturing decisions are the cost and the profit, the importance of the “well designed packaging” is clearly understood.

On the other hand, there is also consumer packaging, a term which generally describes the kind of packaging which reaches the final consumer. In this we have also to include the cost of the unpacking action of the product (action usually taken by the final user). The type and quality of packaging will result in the quality of the contained product. An easy – opening design can reduce customers' costs, facilitate the operation and avoid the destruction of the product by an incorrect handling (Robeson and Copacino, 1994).

It is obvious that packaging addresses not only consumers but also intermediaries since it is designed to facilitate the movement and handling of goods, the easy identification of the contained product and the various instructions for the

careful handling of the product through labels etc. **This dissertation will investigate the present conditions and the problems that occur and at the same time to find a more advantageous way of designing, using and finally handling the packaging and packaging waste for both the industry and the environment.** It will seek to conciliate the packaging issue with the two most important receivers of its advantages and waste, the consumer and the environment.

It will also try to find and analyse new methods in reverse or green logistics for what is relevant to the collection, transportation and recycling or reuse of waste packaging in an attempt to understand and create a base for a better understanding of the problem. Reverse logistics tends to be one of the most important sectors of an organised society since the operation of such systems was underestimated until now, especially where the problems of inadequate planning and infrastructure impact our lives. There are multiple efforts from individual countries and the European Union to effectively confront the problems and lessen the impact of our selective way of life (especially in the Western World) on the environment. These attempts were followed by big problems and reactions from different parts of society (especially the industry) and from increased concern about the cost which in most of the cases is passed to the final consumer. Various problems in the implementation of environmental friendly legislation create arguments about the possibility of success of such efforts. On the other hand, the Earth emerges for imperative changes in the way we live and consume and in the reduction of waste and pollution. As seen above, the confrontation of problems such as the pollution of air and water, the depletion of the ozone layer and the scarcity of landfills, is imperative or we will be driven to face tremendous changes in our lives over the next decades.

3.3. Packaging Reverse Logistics

Emerged environmental concerns, governmental efforts and focused environmental legislation create a framework for reverse logistics. For what is relevant to packaging, reverse logistics focus on the reverse flow of packaging materials from the point of consumption back to manufacturers that could be either recycled, disposed or remanufactured (Lai & Cheng, 2009).

The framework for reverse logistics is created due to emerged environmental concerns, governmental efforts and focused environmental legislation. As far as packaging is concerned, reverse logistics focuses on the reverse flow of packaging

materials from the point of consumption back to manufacturers so as to be recycled, disposed and in some cases remanufactured (Lai & Cheng, 2009).

According to CSCMP (Council of Supply Chain Management Professionals): *“reverse logistics is a specialized segment of logistics focusing on the movement and management of products and resources after the sale and after delivery to the customer. Includes product returns for repair and/or credit”* (Vitasek, 2013). The Dictionary of Transport and Logistics (2002) describe reverse logistics as a *“Distribution terminology for collecting returns (e.g. surplus, damaged or recalled goods) and bringing them back to the depot/warehouse and integrating them back into the system (i.e. for scrap, repair or replacement, etc)”*.

As described by Fernie and Sparks (2004), in order for a reverse channel to be effective, it should be ensured that valuable packaging materials (i.e. materials suitable to be re-processed or remanufactured) can be collected from the market. Lai & Cheng (2009) describe that reverse logistics is becoming popular with firms due to its environmental, economic and strategic contribution to a firm's operations. Sadler (2007) supports that reverse logistics offers significant advantages to the firms, which may derive economic benefits from reducing the volume of wasted products. In addition, it offers valuable service to the consumers who may effortlessly get rid of unwanted goods or materials.

According to Hall et.al (2013), by sending materials back to the recycling centers for remanufacturing, negative effects on the environment could be reduced. The alleged improvements include reduction not only in waste disposal but also in the extraction of raw materials. Moreover, fuel emission resulting from transportation and distribution operations is significantly narrowed down.

However, the serious complexities of reverse logistics should be taken into consideration. As described by Zhao et al. (2008), supply uncertainty (e.g. timing, quantity and quality of the returned materials) cannot be easily forecasted and controlled. In addition, the various operational difficulties, which include the capacity of facilities or other exogenous factors, such as customers', suppliers' and competitors' attitudes, related to issues concerning the various governmental measures, are likely to provoke transformation on the reverse environment, magnifying the complications in the field. Finally, due to its having-until recently- a secondary role, managers are skeptical to invest in operations related to it (e.g. IT, human, and equipment). All the above factors constitute serious obstructions to the development of reverse logistics.

Tibben et.al (2002) discusses the differences between forward and reverse logistics. By analysing the core procedures related to each one of them, they give evidence of the reasons determining why the same procedures can't be implemented in both forward and reverse logistics. One of the major differences is that while in forward logistics the item is sent from one origin to multiple destinations, reverse logistics undertake the role to return the items from multiple origins to one destination. Thus, different administration procedures are necessary to be applied to each of them – forward and reverse logistics. In addition, in forward logistics the products are stacked in an effective way on to pallets as a result of a company's long and efficient design. On the other hand, the returning materials could be heterogeneous and inconsistent, this way leaving them in many cases out of their package, resulting in inconsistent load, causing difficulties in transportation or further waste, due to unsuitable or absent packaging. Furthermore, while the price of a product is more or less fixed by the producer, the returned product is not always of the same value, since its value depends on its condition. Among others, a major difference is that while in forward logistics it is relatively easy to track a product by using Information Technology Systems (e.g. GPS, software, electronic tags, Radio Frequency Identification) in reverse logistics it is more difficult to trace returned products or materials, which makes the process less transparent. Except from the above issues, as cited by Minami et. al. (2010) a major problem concerning reverse logistics is the difficulty to forecast the volume of returned packaging materials and thus to estimate the inventory.

In any case, while reverse logistics may have important advantages for the environment, there are plenty of implications arising, which should be taken into account. These implications encompass not only difficulties in the procedures or the implementation of relevant activities but also contain genuine economic and logistics weaknesses that should be well understood in order to be effectively solved.

3.4. Defining Packaging

Packaging is defined as *“any materials of any nature to be used for the containment, protection, handling, delivery and presentation of goods, from raw materials to processed goods, from the producer to the user or the consumer”* (1994 cited in: European Parliament and Council Directive 94/62/EC of 20 December 1994 on Packaging and Packaging Waste).

Another extensive definition of packaging is given by Beck (n.d.): *“A container providing a means of marketing, protecting or handling a product, including unit packaging, intermediate packaging, and shipping containers. Includes unsealed receptacles such as carrying cases, crates, cups, pails, rigid foil and other trays, wrappers and wrapping films, bags and tubs. Tin-plated steel, hotdip and electrolyte galvanized steel, and galvanized wire shall be considered packaging. Includes individual parts of a package such as blocking, bracing, cushioning, weatherproofing, exterior strapping, coatings, closures, inks, labels, dyes, pigments, adhesives, stabilizers, or any other additive.”*

Ballou (1987), states that in logistics the product is in many ways of minor importance related to the package. Packaging has some physical characteristics (shape, volume and weight), whereas in many cases the product inside may not have the same features.

Sara (1990) wrote that “packaging is the silent sales person and it is the final interface between the company and its consumers...”. This definition gives a brief indication of the basic character of packaging.

According to a survey conducted in the UK by Ipsos MORI (2008) on behalf of INCPEN¹¹ and Valpak¹² only 35% of the respondents believed that the packaging function is to protect the product and almost 1/3 of them (30%) believed that its main purpose is to keep product safe and hygienic. In the same manner a small proportion of 15% answered that packaging extends the life of the product itself.

On the other hand nearly half of the respondents (46%) answered that packaging uses too much materials and furthermore (35%) that the nature of packaging makes it difficult to dispose. The answers are graphically presented in the following Figure 3.2.:

¹¹ INCPEN: The Industry Council for Packaging & the Environment

¹² Valpak: The largest UK compliance scheme approved under the Packaging Waste Regulations.



Source: IPSOS Mori (2008), “Public attitudes to packaging 2008”, Report to INCPEN and Valpak, London.

Based on the same survey (Ipsos MORI, 2008) the level of agreement of the same respondents to the overpackaging issue is clearly shown in Table 3.1.:

Table 3.1. Aspects concerning the overpackaging issue

Most products are:	Proportion
Very over-packaged	43%
A little over-packaged	36%
About right	17%
Under packaged	2%
Don't know	1%

Based on the same survey (Ipsos MORI, 2008) the most over-packaged products according to the participants are presented below in Figure 3.3.:



Figure 3.3. Illustration of the over-packaged products

Source: IPSOS Mori (2008), "Public attitudes to packaging 2008", Report to INCPEN and Valpak, London.

According to the German Ordinance on the Avoidance and Recovery of Packaging Wastes (1998), packaging can be categorized into three types:

- Sales or primary packaging. The immediate containers in which goods are sold (Livingstone and Sparks, 1994). It is the direct material that the product is enclosed to, such as the plastic bottle of orange juice, the metallic can of tuna or the plastic bag of detergent.
- Secondary packaging. This category includes items such as corrugated boxes that can contain one or more primary packages (Rushton *et al.*, 2000). This kind of packaging has no contact with the product itself. This for example could be the corrugated box where plastic packets of salt are placed in. It is used for reasons of unitisation and easy of handling.
- Transport packaging. This type of packaging includes all these means (pallets, containers, crates) that are used to facilitate the transport of goods and to protect the product from damage during transportation.

The importance of packaging can be shown in the words of Meyers and Gerstman (2005), who support the aspect that nowadays and in addition to the four P's of marketing, product, place, price and promotion, two more P's: positioning and

packaging should be added. They add that brand positioning and packaging are two interrelated factors that support each other. For what is relevant to packaging, they state that it is its ability of communicating the positioning of the brand, of conveying the product's benefits to the consumer and of driving the final purchase decision at the point of sale that makes it so important, especially for retail marketing. In addition to the above, Denison and Cawthray (1999) cite, that the competitive environment at the point of sale has never been more aggressive and it is packaging that undertakes to convey the right message to the consumer.

In *Experimental Packaging* (2001), Mason states that contemporary packaging has to be harmonized with modern market conditions. For this reason, he adds that in order to be effective and stand successfully in the competition, packaging has to be:

- **Recognisable.** It is essential to make an immediate positive effect and remain in the consumer's memory. It should have attractive characteristics for what is relevant to its shape, colour or materials used and be instantly recognisable. A characteristic mostly acquired through advertising and marketing.
- **Informative.** The packaging should be able to provide information about the product included; a function that is more informative than the best TV commercial. It is one of the most difficult issues for a designer because it must necessarily appear and often carries a lot of space.
- **Textural.** The use of textured materials can give important competitive advantages to a product. The sense of touch can affect the buying decision and improve the product's attractiveness.
- **Functional.** The package should work just like the advertising said it would. Special form, holes, spouts etc. of the package, should offer the function that is described in the advertisement of the product.
- **Dependable.** Nowadays this tends to be the most important feature, especially for food sector. This aspect of packaging is the most familiar issue to consumers, albeit often not visible until a problem arises (Emblem 2000). Innovative forms of packaging (eg. Tetrapak) will in future replace the older and less reliable materials. A notable example is that of Earth Water International¹³

¹³Earth Water International is a bottled water company, which donates all of their net profits from the sale of Earth Water to the United Nations' UNHCR.

who substituted its PET bottles with environmental friendly Tetra Pak containers that are fully recyclable (White-Sax, 2008).

Underlining the importance of the visual characteristics of packaging Kalkowski (2012) states: *“When consumers make their buying decisions in a matter of seconds, they are hungry for the newest, brightest and most creative packaging to capture their attention.”*

An interesting aspect concerning packaging is cited in Waste Online (2005), which states that packaging innovations are strongly related with social and economic change. The continuous economic growth in the western world, that is translated in an on – going increase in consumer goods and the demand for more, new and innovative products, has boosted packaging operations and transformed them into a vital factor for the whole supply chain. The above can also be verified from the fact stated by the UK Packaging Federation (2002), that 70 – 80 percent of all packaging is used in the supply chains of consumer goods.

3.5. Packaging and logistics

There is an argument that packaging serves multiple logistics activities in the supply chain. Robertson (1990, cited by Stock and Lambert 2001) and Prendergast (1995), suggest that packaging performs the following logistics functions:

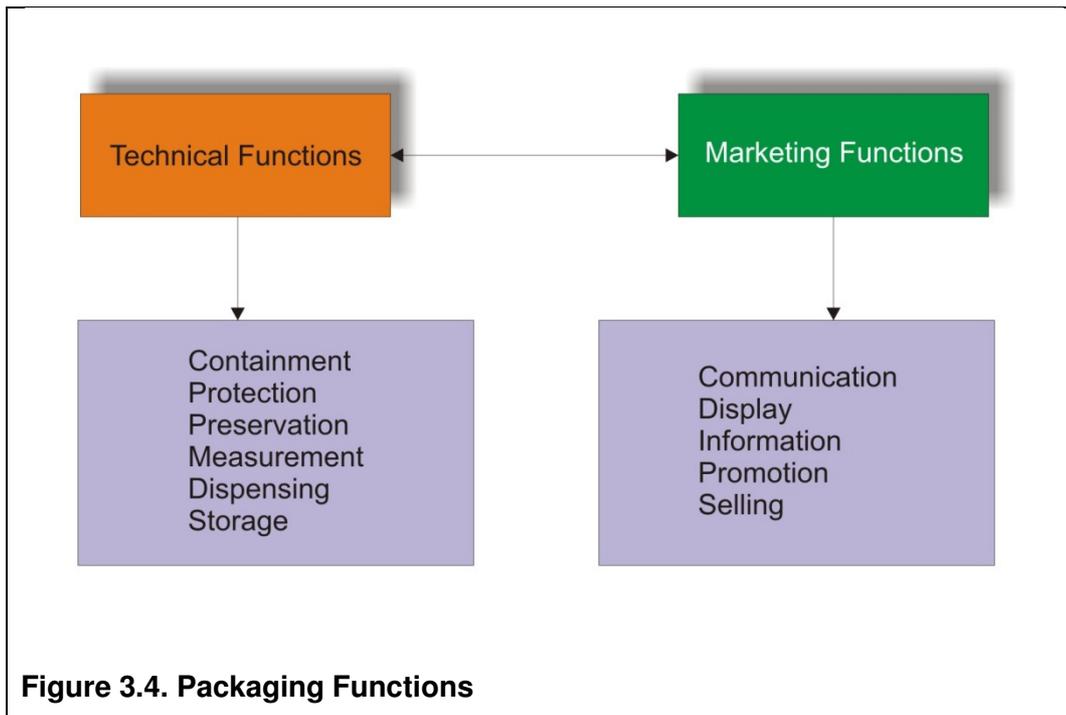
- **Containment and Protection.** It is essential for the products to be contained before their movement from one point to another. In this way the product is protected from damages or losses caused from environmental effects (moisture, dust, insects and contamination) and in the case of a hazardous material, the environment could be protected in the same way. Packaging protects the environment from the product and the product from the environment.
- **Apportionment.** Packaging enables output to be reduced from industrial production to a manageable, desirable, easy to use consumer size.
- **Unitization.** Primary packaging can be unitized into secondary packaging (e.g. by placing it inside a corrugated box). In a second step, individual units of secondary packaging can be put into a stretch wrapped pallet and finally this unit can be placed into a container that is loaded with several pallets. This helps to reduce the number of times a product must be handled.

- Convenience. Packaging facilitates the convenient use of products, saving time and reducing the effort of customers (e.g. blister packs, dispensers).
- Communication. Packaging communicates to various members of the distribution channel by allowing the use of plain and definite symbols such as the Universal Product Code.

In like manner, Murad (2012) supports that packaging aims to protect the contained product and promote it to the consumers. Moreover, an additional objective of packaging is to provide potential consumers with useful information, concerning the contained products, i.e. ingredients, storage temperature, day of production etc. In addition, packaging should provide convenience to the user, for e.g. closure with ease. Furthermore, elements such as the size, the shape or weight of packaging should promote its utilisation. For example, the consumer should be able to choose between a poke of salt (10kg) and a smaller packaging of 200gr, according to his needs. Finally, handling convenience is an important element of packaging's performance, which is strongly connected with the other two elements of facilitation and utilisation.

Ladipo and Olufayo (2011) describe the convenience that packaging offers to the consumer and cite the following customer needs that ought to be fulfilled. Packaging should be introduced in such weight, shape or size that facilitates its handling and storage. The above mentioned writers support that packaging should also facilitate the product's usage by providing functions such as easy opening and re-closing. Another important element is that it should also provide effortless dispensation. The use of innovations e.g. tear-tapes, pouring spouts and squeeze bottles, facilitate the use of the product by customers. Lastly, packaging should support easy preparation of the contained product e.g. frozen cauliflower or other packaged instant food products.

Soroka (1999) gave the following diagram, categorizing the different packaging functions (Figure 3.4.).



Source: Soroka, W. (1999) *Fundamentals of Packaging Technology*. The Institute of Packaging, UK

On the other hand, many researchers argue that packaging itself affects the environment in a negative way. For this reason, the packaging industry is making efforts to diminish, as much as possible, any harmful environmental impact of the packaging they use for their products. Lego's packaging policy makes a typical example towards this direction. As published on the Official Board Markets (2011), the company decided to reduce the overall packaging used in its products in order to become more environmental friendly.

As cited on the Daily Mail (2013), it is extremely critical to recycle all packaging used, due to environmental problems i.e. pollution, climate change and global warming. It is also strongly supported that all circulated packaging should be 100% recyclable, in order to promote recycling. However, as cited on Minami et.al. (2010), recycling and reverse logistics could prove to be not so environmental friendly since, as it was argued, the collection of packaging materials from the supply chain by the recyclers is time consuming, tedious and may further aggravate the environment with fuel emissions. For this reason, the notion of "packaging free" products is introduced. The main idea is to avoid selling products with packaging which after its use requires disposal. Instead, they should be sold by measure. However, this idea excludes consideration of a certain number of factors, such as product standardization, safety and consuming easiness.

According to MacIntosh (2012), refilled bottles are an alternative solution in reducing packaging volume, e.g. refillable soap dispensers. However, the above mentioned practice could be applied only to a limited range of products. Another option is to increase the packaging volume in order to provide better overall protection for the contained products, e.g. single servings packaged individually within a bigger pack in order to stay fresh for longer periods of time and avoid waste as well.

However, it should be underlined that, as described by Billings (2010), although consumers make demands for source conservation and waste reduction, they are attracted to luxurious designed packaging. This is a major contradiction since it gives evidence that although required, consuming behaviour is not always driven by environmentalism. Thus, the balance between a more sustainable packaging system and the individual marketing characteristics, such as luxury or convenience that the packaging used by a company should carry, is fragile.

Since, as shown above, packaging contains and protects the goods that a company moves and stores in the warehouse and furthermore allows the company to effectively use the transportation vehicle space (Coyle *et. al.* 2003), from a logistics perspective, the package, “*where possible, should be given the characteristics that help rather than hinder the logistics process*” (Rushton *et. al.* 2000).

As described by Yam (2009) the three environments in which packaging is called to function are the following:

- Physical Environment. Packaging should be designed to have all the adequate attributes in order to protect the contained product from physical conditions such as temperature, moisture, shock and vibration, falls and bumps etc.
- Ambient Environment. Packaging should provide an adequate level of barrier properties in order to protect the contained product from the negative impacts caused by oxygen, moisture, odors, molds bacteria, light etc.
- Human Environment. Packaging should be user-friendly and provide safety to the consumer. It should also be environmental-friendly due to increased environmental concerns and furthermore its design should comply with relevant environmental legislations and regulations. In addition it should be informative for the consumer providing useful information about the contained product (safety, right storage conditions, ingredients etc) in the local language.

As cited by Bowersox and Closs (1996), “*packaging affects the cost of every logistical activity*”:

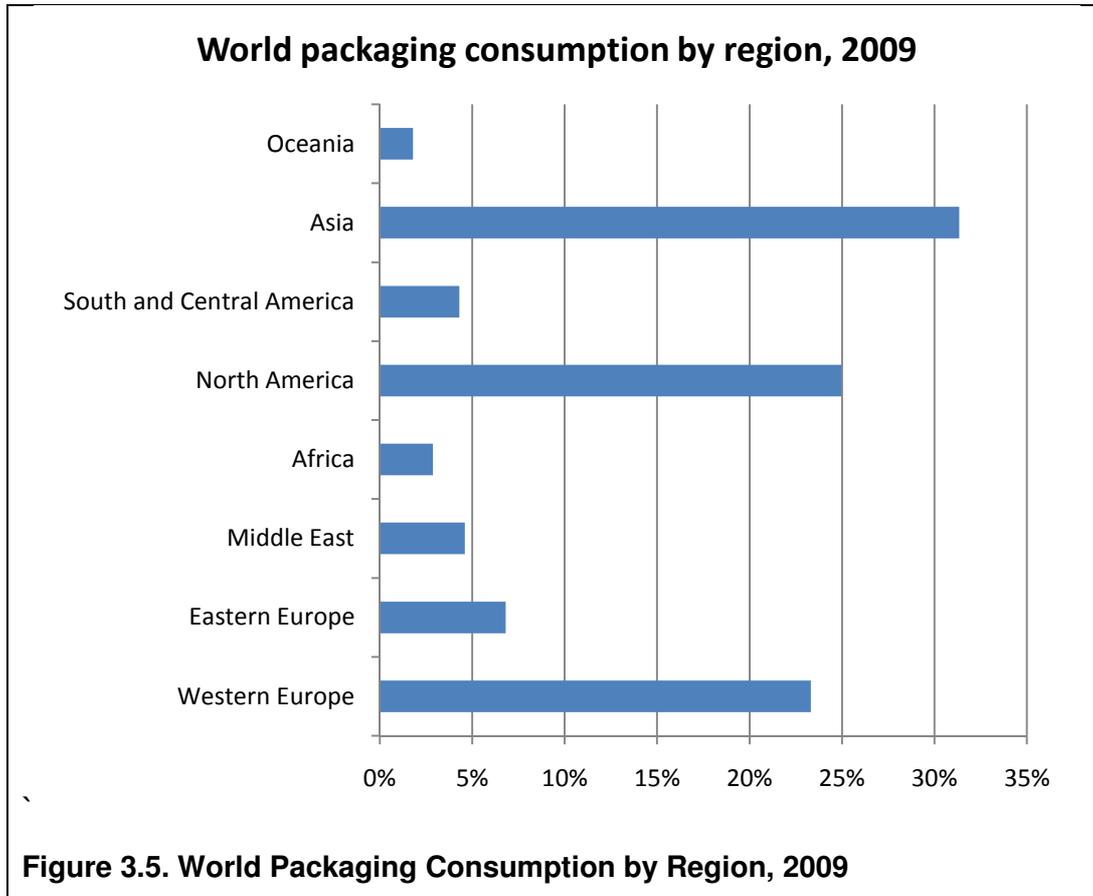
- Inventory Control. The accuracy of manual or automatic identification systems is influenced by the optimization of product’s packaging. By using a well optimised packaging inventory control is improved.
- Speed, accuracy and efficiency. Three factors affected by the convenience in package identification and handling ease.
- Handling cost, affected by the unitization capability and various techniques. By facilitating handling operations the cost remains low (e.g. by causing less damages) while at the same time the operation is quickened.
- Transportation and storage costs, influenced by package size and density. Packaging should comply with the various transportation and storage needs in order to reduce costs and facilitate the whole process.
- Customer Service. Customer satisfaction depends on packaging to achieve quality control during distribution, to provide useful information concerning handling, storage, ingredients etc. and to comply with environmental regulations.

In any case the industry should find new, alternative and more environmental ways of doing business. Packaging is a major field open to such changes. As described in Beverage Industry (2010) companies should be able to provide useful packaging solutions that would be both attractive for the consumers (fulfilling its marketing function) and environmental friendly (e.g. biodegradable, able to be recycled etc).

3.6. Packaging in numbers

The contribution of packaging to the quality of our lives and the profitability of companies can be shown in the data cited by the Association of Plastics Manufacturers in Europe (APME, 2001). APME states that thanks to good packaging, food wastage for example in Western Europe is only two to three percent, versus fifty percent in developing countries caused by inadequate packaging during storage and transit. Most of these losses are correlated with insufficient use of packaging. Furthermore, Charbonneau (2010) supports that good packaging can contribute in wastage reduction by providing the required protection to products during handling, transportation and storage.

A general view of the global consumer packaging consumption by continent for the year 2009 is shown in the following bar chart (Figure 3.5.).



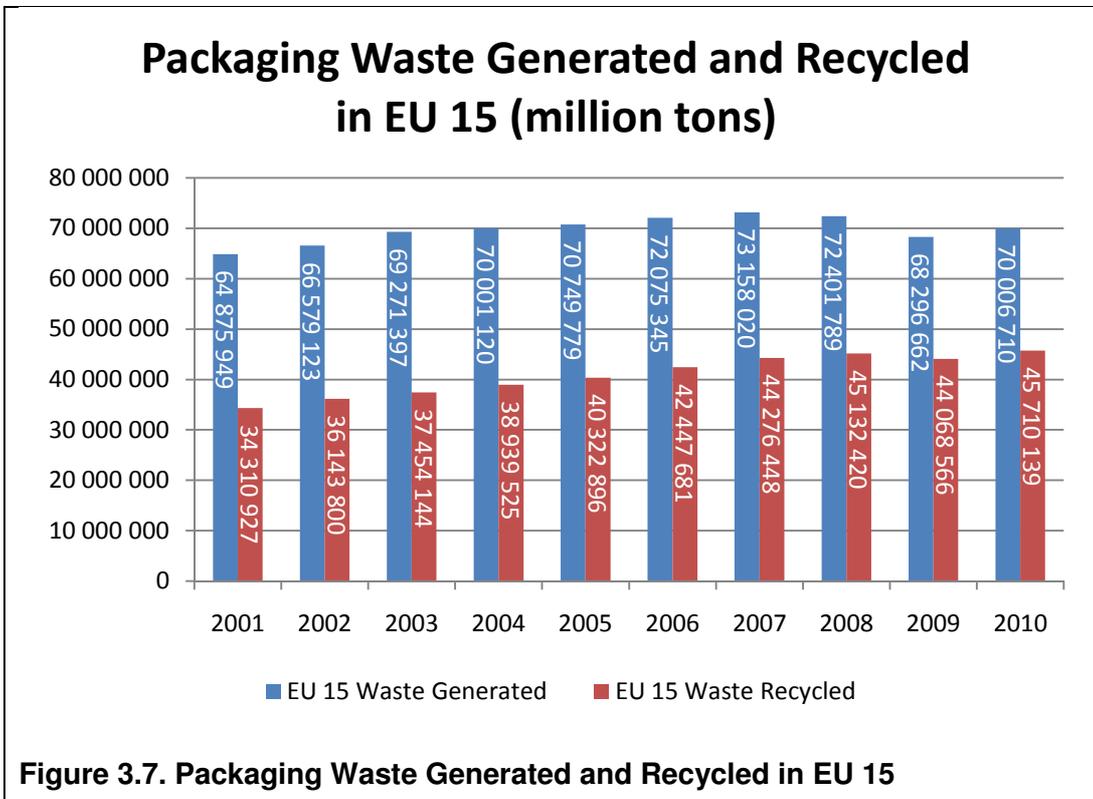
Source: World Packaging Organisation/Pira International Ltda. (2008), *Market Statistics and Future Trends in Global Packaging*

According to Eurostat (2013) in the EU 27 almost 80 million tons of packaging waste was generated for 2010 (~157kg/capita) while nearly 50 million tons (63%) were recycled. Similarly in the EU 15¹⁴ nearly 70 million tons of packaging waste was generated in the same period while 46 million tons (65%) were recycled (see Figures 3.6 and 3.7.)

¹⁴ Data concerning EU 15 are presented because comparing to EU 27 more annual data are available facilitating in this way the evaluation.



Source: Eurostat, Environment statistics (last updated: 25/01/13), see: Waste statistics (env_was), Waste streams (env_wasst), Packaging waste (env_waspac)



Source: Eurostat, Environment statistics (last updated: 25/01/13), see: Waste statistics (env_was), Waste streams (env_wasst), Packaging waste (env_waspac)

The top 15 national packaging markets in 2009, per capita in \$US is shown in Figure 3.8.

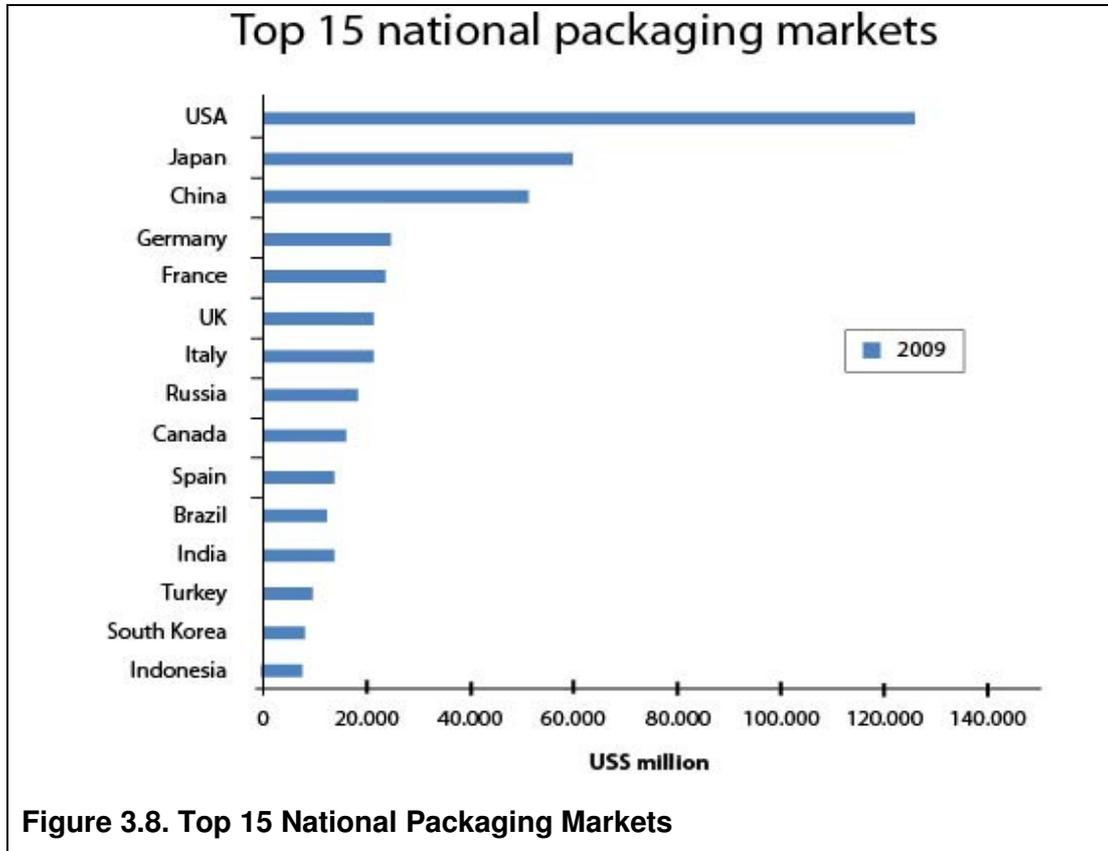


Figure 3.8. Top 15 National Packaging Markets

Source: World Packaging Organisation/Pira International Ltda. (2008) Market Statistics and Future Trends in Global Packaging

There is an augmentative tendency for packaging consumption in the whole world. According to the World Packaging Organisation and Pira International (2008) in 2004 the global packaging market was valued at \$ 459 billion (a 4 percent growth comparing to 2003) and in 2009 it reached \$ 564 billion, an increase of 4,5 percent annually.

The following Figure 3.9., shows the percentage of packaging waste in EU27 for 2010 (Eurostat, 2013). Table 3.2. shows the amount of waste packaging as given in the same source.



Source: Eurostat, Environment statistics (last updated: 25/01/13), see: Packaging waste (env_waspac)

Table 3.2. Detailed data on waste generated per packaging material

Packaging Material	Percentage	Waste in tonnes
Glass	20.3%	15,979,785
Paper, Cardboard	39.5%	31,054,823
Metal	5.8%	4,539,581
Plastics	18.9%	14,847,035
Wood	15.3%	12,010,350
Others	0.2%	240,849
Total	100%	78,672,423

Source: Eurostat, Environment statistics (last updated: 25/01/13), see: Packaging waste (env_waspac)

3.7. Packaging Choice, Nature and Cost

A common question that any manufacturing company who uses any kind of packaging has been called to answer is: “What sort of packaging should I use in

order to serve my needs in the best manner?”. Yet, according to Lambert *et al.* (1998) there are a number of questions concerning the product that should be initially answered:

- What is its nature? (fragile, perishable, hazardous)
- Does it have special dimensions or weight factors?
- Will it be unitised?
- Does it require controlled temperature during transit?
- What storage factor does the product have?
- Does it have limited self life?
- Does it have high value?
- What temperatures will the product be subject to during transit?
- What is the climate at destination?
- What risks are involved due to the nature and characteristics of the product? etc. (Appendix 4)

There is no doubt that it is a complex issue since it encompasses various marketing related, logistics related, warehousing related, and transportation related elements, all assembled under the cost related issue.

The importance of packaging and its relationship with other logistical activities, such as transportation, inventory, warehousing, and information technology, are presented below in Table 3.3.:

Table 3.3. Packaging and other logistical activities

Transportation	
Increased package information	Decreases shipment delays; decreases tracking of lost shipments.
Increased package protection	Decreases damage and theft in transit but increases package weight and transport costs.
Increased standardization	Decreases handling costs, vehicle waiting time for loading/unloading; increases modal choices for shipper and decreases need for specialized transport equipment.
Inventory	

Increased product protection	Decreases theft, damage, insurance; increases product availability (sales), increases product value and carrying costs.
------------------------------	---

Warehousing

Increased package information	Decreases order filling time, labor cost.
Increased product protection	Increases (stacking), but decreases cube utilization by increasing the size of the product dimensions.
Increased standardization	Decreases materials handling equipment costs.

Communications

Increased package information	Decreases other communications about the product such as telephone calls to track down lost shipments.
-------------------------------	--

Source: Professor Robert L. Cook, Department of Marketing and Hospitality Services Administration, Central Michigan University, Mt. Pleasant, MI, 1991

Because of its multiple role, packaging as part of the product itself (Denison and Cawthray, 1999), involves almost every part of a company which is forced to use it. The importance of this choice for what is relevant to marketing can be found in what Meyers and Gerstman (2005) claim, that buyers select products incited by what they see and read on the package. They also add that it is common for a buyer to judge the product by its packaging. As Muratoglu, vice president of marketing and product management at Tetra Pack Inc. supports: “... *packaging can serve as a point of differentiation and generate further value for consumers*” (Furhman, 2011). The previous aspect is coincident to that of Mohajerani, the Head of Fruits and Vegetable Union in Iran (Iran Daily, 2006) who cites that package’s purpose is not just to protect but it also “*presents the product and size in such a way as to create interest in the potential consumer or buyer.*” Moreover, according to Pellingra (2012) “*Packaging’s role is moving from just protecting the product and conveying information to differentiating the product by interacting directly with the consumer.*” This is a fact for all products and it is becoming a trend in the whole world. As cited by Orth (2004) even packaging of minor importance concerning its appearance such as egg boxes is evolving in an effort to differentiate the competition and attract the consumer. Hence,

as stated, these newly designed egg containers are advertising the product while communicating brand messages to the consumers¹⁵.

At a second level, the above marketing function of packaging should be combined with all the other –mainly- logistics functions and assist the solution that serves in the best way the needs of the company. Nobody should forget that the role of packaging on the enhancement and identification of a product is of the same importance with the protection of the product itself. In addition, in some instances packaging's scope is to protect the surrounding items from being damaged by the enclosed product (Wood *et. al.* 2002).

The shape and dimensions of packaging undoubtedly influence the cost of transportation and warehousing. Specialised computer software can be used to recommend a company, for the selection of primary, secondary or transport packaging, loading patterns of packaged goods on pallets, loading patterns of pallets on containers, ships, wagons etc. that could be used to maximize the area or cubic efficiency (of e.g. the container) and at the same time to meet other objectives such as the determination of the centre of gravity, the weight on axles etc.

Another factor influencing the choice of packaging is whether the product is destined for export or domestic distribution. This factor along with the type of transportation selected "*affects packaging requirements both for moving the finished product to the market and for the inbound materials*". For example the peculiar conditions of rail and water transportation usually require more stringent packaging because of the greater possibility of damage compared to air transport, where the shipment is less exposed to various weather conditions, to rough handling at a port, to the humidity of the oceans etc. (Coyle *et. al.* 2003).

On the other hand the choice of packaging materials is determined by factors such as the anticipated life of the pack, the popularity of the product, the need for repeated use, the desired product image and in addition by hygienic related factors such as the protection of the enclosed product (e.g. food) by light or moisture or e.g. from the legitimate level of migration of certain bacteria from the packaging into the product etc. (Emblem, 2000). In the same manner, according to Ladipo and Olufayo (2011) in order to sufficiently protect the product and prevent its degradation the following conditions need to be met: i) compatibility of packaging materials with the

¹⁵ Innovations include the use of recycled PET (Polyethylene terephthalate) or changes in the design of the common container made from moulded fibre. Except from the new marketing approach these changes provide better overall product protection and reduced breakage.

product itself, ii) protection of the product from moisture, gas and external odours and flavours and iii) protection from micro-organisms.

3.8. Package Design

According to Stock and Lambert (2001), the main factors for a good package design are the following:

- Standardization,
- Pricing,
- Product or package adaptability,
- Protective level,
- Handling ability,
- Product packability.

It should be noted that another important factor is the usability of packaging. Since the product itself might be useful or even essential for some people, it might be improper for others. According to Kemp (2011) for some products,

packaging should provide ease of use to the adults and at the same time avoid any accidental use of the product by children. It added that:

“The ideal pack is one that, through a combination of cognitive and physical capabilities, allows ease of access for adults, but remains strictly off-limits for minors.”

However, because of the increasing concerns, environmental friendliness such as recyclability and reusability of packaging are important design factors as well (Wood *et. al.*, 2002). Moreover companies such as Procter & Gamble in an effort to reduce packaging in its operations, is changing its products selling liquid detergents of double-strength concentrations reducing at the same time to half the size of its bottles (Business & the Environment with ISO 14000, 2007). In addition, because of the fact that nowadays the consumers are showing their willingness to buy environmental friendly or “green” products, the packaging industry is forced to follow



Figure 3.10. Corrugated box

Original Idea Source: INAMAR/ACE USA, viewed 11 May 2011, <www.inamarmarine.com/pdf/LossControl/Marks%20and%20Symbols.pdf>

this trend, substituting materials to satisfy and cover the needs of their customers¹⁶. Additionally, as cited by Young (2009) this trend has further advantages since for example the use of flexible, resealable containers apart from their lower weight appear to have –according to LCI¹⁷- lower energy consumption and greenhouse gas emissions compared to various packaging types.

However, it should be noted that sometimes the industry loses the balance between marketing, convenience and environmental protection. As cited in the South China Morning Post (2009) in an effort to attract potential customers, many publishing houses use excessive packaging for their samples in so far as sometimes the packaging weighs as much as the books that are contained. On the other hand Qing and Guirong (2012) describe that green packaging contributes to environmental protection by favouring the use of lighter, recyclable and in many cases biodegradable materials and preventing the use of non-ecological packaging. Furthermore, according to Richardson (2010) “...*lightweighting or reducing the weight of the pack, is a key strategy in sustainable packaging*”. Additionally, recent technological findings enable the production of plastics packaging with unique characteristics such as the need for less refrigeration and the ability to extend the shelf life of the contents (Wood, 2012).

At this point it is useful to determine the concept of a sustainable product. An analytical description is given by Lunati (2013):

- It is safe and healthy for the communities throughout its life cycle.
- It provides a rational combination between performance and cost.
- It is manufactured using “green” production technologies.
- Is composed by healthy materials throughout the life cycle.
- It is designed to optimize materials and energy.
- It is effectively recovered and processed in efficient and effective reverse channels.

¹⁶ According to a survey conducted in the United States (Young, 2008) most consumers believe that a manufacturer has more environmental responsibilities than the consumer. Moreover 85% of the respondents support that the industry should be responsible for the production of more environmental friendly packaging without pushing the cost generated by such an act to the final consumer.

¹⁷ LCI: US Life Cycle Inventory. Data collection portion of LCA (Life Cycle Assessment).

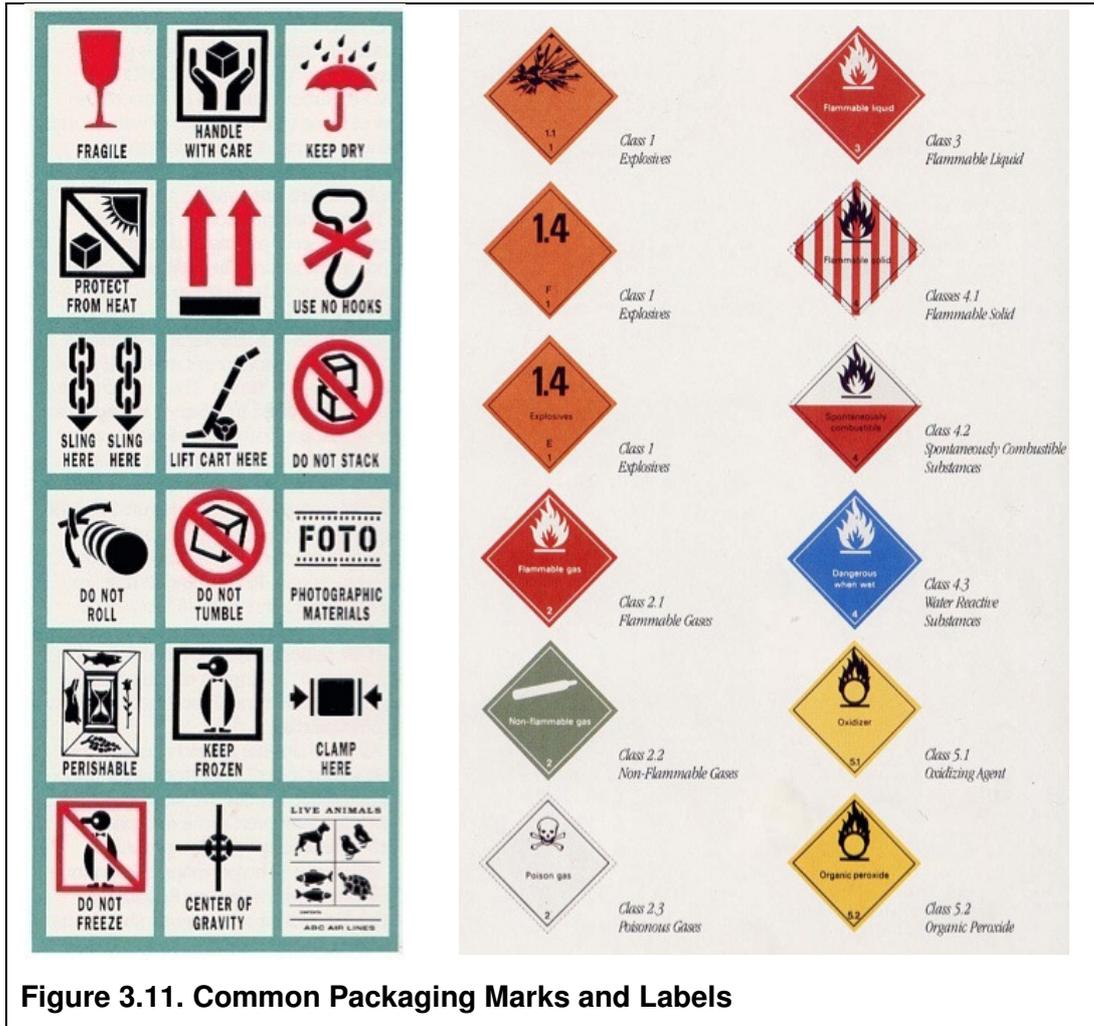


Figure 3.11. Common Packaging Marks and Labels

Source: INAMAR/ACE USA, viewed 11 May 2011, <www.inamarmarine.com/pdf/LossControl/Marks%20and%20Symbols.pdf>

Here, it is relevant to mention other factors such as the informative role of packaging (contents, language, handling instructions etc.) that should be taken into consideration or the increasing use of automations in warehousing systems (Figures 3.10 and 3.11). Such systems entail the optimisation of package design for the facilitation of handling operations or best use of place into warehouse facilities.

In addition, factors of great importance are the:

1. type,
2. size, and
3. length,

of the channel of distribution used by the company. In general, the possibilities of damage for global shipments are higher than domestic shipments. For this reason, global shipments require more or better packaging compared to the domestic ones (and in some cases the packaging should be redesigned from scratch), due to:

- the number of times products are handled,
- climate factors,
- possibilities of pilferage,
- local legislations, and
- customer's requirements.

As described by Bowersox and Closs (1996): “*the physical environment of a product is the logistical system*”. For this reason, package damage mainly results



Figure 3.12. Edge-boards with strapping

Source: Hellagro, viewed 12 May 2011, <<http://www.hellagro.gr/Product/43/Page/164/el/>>

from the movement, handling and storage operations. If a company owns the transportation operations then it controls the overall logistical environment. On the other hand, the use of external carriers increases the possibility of damage since the logistical environment is totally uncontrolled. In that case, the company may be compelled to

redesign at least one part of its packaging, using for example strapping, tie-downs, edge-boards etc. (See Figure 3.12)

In general, handling and movement operations throughout the supply chain (global or local) increase the possibility of damage such as:

- Mechanical shock, impact vibration, compression or abrasion,
- Environmental factors, humidity, pressure and temperature changes, light and other forms of radiation, contamination and exposure to air,
- Potential causes of damage including infestation or bacteria,
- Pilferage. (Rushton *et. al.* 2000)

However, from a marketing perspective, a matter of great importance that underlines the significance of the packaging design is the desired image of the product. Milton (1991) states that packaging can add value to the brand and strengthen the relationships between the customer and the retailer or manufacturer and adds that: “*the visual signals and codes that attract the consumer and affect an actual purchase must continue working in the home*”. Moreover, it should be noted that the image of the product's packaging is important and should stay attractive

during its usage as well. Rundh, (2009) supports that in many cases packages are so attractive that consumers keep using them as containers for other purposes long after their opening. On the other hand as Styling (2013) notes it is not unusual for many packages (due to hard usage) to become scratched and soiled over time, with spoiled labels and even faded brands.

It should be recognised that despite its vital role in the supply chain, the industry always tries to restrain packaging cost in order to keep the commercial profit intact. So the designer is pushed to keep a really fragile balance between packaging cost and efficiency, in an effort to get the most benefit with the lowest cost so that at last, packaging represents a small proportion of the overall unit cost of the product of which it is part (Mason, 2001).

3.9. Improper Packaging – Modern Life - Over packaged Products

As already mentioned in the Introduction, there are many cases where companies are “accused” of using excessive packaging, utilising unnecessary raw materials, aggravating in this way the environment by producing extra litter which in many cases could be avoided (Livingstone and Sparks, 1994).

Nevertheless, improper or inefficient packaging can have as a result higher costs due to handling difficulties and furthermore can reduce future sales due to various damages (ex. moisture, dust, contamination, breakage), caused to the product during transportation or handling (Coyle *et. al.* 2003). According to Behmanesh (Iran Daily, 2006), a lot of the high quality exported Iranian agro products, are wasted due to improper or low quality packaging. Wood *et. al.* (2002) harmonizing with the above aspect underline that ineligible packaging undermines the quality of the products and thus large amounts of food (and other goods as well) become unserviceable. In developing countries the use of improper packaging results in about 25-30% of packaging wastage in the supply chain (Dharmadhikari, 2012). According to Pellingra (2012) in the UK 1.2 million bananas per day are thrown away due to improper or missing packaging. On the other hand, using lighter packaging (meaning the use of less packaging materials) of lower quality doesn't help the environment either. Poulter (2010) supports that the effort of Tesco to minimize plastic usage in its bags resulted in bags of low quality and strength. This in turn has driven customers to double – up the bags (especially for heavy products) in order to avoid potential damage to the contents.

Global trade and different regional consumption habits emphasise the importance of packaging. The expansion of many companies to foreign markets (compared with the domestic markets where they used to trade), has increased the distances between the place of production and the point of consumption (Jahre and Hatteland, 2003). Combining this issue with the stock out costs that may occur because of improper packaging, requires export companies to use more efficient packaging for their products for the minimization of this danger.

Despite the fact that the penalty for being out of stock for the manufacturer or the retailer depends on many things (kind of product, consumption habits etc.) and is not ever stable, it has been observed that sometimes stockouts can cause customers to abstain from buying or search for the product elsewhere (Zinn and Liu, 2001).

Interesting studies in the field reveal significant losses for the manufacturer or the retailer due to stockouts. Results concerning four of these studies have been included in the following Table 3.4. Consumers decided to a) Substitute the item, b) Delay the purchase or c) Leave the store.

Table 3.4. Consumer response to stockouts in four studies of SDL behaviour (%)

	<i>1st Study</i>	<i>2nd Study</i>	<i>3rd Study</i>	<i>4th Study</i>
	<i>Progressive Grocer</i>	<i>Schary and Christopher</i>	<i>Emmelhainz et.al.</i>	<i>Walter and Grabner</i>
Substitute	48.8	22.2	36.0	83.4
Delay	24.0	29.8	25.0	02.5
Leave	28.2	47.9	39.0	14.1

Source: Zinn, W., Liu, P. (2001) 'Consumer response to retail stockouts' *Journal of Business Logistics* [online] Available at: < http://www.findarticles.com/p/articles/mi_qa3705/is_200101/ai_n8929220>

As Sheridan (1992) and Andel (1991) recognise a scholastic packaging investigation can offer significant cost advantages to a company that can be summarized to the following points:

- Lighter packaging may result in lower transportation costs.
- More protective packaging may reduce damage and requirements for special handling.
- Environmentally conscious packaging may save disposal costs and improve the company's image.

3.10. Packaging and the environment

3.10.1. Green or Environmental Friendly Packaging

At the beginning of 1990's, Milton (1991) stated that "*consumers are prepared to substitute performance benefits for environmental well-being, without expecting or demanding a reduction in product price*". Nowadays, on the contrary, according to Mitchell (2010) more and more shoppers are asking for innovations in packaging (e.g. packaging with press-to-close zippers or slider zippers applied) no matter if they have to pay more for this in order to both enhance convenience and provide a better overall protection for the contained product. These packaging innovations not only reduce the consumers' costs by providing a better overall protection of the product itself but at the same time affect the environment by preventing product waste or deterioration.

Throughout the years consumption habits have changed. The consumers are willing to protect the environment and "green" has become an everyday word. However, it is difficult to say if the consumers know exactly what "green" means or when a product is environmental friendly or not. And it is even more difficult for many of them, to define the environmental friendliness of a specific type of packaging. Supporting the above aspect Young (2008) states that even if they want to protect the environment, most shoppers lack knowledge on packaging materials and their environmental impact.

A number of questions, if asked by the consumer, could reveal this blurred area. For example, how does the consumer judge the "greenness" of the packaging?

- Based on the recyclability of the packaging?
- Based on the reusability of the packaging?
- Based on the manufacturing process of the packaging?
- Based on the materials used for the production of the packaging?
- Based on the ability of the packaging to be biodegradable or not?

There are more complicated issues on the environmental friendliness:

- What kind of protection does it offer to the products? Are there any product damages during handling or other logistics processes?
- Is the recycling process of the packaging (if it can be recycled) environmental friendly? What amount of natural resources is consumed during the recycling process?

All these questions encompass the general issues of packaging that are directly connected with the environment. Most of them are addressed below in Chapter 5 - Analysis & Discussion.

3.10.2. Alternative Packaging Materials

There are indications that the industry is seeking to find more environmental friendly ways of doing business. The substitution of some traditional packaging materials with other more ecological substances is indicative of this trend.

For example, Dell announced in November 2009 the use of packaging (for a specific product), made from bamboo, as an alternative to paper based packaging. The general idea behind this campaign was promoted as follows:

“This innovation is the latest expression of Dell’s commitment to minimizing its impact on the planet and making it easy for customers to do the same.” (See Figure 3.13.)



Figure 3.13. Dell’s new bamboo packaging

Source: Dell, viewed 12 May 2011, <<http://content.dell.com/us/en/corp/d/press-releases/2009-11-17-bamboo-cushions.aspx>>

Dell supports that bamboo is an ecological material because:

- It grows fast.
- It is strong.
- Easy on the environment. The plant’s deep root systems protect against land erosion, and when harvested correctly, it doesn’t require replanting after harvest.

Moreover, as cited by Azlan and David (2011), the use of natural fibres from renewable natural resources as biodegradable packaging materials is a new option.

As described, these new environmentally friendly materials could be used for the production of several types of packaging e.g. glass containers. It is also added that natural fibre materials have the following advantages:

- High specific strength and modulus.
- Low cost.
- Low density.
- Renewable nature.
- Biodegradability.
- Absence of associated health hazards.
- Easy fiber surface modification.
- Wide availability.
- Relative non abrasiveness.

In any case new materials and manufacturing techniques are expected to pave the way in the packaging industry. It is very likely that in the near future environmental protection is going to play a significant role and more and more biodegradable materials are going to be used in an effort to provide increased sustainability in the packaging sector.

3.11. Packaging Recovery Methods

3.11.1. Recycle

According to EPA (United States Environmental Protection Agency, 2009) recycle is defined as: *“Minimising waste generation by recovering and reprocessing usable products that might otherwise become waste (i.e. recycling of aluminum cans, paper, and bottles, etc.).”*

As environmental concerns grow recycling processes and practices are evolving in both developed and developing countries (Borchardt, 2009). As cited by Twede (2009) recycling of packaging materials has become more widespread compared with the other practices due to the increased danger for pollution provoked by land-filling or incineration. However, according to Gerretsen (Ontario’s Environment Minister, 2008) although nowadays people recycle more (compared to the past) at the same time they are consuming more. This fact underlines the need to boost environmental friendly practices in order to overcome the environmental problems generated by the increased demand for new products.

The following Figure 3.14. clearly points out the recycling of packaging waste by country in the EU:

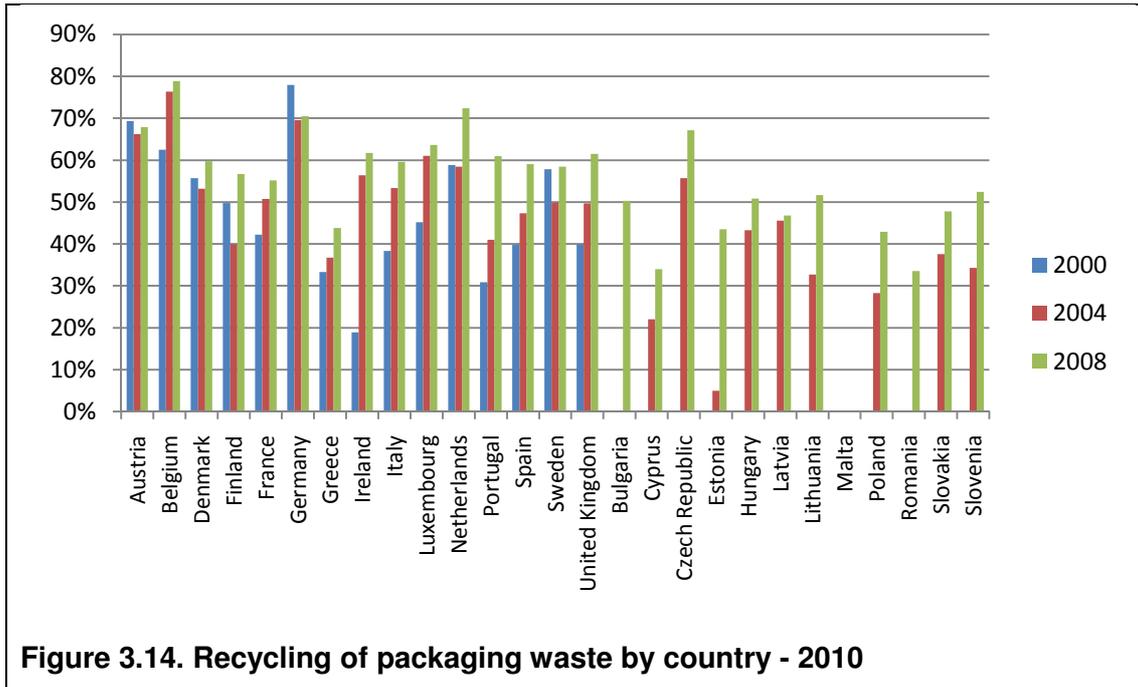


Figure 3.14. Recycling of packaging waste by country - 2010

European Environment Agency (EEA) , 2010, Recycling of packaging waste by country, [online: <http://www.eea.europa.eu/data-and-maps/figures/recycling-of-packaging-waste-by-country-2>]

In order to assist recycling, the industry has adopted packaging design techniques including:

- the design of packages for easier recyclability, and
- the use of recycled materials in packaging manufacturing (Selke, 2009).

In addition to the above, Smith and Pottier (2010) state that green efforts concerning packaging include not only the recyclability of packaging itself but the use of recycled materials as well. They also add that the shape of packaging and the maximum efficiency from the point of origin to the point of use is another important factor in an effort to reduce the environmental impact of packaging.

It should be noted that there is a strong association between the kind of packaging materials and the average recycling rates. Although the equivalence may change over time, paper packaging materials have the highest recycling rate, followed by aluminium and steel cans, glass containers and plastic packaging (Selke, 2009).

3.11.2. Reuse

As described by EPA (United States Environmental Protection Agency, 2009) reuse is defined as: *“The use of a product more than once in its same form for the same purpose or for different purposes, such as reusing a soft-drink bottle when it is*

returned to the bottling company for refilling, or reusing a coffee can as a container for nuts and bolts.”

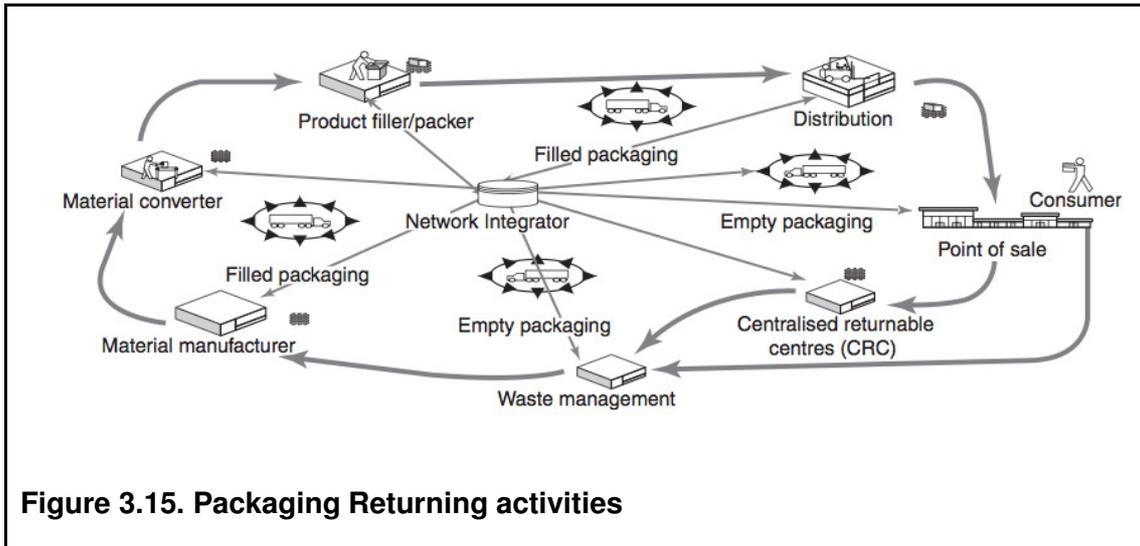
However, while from an environmental point of view, reusing containers is suggested, there is a main disadvantage in this process: If the container is not washed thoroughly and the previously carried contents contained various contaminants e.g. salmonella bacteria associated with poultry, this may contaminate wooden containers (Wood *et. al.*, 2002). As Gibson (2010) states nowadays the packaging industry is able to produce crates especially designed for multiple transits.

Another main disadvantage is that reusable containers are heavier than the one-way containers of the same material due to the fact that the reusable containers must withstand the return process (handling, transportation, washing etc). This means that more energy is needed and further environmental aggravation is caused during the land filling of the packaging at the end of its life (Mandel, 2009). In addition, as cited by Griff (2009) refillable containers are causing the following environmental problems:

- Water pollution from the washing process,
- Air pollution from less efficient truck usage (multiple returns), and
- Sanitation problems in both shops and homes caused by washing, or storage of the containers.

Twede (2009) states that from an economic point of view, packaging reuse is more costly compared to other practices because it is aggravated with sorting and return transportation costs. Moreover packages manufactured to be reused should be designed in order to ensure that they retain their properties and special characteristics during their life cycle (Bix *et. al.*, 2009).

A reusable packaging system is similar to the one presented below in Figure 3.15. After their use packages return from the point of sale to a centralised returnable centre (CRC) where they are collected, handled, washed and further processed for reuse (Dominic, 2009).



Source: *The Wiley Encyclopedia of Packaging Technology (2009)*. Third Edition. Edited by K. L. Yam. John Wiley & Sons, Inc., Hoboken, NJ, USA.

3.11.3. Incineration

As defined by EPA (United States Environmental Protection Agency, 2009) incineration is: *“The destruction of solid, liquid, or gaseous wastes by controlled burning at high temperatures. Hazardous organic compounds are converted to ash, carbon dioxide, and water. Burning destroys organics, reduces the volume of waste, and vaporizes water and other liquids the wastes may contain. The residue ash produced may contain some hazardous material, such as non-combustible heavy metals, concentrated from the original waste.”*

Incineration could also be used to produce energy through the heat generated during the process. However, this practice has serious disadvantages. According to Mandel (2009) the presence of some heavy metals (cadmium, lead) in the packages could leave toxic waste after the procedure of incineration. For example, as cited by Selke (2009) incineration of PVC (Polyvinyl Chloride) is thought to be harmful for the environment because of fear that the incineration of the specific material would lead to increased dioxin production.

For this reason and because of the other advantages of the incineration, countries such as the US have introduced relevant legislation prohibiting the use of lead, cadmium, mercury and hexavalent chromium into packaging materials while allowing it only in special circumstances (Selke, 2009).

However, the serious concerns on incineration restrict the method from being commonly accepted. The main idea behind the opposition to incineration is that:

“The best recovery of energy from waste is achieved by maximising re-use / recycling together with anaerobic digestion of food waste” (Western Mail, 2011).

3.12. Summary

Packaging is present and apparent, adjusting, improving and participating in our lives. The impressive growth that the packaging industry experienced during the 20th century was partly the result of the rapid development of new technologies and the discovery of new materials and approaches into using these materials for packaging purposes.

On the other hand industrial development has caused serious environmental implications forcing countries, governments, organisations, consumer associations and the industry to take serious action against environmental aggravation. One of the areas under investigation was the packaging field that in many cases was accused as a main environmental aggravator. Especially in the European Union, after several, earlier legislations, the 94/62 EC/EU Packaging and Packaging Waste Directive was adopted in an effort to force companies to operate in a more environmentally friendly way.

However, as logistics is a dynamic field incorporating interacting operations, the effort to restrict packaging’s impact on the environment provokes serious implications to the regularity of the system. Channels of distribution, modes of transport and transportation costs are all tied in with the packaging issue influencing decisions such as: the type of packaging, the chosen packaging materials, packaging design, the channels of distribution, the waste management approaches etc.

The different packaging materials available (the most popular being paper, plastic, glass and metal) are all having their own characteristics and attributes and are preferred in special circumstances against the others having at the same time different levels of environmental aggravation.

The different packaging recovery methods were also presented and briefly analysed above. Although the basic trend is to “reduce” the use of packaging where possible, the main methods namely recycle, reuse and incineration, are the main packaging recovery methods leaving landfill as the last possible solution. As successfully cited by Bix et. al. (2009):

“Recycling reprocesses the materials present into new forms. Incineration captures the energy released as the package is burned... Finally, packages may end up in the solid waste stream, where they are land-filled.”

A well – aimed comment by Wilson (2008) is that the role of packaging is to protect the products and extend shelf-life. For this reason, he adds *“a balance has to be found between making the pack fit for purpose, achieving brand recognition and minimising environmental impact”*.

This research investigates a number of issues which either have not been studied yet, or if they have, this has been without relevance to the Greek Market. Starting with the analysis of environmental legislations, this investigation makes a detailed analysis of the issue while focusing on the Greek market and its potential peculiarities. More specifically, it pays special attention to whatever is relevant to the assimilation of the pertinent legislation by the participants of the supply chain, i.e. suppliers, packaging manufacturers, industrial customers, wholesalers-retailers and final consumers, taking into account the potential barriers provoked by their implementation to the market and the competition, as well. Furthermore, this investigation covers a most significant issue, which is the push of cost generated by such legislations to the succeeding links of the supply chain, being under investigation. Thus, the present research offers an insight on these issues, while analysing the problems with relevance to the Greek market.

Moreover, the investigation holds a detailed analysis of the packaging redesigning process, focusing on secondary packaging. The methodology of the analysis creates the appropriate framework for conducting and evaluating the packaging redesigning process. This methodology however, could be easily adopted and adjusted to any form of packaging (e.g. primary or transportation), serving as a pattern for establishing a company’s redesigning strategy.

In addition, the overpackaging issue is not solely presented and described as a general theory or a wide industrial problem. It is being investigated through using both theoretic and laboratory methods, while the outcome is supported by strong experimental evidence. Here, once more, the investigation of the overpackaging issue is being focused on the secondary paper packaging which in turn can be adjusted to any form or packaging type.

Based on the data obtained by the questionnaires, the “reverse channel” issue is also investigated. The need for the establishment of a reverse channel of distribution, e.g. by governmental authority, is being investigated with relevance to

the Greek market. Regardless of what is the case in other countries, there is no evidence whether or not Greece makes a typical example of it. The data obtained however, gives evidence of this issue, underlining the reasons for the establishment or not of such a channel by an independent entity.

It should be mentioned that the literature on the packaging issue relevant to the Greek market is limited. Thus, the significance of the present study is that all of these aspects are studied in relation to the Greek actuality, thus enriching the packaging literature.

CHAPTER 4 – RESEARCH METHODOLOGY

4.1. Introduction

This chapter concentrates on providing an overview of the methodological approach used in this investigation. The supply chain used, the data collection method and the methodological approach for the definition of the sample for each link of the supply chain are thoroughly analysed. The design method related to the questionnaires is also described in detail.

This chapter is divided into five main sections. Section 4.2 introduces the theoretical background of Research Methods. Section 4.3 includes the description of the case study while the data collection method and the questionnaire methodology are described in 4.4. Section 4.5 presents the way that the questionnaires were sent and other methods used for the facilitation of data collection. The concept of minimization of bias in questionnaires is discussed in section 4.6. Section 4.7 explains in detail the sampling method followed for each link of the supply chain, providing information on the special circumstances occurring in each one of them. Finally, section 4.9 presents the main fields targeted by the individual questions included in the different questionnaires developed for each link of the packaging supply chain.

4.2. Research Methodology

In order to answer the research question, it is necessary to consider existing theoretical elements and current conditions in the real world (including operations, methods and knowledge). Yin (1984), cited that one of the most important factors in a research project is the combination of theory and real life and the way that the researcher finally succeeds to formulate theory, based on findings and results. For this reason, case study research of a general packaging supply chain, where there are multiple participants is being undertaken, since this method enables a more schematic and clear approach, allowing for a more in depth analysis and understanding of the research objective (Yin, 1994, Miles and Huberman, 1994). In addition, according to Saunders *et.al.* (2003), a case study approach is very useful in most cases, since it is likely to answer important questions such as what was the case study, the reason for selection and what actually happened in a very specific situation.

4.2.1. Inductive and Deductive methods

Before proceeding with the detailed research methodological analysis, it is interesting to examine the differences between the inductive and deductive methods. The main idea of the inductive method is to base the investigation on particular cases and not just on theory (Silverman and Marvasti, 2008). As Gray (2004) describes:

“Through the inductive approach, plans are made for data collection, after which the data are analysed to see if any patterns emerge that suggest relationships between variables. From these observations it may be possible to construct generalizations, relationships and even theories.”

In addition, Gray (2004) describes the following:

“The deductive approach moves towards hypothesis testing, after which the principle is confirmed, refuted or modified. These hypotheses present an assertion about two or more concepts that attempts to explain the relationship between them.”

In the same manner, according to Ruane (2005) a deductive approach is the method through which the researcher tests an established theory, whereas an inductive research tries to generate theory, based on the examination of empirical issues.

However, as Gray (2004) describes, these two methods i.e. inductive and deductive could also be combined when examining an issue. *“A researcher may turn a collection of data into a set of concepts, models or even theories (inductive approach) which are then tested through experimentation (deductive)”*.

Based on the above theoretical analysis, it is feasible to determine the nature of the methodology that was followed in the research. More specifically, this investigation is based on an inductive approach, since all parts analysed have been designed, developed and processed based on especially designed case studies.

The two aims in the present research, firstly, to provide an evaluation of the paper packaging issues in relation to the barriers generated by the implementation of the Packaging and Packaging Waste Directive (94/62/EU), and secondly, to provide alternative suggestions for a more sustainable Packaging Supply Chain, have both been investigated based on case studies. Lastly, it is important to

underline that a deductive approach, which requires hypothesis testing in order to confirm or reject a principle, has not been adopted in this research.

4.2.2. Qualitative and Quantitative approaches

The type of research used in an investigation is mostly determined by the research topic field and nature. However, qualitative and quantitative methods may be combined and the analysis may be based on both methods in an effort to enrich the outcomes and facilitate the data analysis and description.

According to Silverman and Marvasti (2008) qualitative research appears to be less flexible in terms of data processing and analysis compared to quantitative research. The main idea is that qualitative research allows the respondent to describe his thoughts since “open-ended” questions mainly used in this kind of research are more flexible compared to “always, never, sometimes”, “yes/no”, “many times, often, never” that are offered as possible answers to the quantitative kind of research.

According to many researchers a main weakness of qualitative research is that the conclusions drawn from the analysis are difficult to be appraised in terms of validity and reliability (Anfara, 2008). In a same manner Berg (2001) describes that quantitative methods are thought to be more accurate comparing to qualitative methods mainly because numbers are thought to be more precise comparing to “the meanings, concepts, definitions, characteristics, metaphors symbols and descriptions of things” (Berg 2001) that qualitative research contains.

In addition as Vanderstoep and Johnston (2009) point out, quantitative research is more about numbers and percentages about a case under study whereas qualitative research produces descriptions about a case under study. Maybe that is the main reason that according to Berg (2001) quantitative research is “more quickly accomplished” than qualitative research.

On the other hand as shown by Gray (2004) the sample size in qualitative research is relative small compared with the quantitative type of research where a large sample size is needed. In addition as Vanderstoep and Johnston (2009) state that despite the small sample size (e.g. 20 to 35 participants) and the lack of randomness in qualitative methods, a better understanding of the population under study is provided since “techniques such as interviews and focus groups allow the research participants to give very detailed and specific answers”.

An illustrated comparison of Qualitative and Quantitative approaches to research is shown in Table 4.1, where Figure 4.1 presents the Qualitative Approach and Figure 4.2 presents the Quantitative Approach. The main differences, the advantages and the disadvantages of the two methods are presented in Table 4.2.

Table 4.1. Comparison of Qualitative and Quantitative Approaches to Research

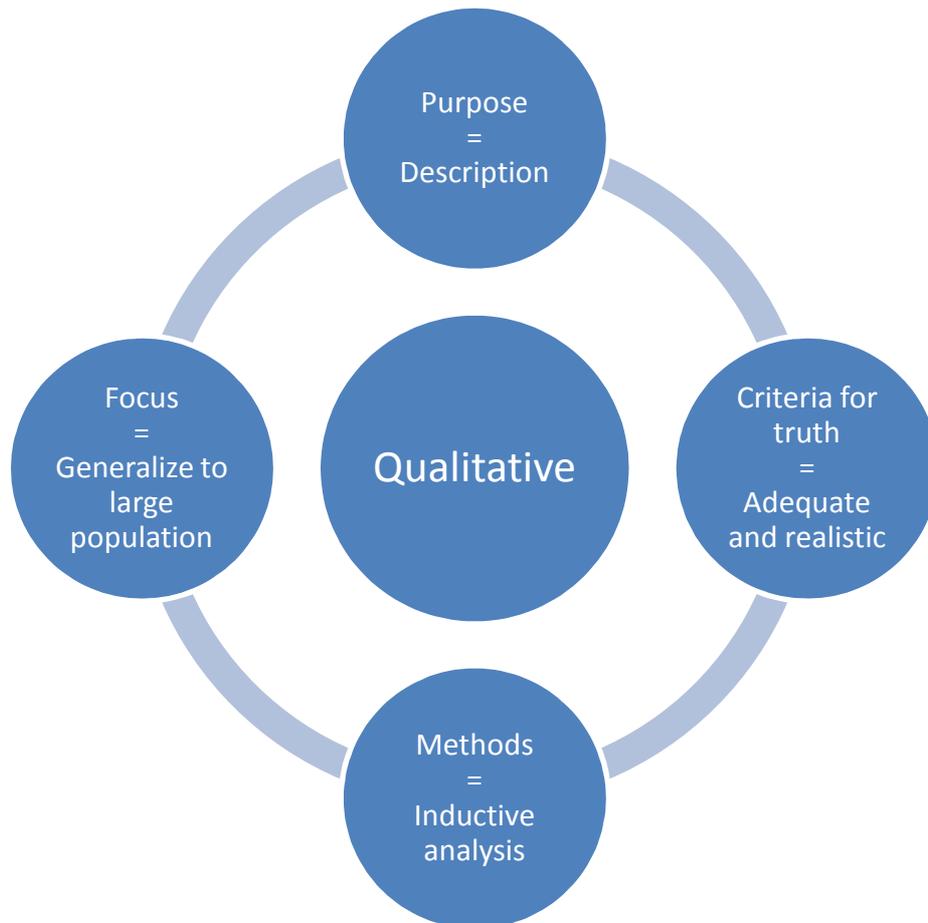


Figure 4.1. Qualitative Approach – The main purpose of it is to describe a given situation. In addition, it is mostly focused on large population while it tends to be adequate and realistic. The method used is an inductive analysis.

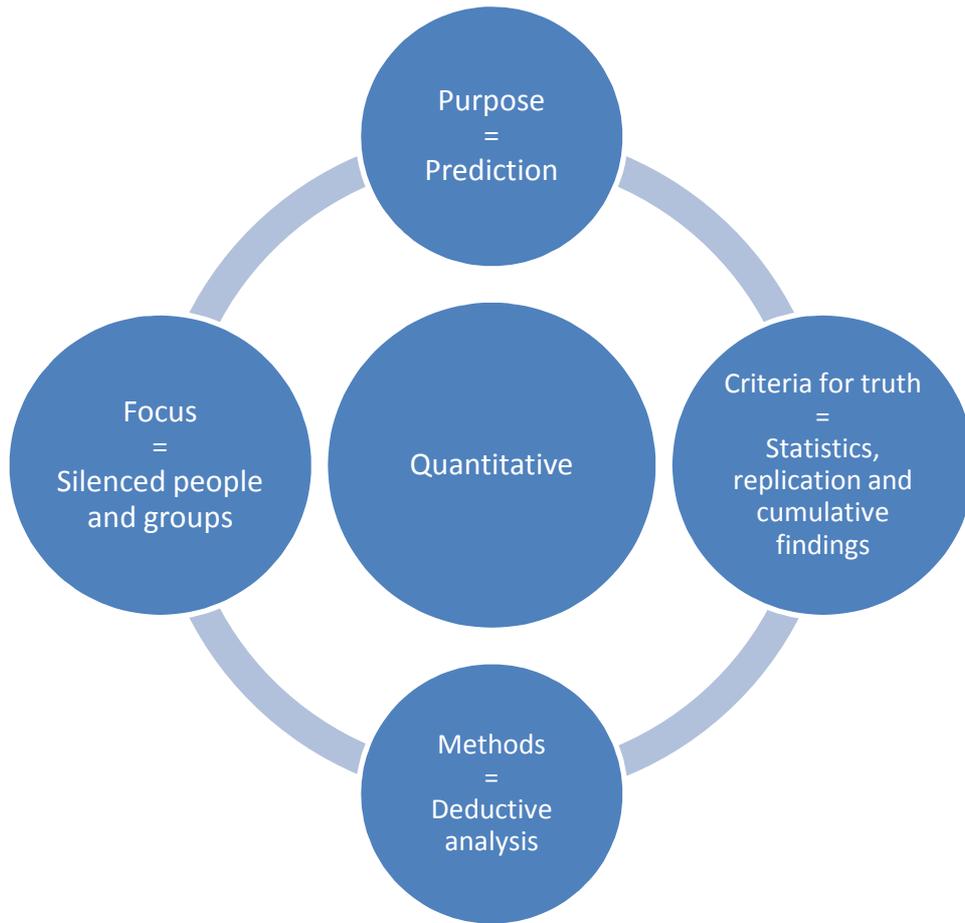


Figure 4.2. Quantitative Approach – The main purpose of it is to predict. It is mainly focused on people and groups while it uses statistics, replication and cumulative findings. The method used is a deductive analysis.

Adopted from: Vanderstoep and Johnston (2009), p.167

As Norum (2008) points out a main characteristic of qualitative research is its purpose to provide working understandings. At the same time while quantitative researchers can use several statistical tools (means, statistical tests etc) to describe or support particular findings, qualitative researchers need to use their analytical skills and evaluate the strengths of their findings (Vanderstoep and Johnston, 2009).

4.2.3. Case Study approach: Advantages and Disadvantages

Before exploring the Case Study concept it is useful to provide a definition in order to understand the nature of the method. According to Blatter (2008):

“A case study is a research approach in which one or a few instances of a phenomenon are studied in depth.”

Table 4.2. Quantitative versus Qualitative Research

Characteristic	Quantitative Research	Qualitative Research
Type of data	Phenomena are described numerically	Phenomena are described in a narrative fashion
Analysis	Descriptive and inferential statistics	Identification of major themes
Scope of inquiry	Specific questions or hypotheses	Broad, thematic concerns
Primary advantage	Large sample, statistical validity, accurately reflects the population	Rich, in-depth, narrative description of sample
Primary disadvantage	Superficial understanding of participants' thoughts and feelings	Small sample, not generalizable to the population at large

Adopted from: Vanderstoep and Johnston (2009), p.7

Berg (2001) argues that a common use of case studies is to act as a bridge between theoretical studies and practice. As Lundy (2008) describes this type of research provides an in-depth examination of a specific case (that could be a person, a group or an institution) or a phenomenon, seeking to provide further details and better understanding of the issue.

Here it is important to mention when a case study is used. As Gray (2004) states:

“The case study method is ideal when a ‘how’ or ‘why’ question is being asked about a contemporary set of events over which the researcher has no control.”

In a same manner, Yin (2004) supports that:

“The case study method is best applied when research addresses descriptive or explanatory questions and aims to produce a first-hand understanding of people and events.”

Vanderstoep and Johnston (2009) describe different types of case studies summarized as follows:

- Single case study which is based on the investigation of a single case.
- Collective case study which is based on a comparison of multiple related cases.

Furthermore, if a case study is focused:

- On one person – is called “biographical case study”.
- On one event – is called “critical incident study”.

An important characteristic of case study research is that it can be easily used to provide the ground for comparative analysis (Mills, 2008).

According to Yin (2003) there are main objections concerning the case study method. The three main problems pointed out by Yin (2003) are summarized below:

- Lack of rigour. Yin (2003) describes that case study strategy can become sloppy and follow non-systematic procedures.
- Scientific generalization can be difficult succeeded from the analysis of a single case or a single experiment.
- Case studies take too long to be completed.

However case studies have important advantages that make them strong tools when conducting an investigation. Blatter (2008) describes a number of advantages of the specific strategy. He describes that case studies consisted the major source of theoretical innovation. Furthermore, this type of research is usually characterized by descriptive goals although it implements causal questions as well. In addition, Blatter adds that the strategy provides an in-depth analysis and empirical completeness. Finally, the method can provide construct and internal validity advantages. This is because “case studies can use more and more diverse indicators for representing a theoretical concept and for securing the internal validity of causal inferences and/or theoretical interpretations for these cases.” Blatter (2008, p.69)

Another concept that needs to be specially considered and described is the research paradigm. In general, as described by Kuhn (1970) cited in Bates, (1999) a

field's paradigm: "...consists of the core body of theory and methodology of a field, along with an associated world view regarding the phenomena of interest to the field". (p.1043)

Cibangu (2010) describes paradigm as a philosophy; a set of aspects, viewpoints, experiences and perspectives used to confirm and certify a methodology for a given investigation. It should be noted that research paradigm is additionally used to determine research aims and priorities.

4.3. Case Selection and description

Multiple companies participating in a Greek packaging supply chain contributed to an understanding of the problems that occur or might occur in a packaging supply chain after the implementation of the Packaging and Packaging Waste Directive (94/62/EU). For this reason, the selected supply chain was divided into six different links: a)Suppliers, b)Packaging manufacturers, c)Industrial customers, d)Wholesalers, e)Retailers and f)Final Consumers (see Figure 4.3). The general characteristics of the companies and the individuals that participated in this research, are shown in Table 4.3.

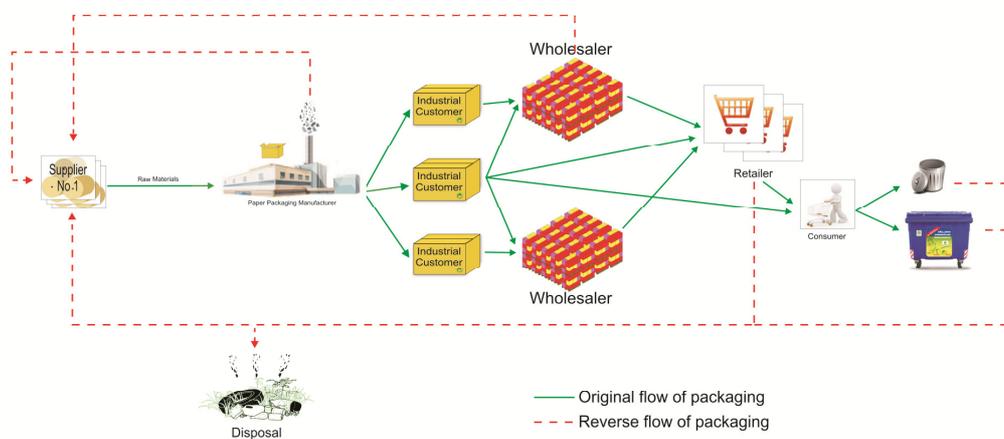


Figure 4.3. The packaging Supply Chain

Source: The author, “Georgakoudis”, 2011

It should be noted that for the various resources (e.g. ICAP) the size of the market (meaning the number of the companies activating in paper packaging field) is different from those presented as a sample size below. The main reason for this is that the main indicators describe the general situation in the market, including companies with similar but not identical products. Thus according these indicators,

the companies producing paper in the Greek market amount to 23. However, the companies that recycle and produce paper destined for use in the paper packaging sector under investigation are just 4.

In the same manner, based on the same indicators, the Paper Packaging Manufacturers appear to be more than 101. However, the companies that produce corrugated boxes in the Greek Market are 15, with just 8 of them operating in Northern Greece.

Table 4.3. General characteristics of the companies and the individuals that participated in the research

Sector	Population	Sample Size	Questionnaires Received	Interviews Carried Out	Participants Origin
Suppliers	4 ⁽ⁱ⁾	4	2	1	Greece
⁽ⁱ⁾ Due to the small number of companies producing recycled paper destined for use in the paper packaging sector in Greece, no sampling method was needed and the questionnaire was sent to all of these companies.					
Packaging Manufacturers	9 ⁽ⁱⁱ⁾	6	4	2	Greece
⁽ⁱⁱ⁾ Paper packaging manufacturers in Greece, consist of 38 companies while 14 of them operate in Central and Northern Greece. In Northern Greece, there are 9 companies producing corrugated paper packaging while only 6 of them own and operate their own corrugators.					
Industrial Customers	600 ⁽ⁱⁱⁱ⁾	104	89	8	Greece
⁽ⁱⁱⁱ⁾ According to Eurostat of the 95,303 manufacturing companies operating in Greece, 26% are located in Northern Greece, thus 24,800 companies. Of them, 600 companies consist of active Multi Pack's customers.					
Wholesalers - Retailers	306,000 ^(iv)	5	2	-	Greece
^(iv) According to Eurostat 306,000 wholesalers and retailers operate in Greece. The number of companies operating in Northern Greece is not specified.					
Consumers	n/a ^(v)	290	271	-	Greece
^(v) The number of final consumers cannot be specified.					
Total		411	368	11	

For the original investigation of each individual sector, a different number of companies were selected. Concerning the links of: Suppliers, Packaging Manufacturers, Industrial Customers and Wholesalers - Retailers, the sample was identified based on contacts from the sponsoring company: Multi - Pack S.A and the ICAP Companies Catalogue (2007). The sample design is thoroughly analysed later in this chapter. Questionnaires for each specific link were used as the main tool for data collection, since numerical results are relatively easy to analyse and tabulate.

The availability and access to the data was also an important factor, especially for companies that dominate the Greek market. During the research, it was noticed a hesitation and sometimes a refusal of the administrators to participate in studies, so in order to increase the participation of the companies to the research, the interviewees were assured for the confidentiality of the data.

It was noted the highest response rate of 93,45% was from final consumers (FC) (Chapter 5, Table 5.1b). They were selected randomly and were asked to complete the questionnaire in different grocery stores, spread all over the city of Thessaloniki. For a second stage, they were categorized by age, to understand if there were different perspectives, concerning economic-environmental matters.

4.4. Data Collection

4.4.1. Questionnaire Methodology

A questionnaire is an effective and useful research instrument in collecting data from various respondents and “one of the most widely used social research techniques” (Blaxter *et.al.*, 2006). Ruane (2005) states that “a questionnaire is a self-contained, self-administered instrument for asking questions” and that an adequately designed questionnaire can give the researcher the chance for data collection without the need to be in direct contact with the respondents. In addition, Brace (2004) supports that the questionnaire is the mean to acquire information on a subject, thus it can be described as “the medium of conversation between two people”. According to Jack and Clarke (1998) “*the questionnaire can be a cost-effective research tool for use in data collection*”.

Gray (2004, p187) provided the following definition:

“Questionnaires are research tools through which people are asked to respond to the same set of questions in a predetermined order.”

However the accomplishment of an investigation using a questionnaire depends on the successful selection of the variables and an adequate analysis of them. This means that the data collected should be statistically examined in such a way that would allow detecting possible associations and trends between the variables (Given, 2008).

In addition, Berg (2001) supports that the main advantage survey questionnaires offer is that –under some specific circumstances- could provide anonymity. It is described that although the researcher is acquainted with the respondents, their anonymity shall be retained, provided the questionnaires remain unsigned with no identifying marks when retrieved.

According to MacDonald and Headlam (2009) the main advantage of questionnaire surveys is their ability to gather a wide range of information from plenty of sources. In addition, questionnaires appear to be more economical advantageous compared to other types of research such as personal interviews that require time and pre-conducts with the interviewee. In addition, geographical restrictions do not seem to pose a serious hindrance for a questionnaire based survey. However as described in *The Dictionary of Human Geography* (2009), an issue that should be seriously considered, concerning the questionnaires in a survey, is that since the questions are asked from a specific perspective, the interviewer's presence (face to face or telephone interview) may affect the results, thus undermining the validity of the research.

In any case, questionnaires appear to have significant advantages, as well as disadvantages. However, as described above, for a questionnaire survey to be successful depends not only in the way it is structured but in the way it is processed as well, since basic rules should be followed in order to minimize any weaknesses and ensure the validity of the data collected.

4.4.2. Design of a Questionnaire

The structure and appearance of the questionnaire depends mainly on the method used and the objectives of the research. The method chosen in the present research was the completion of the questionnaire by respondents. The main advantages of this method, according to Gray (2004), are the following:

- Low cost in terms of both time and money.
- The collection of data is faster comparing to other methods.

- The sample can be widely spread.
- Respondents can complete the questionnaire at their own convenience.
- Respondents' anonymity can be assured.
- There is a lack of interviewer bias.

However, on the other hand:

- Some people find verbal communication easier than using written word.
- The researcher doesn't have the opportunity to provide further explanation.
- The respondents may leave some questions blank or give inaccurate answers.
- The researcher can't be sure for the identity of the respondent.

Other factors should also be considered during the design of a questionnaire.

Some of them are the following (Ruane, 2005):

- The wording of the questions and its impact on the results of the data that are going to be collected. The questions should be formulated in such a way in order not to affect the attitude (e.g. bringing the respondents in a defensive stance) and consequently the answers of the respondents.
- The way that the questionnaire is structured.
- The type of the questions – closed and open ended questions. The closed-ended questions provide the respondents with a number of pre-determined response alternatives, thus the researcher determines the framework in answering the questions. The open-ended questions are less limited, since the respondent is free to quote its unique answer.
- The length of the questionnaire in terms of the number of questions and the estimated time it will take to complete. According to Smith (1994) the longer the questionnaire the lower the response rate.
- The way that the questionnaire is delivered. Nowadays except from the traditional mail delivery, the development of electronic tools, such as e-mail, web pages etc. facilitates and speeds-up the research process for a relatively low cost. However, such tools need special care and meticulous development in order to assist and enrich the research process.

4.4.3. Level of Rigour

The types of questions used in all of the five different questionnaires are mainly closed and scaled. At the same time some open questions have been

included. As described above closed questions provide the interviewee with a) a pre-existed set of answers, b) multiple choice or c) ranking scale response options. In addition, closed questions give the advantages of:

- Easy answering.
- Faster response.
- Keeping the answers into a framework avoiding verbosity.

On the other hand, open questions give the interviewee the ability to put forward an opinion, and they are less leading than closed questions. A main advantage is that they can provide the researcher with useful information since the respondent is asked to describe their feelings without limitations.

In any case, the questions should be clear and easily understood by the interviewee. Special care should be given to the fact that the meaning of the questions should not be misleading for the interviewee, offensive or insulting, because in such a case the researcher may receive blank or incorrect answers.

The methodological design of a questionnaire is an essential step for successful research and quite a demanding process. According to Gendall (1998), each one of the questionnaire layers (question design, question wording and layout) cannot be isolated from the others but instead all of these elements should be combined in order to ensure regularity in the research process.

4.4.4. Bias in a questionnaire

The questionnaire should provide the researcher with responses as impartial as possible in order to ensure objectivity. In most of the cases, measurement contains a degree of measurement error. Two main forms of measurement errors are noise and bias. Both should be avoided.

Noise refers to an error in the measurement process that is non-patterned thus “there is no set direction to the error involved in the measurement process” (Ruane, 2005). This means that the measurement could either surpass or underestimate the true value.

On the other hand, bias refers to a patterned error in the measurement process where according to Ruane (2005), “the mistakes are consistently in one direction or the other and the error may be consistently overestimating or consistently underestimating a true value”.

In any case, the researcher should set the framework of the research methods in order to avoid –where possible- noise and bias in the analysis of the responses. The quality and the validity of the responses and at the same time the methods of analysis will be mainly affected by the way that a question is structured and the type of answer required. The most usual types of responses are the following:

- Open ended- where the interviewee is asked to describe their opinion without any indications or the restriction of lack of space.
- Category– where the interviewee is provided with a list of possible responses, such as: “What is the most important for you? :
 - Option 1
 - Option 2
 - Option 3
 - Option 4
- List- where the interviewee may select more than one from a list of responses.
- Ranking- where the respondent is asked to rank responses in order e.g. Put in order of importance the following cases (1 indicating the most important, 2 the next most important etc).
- Scale-Rating, for example: 1- Strongly Agree, 2- Agree, 3- Neutral, 4- Disagree, 5- Strongly Disagree.
- Forced choice, where the respondent is forced to make a choice between alternatives, for example: Yes/No. (Gray, 2004 and Gendall *et.al.*, 1991)

However, open-ended questions should be neutral in order to minimize bias into the findings of the research. Non-neutral questions may lead the respondents to answer in a different way regardless of how they think. In addition, since these questions allow the participants to respond in whatever way they choose, data are likely to be wide-ranging, complex and lengthy and for this reason could lead to bias, as the quality of the response depends on the subjective way that the researcher interprets the answer (Given, 2008).

In general, the lower the response rate in a survey, the higher the possibility of sampling bias since there is the risk of lower accuracy in the responses. For this reason, the following elements should be considered in designing the research in order to increase response rate:

- Send a compelling cover letter with the questionnaire explaining the purpose and the importance of the research.
- Formulate short and concise questions.
- Adopt an appealing layout for the questionnaire.
- Adopt a coherent organization of the questions.
- Judicious use of open ended questions.
- Provide clear instructions and advices on how each question should be completed.
- Keep contact with the delayed respondents by e-mail or telephone.
- Conduct a pilot survey, sending the questionnaire to a smaller sample before sending it to the final group of respondents, in order to test it and reveal its weaknesses. (Ruane, 2005 and Gray, 2004)

In addition to the above, Dillman (2007) cites a number of important elements that should be considered in the design of a questionnaire in order to increase the response rate. The researcher should try to:

- Make the questionnaire interesting and respondent – friendly e.g. including questions that are clear and easy to comprehend.
- Avoid embarrassment.
- Make questionnaires appear short and easy.
- Minimize requests to obtain personal information.
- Make the task appear important.
- In case of mail surveys, the researcher could include return envelopes with real first-class stamps.

After gathering the completed questionnaires, the data should be analysed using a specific method or a combination of methods in order to answer the research questions. On the one hand, it is easier for closed questions to be coded and analysed via software (e.g. SPSS) since a prompt list of possible answers is used. On the other hand, the coding process for open questions is more complicated and time consuming, since the questions need to be coded into a number of categories depending on how the respondents answer and what answers are being looked for (Brace, 2004). In general terms, the answers are going to be separated or categorized into a smaller number of groups determined by the researcher, in order to facilitate the analytical process. However, according to Reja *et.al.* (2003) open – ended questions have the disadvantage of producing more missing data compared to close-ended questions.

4.4.5. The Pilot Study

A good practice in order to evaluate the appropriateness of a questionnaire is to conduct a pilot study (Brace, 2004).

In this project, each one of the following four different questionnaires: Suppliers, Packaging Manufacturers, Industrial Customers, Wholesalers and Retailers, were piloted with four business managers, one for each type. For Final Consumers, 10 questionnaires -approximately 5% of the total sample-were piloted.

The questionnaires were tested in terms of wording, clarity, style, content, time needed to be completed and structure of questions. Based on the feedback obtained, the questionnaires were restructured and improved in order to facilitate and effectively improve the data collection process. Where needed the questions were edited and some open questions were replaced by closed questions, in order to reduce the time needed for the respondents to answer and to avoid ambiguous meanings. In some questions, further instructions were provided because the wording was found to be too complicated for the respondents to answer in a meaningful way.

4.5. Analysis of the Questionnaire Design Method

Questionnaires were sent to all companies and in some cases -where some elements needed some further investigation or clarification- semi-structured interviews with managers from the companies were used. For what is relevant to the consumers, a face-to-face approach was preferred in order to increase the response rate. This would ensure less misunderstanding, given that the consumers are not familiar with the research issue. For this reason, electronic and printed versions of the questionnaires were developed. Where needed, the electronic versions were sent by e-mail, together with an introductory letter. The introductory letter included information about the scope of the research, the time needed for completion and relevant contact details. In cases where the questionnaires were sent by e-mail, the respondents were asked to complete the questionnaire by putting an “X” into the appropriate box or write their comments where it was asked to describe their opinions. For the next step, they were asked to save the electronic file and return it by e-mail. The collection of data, lasted for five months, from September to December 2009.

Finally, the respondents were asked to tick a box in case they wanted to receive a summary of the results of the research. Furthermore, they were asked to mention the name of the company they represent and in addition to provide their names, although they were assured that their personal data were not going to be published for reasons of confidentiality. The names were important in order to ensure that any errors, mistakes or missed answers could be followed up.

The questionnaires (*both in printed and electronic form*) are presented in Appendix 1 and the introductory letter is presented in Appendix 2. A case study protocol, specifically designed for this research, helped to guide the data collection (Yin, 1994).

4.6. Minimization of Bias in a Questionnaire

As already discussed in Chapter 4.4.4 (Bias in a questionnaire), the questionnaires were designed following a number of rules, in order to avoid or at least minimise the possibility of noise and bias in the data collection process:

- A covering letter was sent with the questionnaire explaining the scope and the importance of the research.
- The questions were short and concise in an effort to be less complicated and tedious and they followed a logical and coherent sequence.
- Clear instructions and advice was provided to the interviewees on how each question should be completed.
- The interviewees were assured that their personal information would be kept confidential and for this reason there was no pressures by the researcher to obtain personal information.
- Open questions were used with special attention and economy and required no more than a phrase or two to be completed. In addition, in most of the cases, open questions followed specific closed questions, where the interviewees were asked to cite their opinions.
- The electronic editions of the questionnaires have been developed in Microsoft Word, because it is the most common used text editor. The questionnaires were locked just for completion and sent with an e-mail to the respondents.
- The five different questionnaires were tested using a pilot study in an effort to minimize problems, unclear areas, faults and imperfections before the conduction of the main study.

- After the collection of the data, the questionnaires were checked thoroughly for unanswered or missed questions. Where needed e.g. where the missed questions were thought to be due to inattention and not due to lack of knowledge, the respondents were given a further chance to complete the questionnaire.

4.7. Sample Surveys of Supply Chain Partners

The sampling method is not the same for all of the links due to the fact that the links that were included in the research are separate and combine their own characteristics and peculiarities. An inappropriate sampling frame and problems such as the hesitation or refusal of some companies to participate in the research could have caused systematic, non-compensating errors, which could not be eliminated or reduced by an increase in sample size (Moser and Kalton, 1971). In order to avoid not covering the population adequately, completely and accurately because of the above problems, a multi stage sampling design was selected.

The research targets businesses in Northern Greece. The main reason for this is a) the geographical vicinity with the Balkans (mainly with the countries that are not members of the European Union) and b) the relatively big distance from southern Greece, where the majority of the population is located.

The above two factors, add further costs to the industries of Northern Greece since on the one hand:

- these Greek companies strive to compete with companies from the other Balkan countries, that are taking advantage of a)the lower labour costs – compared to Greece- and b)the non-compliance with the European Directives, two factors that keep their costs down,

and on the other hand,

- the far distance from the main mass of the consumers in Southern Greece wipes out any competitive advantage.

In order to build the Supply Chain, several companies representing the different links were selected for the sample survey.

4.7.1. Link 1 : Suppliers

The suppliers¹⁸ are a small number of companies. There are four companies in Greece, producing recycled paper destined for use in the paper packaging sector. For this reason, no sampling design was needed and the questionnaire was sent to all of these companies.

Supplier 1 is one of the biggest companies producing paper in Greece. The annual turnover of the company for 2009 is nearly 22.000.000€. Founded in 1964, the company is based in Southern Greece and its activities are not restricted to the production of paper destined solely for the packaging sector but include the production of other kinds of paper, such as tissue paper. Furthermore, the company is one of the oldest in the specific sector in Greece and its participation has a special importance for the survey.

Supplier 2 is the newest paper producer in Greece. The company is based in Northern Greece, producing exclusively recycled paper. In addition it is the only paper recycling centre in Northern Greece. Its products are solely destined for use in packaging (corrugated boxes, paper bags etc).

Supplier 3 is a paper industry, producing packaging paper, corrugated board and carton boxes of all types. The company was founded in 1960 in Southern Greece.

The total paper production comes from 100% recycled raw material and is sold in the domestic market to other paper board enterprises or is used by the company. In addition, it produces certain Paper qualities for packaging (Crepe Paper).

The annual turnover of the company for 2009 is nearly 20.500.000€.

Supplier 4 was established in 1983 in Southern Greece. It specializes in the production of packaging papers, mainly for corrugated boxes, such as Unbleached Kraftliner, Semi-Kraftliner (TL1), Testliner (TL3) and Corrugating Medium. In addition, Kraft wrapping/packaging papers for shopping bags, fruit and bakery bags and envelopes, are produced. The annual turnover of the company for 2009 is nearly 7.000.000€.

¹⁸ The suppliers, are Greek companies producing recycled paper. Kraft paper is not produced in Greece, due to lack of resources.

4.7.2. Link 2: Paper (Corrugated) Packaging Manufacturers

The Paper Packaging Manufacturers in Greece, consist of 38 Companies, while 14 of them operate in Central and Northern Greece. In Northern Greece solely, there are 9 companies, producing corrugated paper packaging while only 6 of them own and operate their own corrugators (liners)¹⁹.

At this stage, questionnaires were sent to all companies of Northern Greece that operate their own corrugators without exception (6 companies), since the sample is small and specified. The reasons for this selection are the following:

1. the three packaging manufacturers that do not operate their own corrugators are being supplied with paper boards by the other companies owning corrugators, and
2. the companies that operate their own corrugators can supply the research with more representative data since they have a broader technical knowledge and a better and broader insight of the market.

¹⁹ A company owning a corrugator (liner) is able to transform paper into sheets of flat paper board. In a second stage, paper board is transformed into corrugated box.

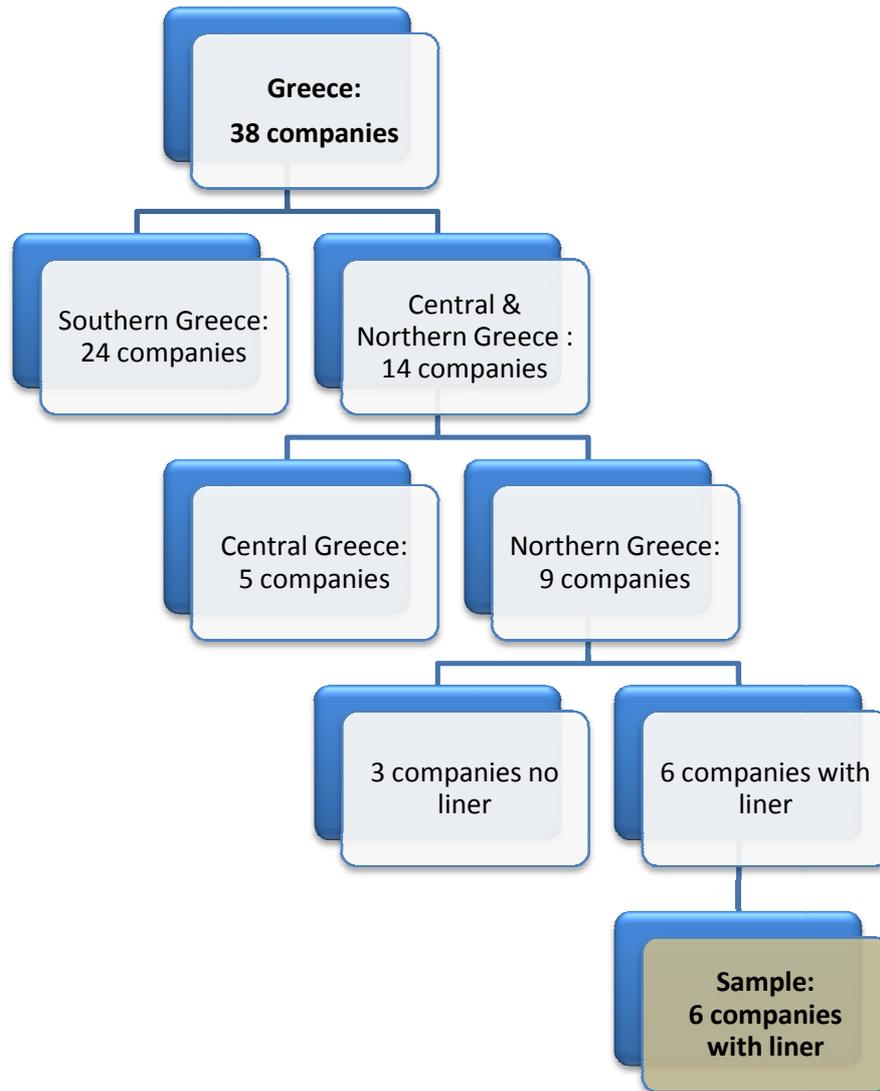


Figure 4.4. Paper Packaging Manufacturers Sample Design

For reasons of confidentiality, the names of the companies, are not going to be referred to the research. They consist of:

Manufacturer 1: Multi Pack S.A. is one of the oldest companies operating in Northern Greece with more than 30 years of existence. It is a small to middle sized company focusing mostly in the market of Northern Greece. The experience of the company in the field and furthermore its insight of the local market is thought to be of the most important factors for its participation in the survey.

The annual turnover of the company for 2010 was nearly 1.150.000€, 2011 ~ 1.100.000€ and 2012 ~ 1.290.000€.

Multi Pack’s manager (the researcher) provided all the necessary information for the conduct of this research. It should be mentioned that in order to complete this

research not only having a great deal of important information was urgent, but also the special knowledge on technical features, concerning paper corrugated packaging in general, as well as paper raw material (g/m^2 , technical strength, paper grades) and further information, relevant to the packaging design and overpackaging issue.

Manufacturer 2 is a middle to big company activating in Northern Greece with an annual turnover of 40.000.000€ for 2010. Its expansion during the last 20 years, with the establishment of two industries producing paper packaging, the big range of products and the coverage of the whole country as a supplier, classify the company as an important link for the investigation.

Manufacturer 3 is a middle to big company activating in Northern Greece with an annual turnover of 5.700.000€ for 2010. The evolution of the company during the last 15 years and its exporting activities, are strong elements for the inclusion of the company in the investigation.

Manufacturer 4 is a full-service supplier of packaging solutions and offers both transport and consumer packaging with an annual turnover of 43.500.000€ for 2010. The company owns 170 facilities in 21 countries.

Manufacturer 5 is a middle-sized company with more than 15 years of existence with an annual turnover of 10.700.000€ for 2010.

Manufacturer 6 is a small to middle sized company with an annual turnover of 2.200.000€ for 2010.

4.7.3. Link 3: Industrial Customers

Here, the sampling was done based on a stratified, three-stage sample.

Population

The sample was to cover the industrial customers that operate in Northern Greece and use any kind of corrugated paper packaging. An important question was if companies that operate in remote areas of Northern Greece should be included. Given that Northern Greece is usually mentioned as a united area with its unique characteristics, mostly influenced by elements such as the geographical proximity with countries that do not participate in the European Union (Albania, FYROM, Turkey) and the relatively big distance from the dense market of southern Greece, it was finally decided that any companies operating in Northern Greece, would have the same validity for the research study.

Sample Size

The sample size was fixed with regard to the available companies and the precision required in the analysis. The sample was stratified by several factors and spread over two sampling stages. The calculation of the necessary sample size was a very approximate one. It was agreed that the sample at this stage should be of the order of 80-90 companies. The actual number finally decided on, was determined mainly by the number of Multi Pack’s customers and the relatively limited time for when the survey should have been finished.

Based on previous experience, that the proportion of the selected sample returning replied questionnaires –taking into account the non–response rate- would be about 86%, an initial sample of 104 was selected. The actual proportion was 85,58% (there being 89 who successfully completed the questionnaires).

Type of design

The sample of the current link, was based on a multi-stage stratified design:

Table 4.4. The sample was based on a multi-stage stratified design

Stage	Sampling Unit	Stratification
I	Multi Packs’ Customers	
II	Administrative District	Geographical Region: Northern Greece

According to Eurostat, of the 95,303 manufacturing companies operating in Greece, ~26% are located in Northern Greece, thus ~24,800 companies. Of them, 600 companies, consist of active Multi Pack’s customers. Of the 600 companies, an amount of 17,3% thus 104 companies were selected, based on their packaging consumption volume. For this reason, the companies that have on average two orders per month were selected.

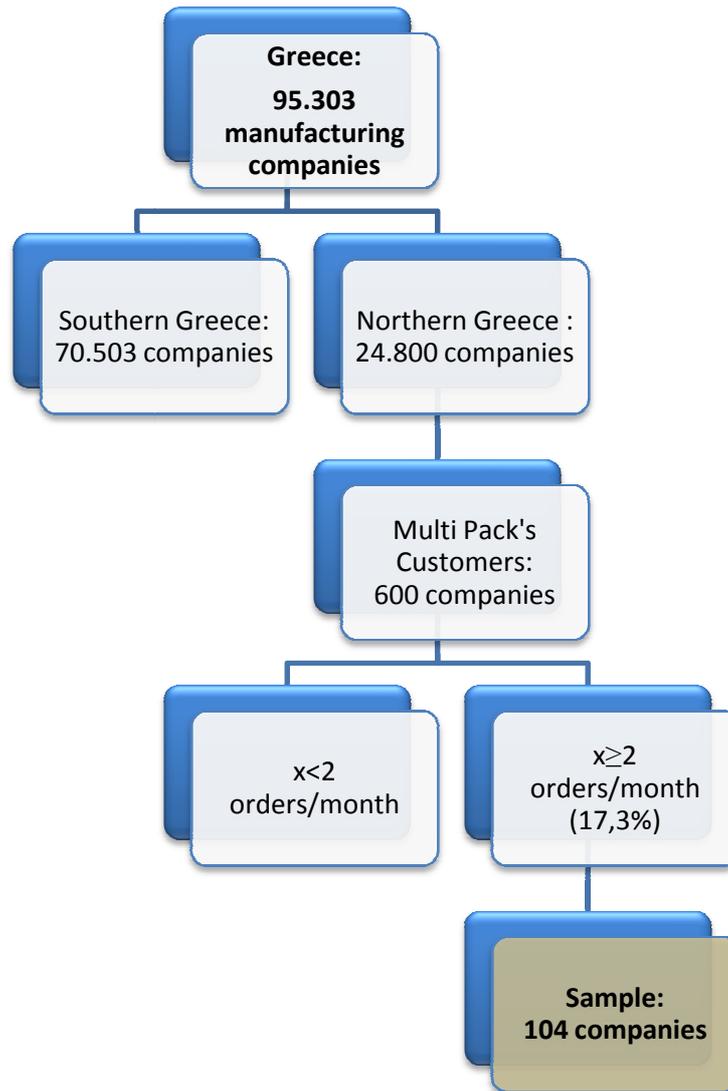


Figure 4.5. Industrial Customers Sample Design

4.7.4. Link 4: Wholesalers – Link 5: Retailers

Of the ~306,000 Wholesalers and Retailers that according to Eurostat operate in Greece, a small representative sample of:

- two Wholesalers, and
- three Retailers,

were selected to participate in the investigation. It was found to be too difficult to conduct this kind of companies due to the following reasons:

- Total unwillingness to participate to the investigation and provide answers and data.

- In addition, most of them were reluctant to provide detailed information through telephone contacts or to answer to electronic questionnaires. Instead, they suggested the researcher to arrange personal appointments with their managers. However, due to high distances it was found to be economic prohibitive to arrange meetings and make personal visits at their facilities.

4.7.5. Link 6: Final Consumers

Population

The population to be sampled consisted of consumers aged 18 and over in Northern Greece. The question immediately arose whether remote areas -such as Florina and Kastoria (in the West) and Alexandroupoli and Komotini (in the East)- should be included. Interviewing in such areas is time-consuming and the cost tends to be disproportionately high, compared to the value of the results.

For all these reasons, the city of Thessaloniki was selected as the main area of investigation since it combines the following elements:

- a) It is the second biggest city in Greece and the biggest city of Northern Greece.
- b) It brings together people coming from smaller cities/towns or villages of Greece thus people with different cultural backgrounds.
- c) Its residents comprise of people coming from different economic backgrounds.

The sampling of the Final Consumers, was totally random. The investigation time was divided into three Saturday mornings. In each one, three different interviewers²⁰ were based in two different big grocery markets. In total, the interviewers visited 18 different places. The investigation was not focused in a specific area of the city of Thessaloniki, but instead the following areas were visited: Kalamaria, Depot, Center, Ksirokrini, Evosmos, Stavroupoli, Neapoli, Polichni, Kordelio, Menemeni, Meteora, Efkarpia, Retziki, Panorama, Pylaia, Toumpa and Charilaou, covering in this way most areas of the city. This spread was necessary, in order to ensure the full participation of people, coming from different economic levels.

The main duties of the two research assistants was to approach the final consumers and persuade them to participate in the research. Although the

²⁰ Georgakoudis Elias, Dr. Michaleas Antonios, Tsemekidis Konstantinos

researcher had previously provided the assistants with information on how to answer specific questions that might come from the final consumers, the assistants fed back no problems or misunderstandings by the consumers. The contribution of the two assistants to the research proved to be significant since it saved time for the researcher, speeding up the whole process.



Figure 4.6. City of Thessaloniki: Areas where the investigation was carried out

Sample Size

Undoubtedly, price is a very important factor in buying a product although it is not the most important factor for all the consumers and in every buying decision. The type of the product itself influences the relevance of the price with the final buying decision of the consumer. According to the Farmers Guardian, a survey carried out by BBC's Countryfile programme (In Brief, 2012), showed that 92% of the respondents felt price as the most important factor when buying food.

On the other hand, according to Bohem (2007) price was the main factor in buying technology products for only 23% of the respondents, followed by quality (21%), brand (11%), recommendations from sales associates (15%) etc.

Based on the Greek experience, price is very important when it comes to every day products. According to a survey carried out in Greece in 2009 by the General Secretariat for Consumers (2009), nearly seventy percent of the consumers underline price as one of the most important factors in which they base their buying decisions. Nowadays, this fact is further strengthened by the difficult economic conditions occurring in the country, influencing the life of the Greek citizens.

For all the previous reasons, the size of the sample was determined based on the assumption that the most common factor affecting the buying decisions of the consumers is price. It was expected that a very high percentage of the respondents (80%) would think of price as the most important factor in buying a product.

So, in order to estimate the proportion of π in the population who think of price as the most important factor in their buying decisions, the standard error of the estimator is:

$$S.E.(p) = \sqrt{\left(1 - \frac{n}{N}\right) \frac{\pi(1 - \pi)}{n}}$$

Then

$$S.E.(p) = \sqrt{\frac{\pi(1 - \pi)}{n}}$$

And inverting this formula, we obtain:

$$n = \frac{\pi(1 - \pi)}{[S.E.(p)]^2}$$

So, it is expected that (π) 80% of the consumers would think of price, as the most important factor in buying a product²¹ and a standard error of more than 2,5% would be undesirable, then the required sample size is $n=256$ (Moser and Kalton, 1971).

$$n = \frac{0,8(1 - 0,8)}{0,025^2} = \frac{0,16}{0,000625} = 256$$

Because of the fact that the sample size is small in comparison with the population size N (the sample of 256 people, represents the 0,0213% of the approximately 1.200.000 population of Thessaloniki), there is no need to use a finite population correction factor (fpc). The f.p.c. factor is used to define both the standard error of the mean and the standard error of the proportion when the sample size is big in comparison with the population size N and the finite population correction factor would not be negligible. In this case, the following equation would reduce the initial estimate to the most appropriate sample size, that would have given the required degree of precision.

$$n' = \frac{n}{1 + \left(\frac{n}{N}\right)}$$

²¹ Further details on the specific issue can be found in Chapter 5.7.3 – Summary of the Questionnaires: Final Consumers (FC).

The sample was selected randomly, in order to ensure the validity of the data. The sample consists of 271 people, giving a slightly smaller standard error of 2,4%:

$$n = \frac{\pi(1 - \pi)}{[S.E.(p)]^2} \Rightarrow 271 = \frac{0,8(1 - 0,8)}{[S.E.(p)]^2} \Rightarrow [S.E.(p)]^2 = \frac{0,16}{271} \Rightarrow$$

$$[S.E.(p)] = \sqrt{0,000590} \Rightarrow [S.E.(p)] = 0,024$$

Of the respondents, 148 (54,6%) were female and 123 (45,4%) were male. The predominance of the women in the sample was expected because of the day and the places where the investigation was carried out.

4.8. Sample Size and Response Rate

The gathering of questionnaires was probably the most difficult part at this stage. The convincing of companies and final consumers to fully and accurately complete the questionnaires providing the research with useful data was a complicated process.

The information about the response rate will be provided in Chapter 5.2.2.

4.9. Questionnaires

Five different questionnaires were developed, in order to cover the five segments of the supply chain. The questionnaires (*both in printed and electronic form*) are presented in Appendix 1.

The questions targeted three main fields while a fourth one was derived from the combination of these three fields:

1. Environmental: focused in revealing specific details, concerning:
 - packaging volume circulated in the supply chain,
 - the most preferred packaging material by the industry,
 - procedures undertaken after the use of packaging,
 - the way in which used packaging was transported to its final destination, for example the recycling centers or the dump.

The environment is a significant issue related to first aim of this investigation (Chapter 1.2 – Research Aims and Objectives). Aim 1 is seeking to provide an

evaluation of the paper packaging issues and for this reason it is necessary to investigate the role and importance of paper packaging in the supply chain and furthermore to examine the way in which the paper packaging materials aggravate the environment. It is also important to examine the current recycling procedures and to discuss the need for the establishment of a reverse channel of distribution for paper packaging materials. It is also relevant to investigate the demand for environmental friendly packaging from a final consumer perspective.

2. Economic: focusing on the extra cost that the Directive generates and the push of that cost, from the industry to the final consumer.

The economic consequences derived from the implementation of the Directive 94/62 EC/EU is a main issue addressed by Aim 1. One of its primary objectives is to evaluate the extent to which the current directive affects or might affect the prices of the packaged products in Greece.

3. The different levels of acceptance of the Directive, in the different investigated sectors, since each one of them had its own reasons in accepting or rejecting the possible positive consequences of its implementation.

The level of acceptance of the directive in Greece is investigated and discussed. In addition, the combination of the data derived from the investigation of the above three fields targeted by the questionnaires fulfils one more objective of Aim 1 that is to provide an in-depth analysis of the role and performance of paper packaging in the Greek market.

4. The increased competitive advantages of products imported from countries outside of the European Union, where they are not forced to pay for environmental measures. This issue, generates a serious obstacle concerning the preference of the domestic – European products compared to the imported from countries such as China.

This very last issue, although not directly investigated, is discussed based on the analysis of the data collected from the Final Consumers link. A question addressing the consuming habits of the final consumers evaluates the dangers generated in the free economy where different laws, directives, legislations are active, creating various obstacles or disproportionate advantages to some of the products under circulation.

4.10. The Role of the Researcher

A significant peculiarity of the research is the dual role of the researcher. Except for being the conductor of the research, at the same time he was an employee at the company that provided assistance for the investigation i.e. Multi Pack S.A. The researcher was required to keep the balance between his professional experience and the academic perspective of the research.

In such cases, bias is an inevitable effect. However, in an effort to be as independent as possible during the conduct of the investigation the researcher decided to follow specific and predetermined methodology on the issues. For each one of the issues examined, where possible, the researcher tried to triangulate the data and the outcomes in order to minimise its own bias that may have come from his own experience and inadvertent impact.

In addition, the researcher avoided using just his own knowledge of the overpackaging and the redesigning issues during the investigation. Instead, he worked with other departments such as the production, the warehousing and the marketing departments of the company in an effort to acquire data and enrich his knowledge with different management approaches. By following this specific procedure the researcher ensured the accuracy of the results especially of those connected with technical procedures and practices.

4.11. The Greek Packaging Context

During the 1980's and 1990's, Greece as a member state of the European Union benefited from the favorable economic circumstances occurring in Europe. The packaging industry in Greece followed this economic development. Several sources reveal that packaging waste generated in Greece during the period 1997-2010 showed an upward trend. This fact denotes the development mentioned above.

A detailed part regarding the Greek context, in relation to the package industry, is considered in Chapter 1, in the paragraph entitled: "The Greek Packaging Market", at pages 19-28.

4.12. Summary

The methodological approach used in this investigation is analysed in detail in this chapter. The selection of the case and the description of the supply chain developed are also described in detail. Furthermore, the individual characteristics of the participants and the way that the different questionnaires (one for each of the links) were developed are also presented and discussed. Special focus has been given to the way that the sample was structured and specified for each one of the different links.

Theoretical elements behind the methodology used in the investigation such as inductive and deductive methods, a comparison between qualitative and quantitative approaches, advantages and disadvantages of using a case study, level of rigour and bias in a questionnaire, are all discussed in this chapter.

CHAPTER 5 – ANALYSIS AND DISCUSSION

5.1. Introduction

This chapter concentrates on the analysis and discussion of the data collected from the different links of the supply chain. The various questionnaires developed for the links of the supply chain are presented and further analysed. The results are then discussed providing an overview of the investigation and an understanding of the general framework of the research.

5.2. Analysis and Discussion

After the collection of the data, the questionnaires were scanned and checked for omissions. For the next step, the data were recorded into SPSS for further analysis. Some of the questions, such as the company name or the names of the individual consumers, were not included since they were not subject for analysis and furthermore the respondents were assured that their anonymity was going to be protected.

All the remaining questions were included in the analysis since they measured the subjective opinions and aspects of the respondents on specific issues asking them to rate and rank their responses. The results of the questionnaires apply to the last four months of 2009: September, October, November and December.

5.2.1. Questionnaires: Detailed analysis

In order to analyse each one of the questionnaires, the significance of the questions included and to simplify the research process, the sectors were coded as presented in Table 5.1a. Thus for example, when referring to question C4, this is the 4th question of the questionnaire designed to be answered by the final consumers. The questionnaires are presented in Appendix 1.

Table 5.1a. - Coding the questions

Sector	Code	Number of Questions
Suppliers	S	14

Packaging Manufacturers	PM	12
Industrial Customers	IC	14
Wholesalers	W R	14
Retailers		
Consumers	C	14

Structure of the analysis

The structure of the analysis will follow the structure of the supply chain. For example starting with Suppliers followed by Packaging Manufacturers, Industrial Customers, Wholesalers and Retailers and finally the Consumers.

5.2.2. Sample Size and Response Rate

Overall, 411 questionnaires were sent out and 368 were finally received, representing an 89,54% response rate (see Table 5.1b). For what is relevant to Final Consumers (FC) although (as shown above) it has been estimated that the sample size (N) should be 256, finally, 290 questionnaires were sent. The reason for this was the view that if more than the needed questionnaires were sent and collected then more accurate data could may be provided for analysis to the research. In addition, in an effort to triangulate evidence from multiple sources, data collection included the comparison and combination of various sources such as, questionnaires and documentation.

Table 5.1b. - Response Rate

Sector	Questionnaires Distributed	Questionnaires Returned	Response Rate
Suppliers (S)	4	2	50%
Packaging Manufacturers (PM)	8	4	50%
Industrial Customers (IC)	104	89	85,58%

Wholesalers- Retailers (WR)	5	2	40%
Consumers (C)	290	271	93,45%
Total	411	368	89,54%

5.3. Suppliers (S)

5.3.1. Questionnaires: Suppliers (S)

This sector represents the initial stage (source) of our supply chain. A categorisation of the participants of the specific sector (S1)²² is crucial, since if combined with questions: S2, S3, S4 and S5, it can help us to make some further conclusions, concerning the volume of waste per material during the manufacturing process or the proportion of recycling or disposing of these materials per sector. In addition, crucial comparisons can be made, based on the environmental friendliness of each one of these materials, destined for the packaging sector.

Question S2, refers to the amount of raw materials produced by each of the participants. It is very important to understand the volume of materials in circulation in the market. This question, along with relevant literature, can guide us to make comparisons between materials that are easier to recycle and check the environmental friendliness of each one of them.

Question S3, concerning the amount of waste produced during the manufacturing process, includes very sensitive data, since it can be used to compare which manufacturing process (S1), is the most environmental friendly (in terms of waste per volume). The outcome could be very surprising and it should set one thinking, how to face the problem of pollution. Since the manufacturing process of each one of these materials is expected to pollute the environment in a different way, it is maybe unfair to confront all of the materials used in the packaging sector in the same way.

The purpose of Question S4, is to collect the data concerning the amount of waste received from the supply chain by the recycling centres. The outcomes, further combined with the outcomes of Question S1, could be used to indicate the level of recycling for each specific material. This Question along with S2, shows us

²² As shown above the first letter "S" indicates the sector e.g. S=Suppliers while the number indicates the specific question e.g. 1st Question.

the proportions of raw materials produced in conjunction with the materials recycled. These proportions along with S5 and S9, have the potential to indicate the environmental friendliness of each one of the packaging materials, in terms of:

- Environmental pollution (disposing or recycling),
- Energy (for some of the materials, the recycling process consumes less energy than the production of new materials),
- A combination of the above two elements, since the question to answer is: Should we choose:
 - a) to recycle materials based on a manufacturing process that aggravates the environment in terms of pollution and energy consumption (given that the manufacturing process is steady and can't easily change),
 - b) not to recycle them but instead to dispose of them and aggravate the environment in a different way, or
 - c) to substitute these materials with other, more environmental friendly materials?

Questions S6, S7 and S8 intend to show the way that the take-back programmes are currently designed. The market always finds ways to operate in an effective way in the name of profit. For this reason, where needed, it has already set up take - back programmes, collecting the waste from the supply chain (the packaging manufacturers, the retailers and wholesalers), recycling this waste and reselling it again. Thus, these questions underline a serious matter: "Why don't we stimulate the market to use those packaging materials that would be advantageous to collect, recycle and reuse, solving in the same way the problem of disposing and pollution?"

Questions S10, S12 and S13 are just informative, in order to understand if the companies know about the Directive and if they have considered the way that this Directive might affect their business.

The specific purpose of Question S13 is to investigate the public opinion concerning the specific Directive and the level that people think that is going to contribute in a better environmental performance. The same question (modified after the pilot), is included in all the questionnaires destined for the different sectors (S13, PM11, IC10, WR11 and C11), in order to evaluate if there are different perspectives concerning the Directive, depending on the point of view of each one of the links of

the supply chain (e.g. Do Packaging Manufacturers have the same perspective with the Retailers or the Final Consumers?).

Question S11, is intended to present the level of acceptance of the Directive by the individual companies producing packaging materials. It is an open question, expected to reveal an opposition to the specific directive, especially if the companies have already set up take – back programmes to assist their operations. This question is included in all the questionnaires destined for the different sectors (S11, PM8, IC9, WR9 and FC10) and intends to show if there are significant changes between the perspectives of the participants in the supply chain. Cost is a very sensitive issue for the industry and the purpose of the question was not to specifically identify this cost, but instead and along with Question S14, to understand how the companies confront such an issue.

Question S14 is one of the most important questions, since its purpose was to show if the industry intends to push that cost down to the final consumer. S14 along with PM12, IC13 and WR13, asks the same questions to all of the participants of the Packaging Supply Chain except from the final consumer. They were expected to prove that the cost is always being pushed down to the final consumer through the prices of the products.

5.3.2. Results of the Questionnaires: Suppliers (S)

S1: Kind of raw materials produced?

The respondents had to choose between the main material categories: Paper, Glass, Plastic and Metal. Both of the respondents were coming from the Paper Industry. The questionnaire is built as a general questionnaire, so it can be used in other cases. However, the responses to this question (S1) will be omitted from the analysis, since all of the respondents are coming from the same industry (paper industry).

S2: Amount of raw materials produced per month?

The respondents produced between 500 and 700 tonnes of paper per month:

- 501-600
- 601-700

According to Eurostat (2013) the total amount of paper and cardboard packaging recycled for the year 2011 is 347,900 tonnes. Although each of the

respondents represents a low proportion (approximately 0.2%) of the total market, the responses are indicative of the current situation in the Greek paper packaging market.

S3: Amount of waste during the manufacturing process per month?

The respondents produced between 0 and 50 tonnes of trims per month. These trims represent approximately 8-10% of the total packaging recycled per respondent company. According to the respondents, this amount of trims is acceptable and expected in their annual recycling production.

S4: Amount of waste received from reverse flow per month?

The respondents were receiving on average 100-150 tonnes of waste paper per month. This amount of waste paper is destined for use in the recycling process.

S5: Amount of collected waste materials destined for recycling or disposing?

The respondents were asked to give the amount of waste materials that they were able to recycle and that which had to be sent for disposing because of its very low quality.

Table 5.2. - Collected waste materials destined for recycling or disposing

Suppliers	Recycling	Disposing
1	70%	30%
2	75%	25%

S6: Method of collecting waste materials?

The respondents were asked to give the method they were using for collecting the materials from the supply chain. They had to choose between the following options:

- Collect using own trucks
- Collect using 3PLs
- They are being sent back to the supplier
- Other

The respondents were using their own vehicles to collect the waste materials from the supply chain.

S7: Who pays for the collection of waste from the supply chain?

This was used in combination with S6 (**Method of collecting waste materials?**) and S8 (**Do you pay anything for the waste (concerning packaging materials) that you receive - collect?**) in order to show the way that the take back programmes are currently designed.

The respondents answered that they undertake in full the cost for the collection of this waste.

S8: Do you pay anything for the waste (concerning packaging materials) that you receive - collect?

This one was to be combined with the S6 and S7 questions in order to understand the design of the reverse channel.

Here, the respondents answered that they pay for both the transportation and the material cost.

S9: Is it more environmental friendly to recycle the waste or to produce new raw materials, in terms of energy and natural resources?

The respondents were asked to answer based on their experience, if it is more environmental friendly to recycle or to produce new materials.

Table 5.3. - Is it more environmental friendly to recycle the waste or to produce new raw materials, in terms of energy and natural resources?		
Supplier 1	Recycle	Produce
Energy	✓	
Natural Resources	✓	
Supplier 2		
Energy	✓	
Natural Resources	✓	

S10: Have you ever heard about the Packaging and Packaging Waste Directive (94/62/EU)?

The respondents were asked if they were aware of the Packaging and Packaging waste directive. Both of them answered that they were informed about the specific Directive.

S11: Do you think that if the Directive, obligates the companies to set up take-back programmes, in order to collect their packaging from the supply chain or instead, to pay a tax to the government, is going to be affordable by the individual companies?

Here, both of the respondents were negative towards the implementation of the specific directive and the enactment of legislation that would increase their operational costs. They both support that relevant legislations are not affordable by the individual Greek companies.

S12: How do you think that your business is going to be affected by the Directive in the future?

This was a subjective question in an effort to collect more information on the issue. Unfortunately, none of the respondents gave additional information.

S13: In your opinion, do you consider that the European Packaging Directive, is going to contribute in a better environmental performance?

None of the respondents believe that the implementation of the Directive is going to contribute in a better environmental performance.

S14: Do you think that the implementation of this Directive, is going to affect the prices of your products reflecting the increase of cost?

Both of the respondents answered that the prices of their products are going to stay unaffected by the implementation of the Directive, meaning that they are not intending to increase the prices, pushing the cost down the supply chain.

5.3.3. Discussion of the Questionnaires: Suppliers (S)

The Suppliers that participated in the research are from the paper industry. The amount of raw materials produced per month is ranging between 500 and 700 tonnes and at the same time, the amount of waste produced for the same period from each of the suppliers, does not exceed the weight of 50 tonnes.

Each participant collects an average of 100-150 tonnes of waste paper per month from the supply chain, using their own fleet of vehicles. Of the total amount of waste collected, 72,5% is recycled, while the rest is sent for disposal due to its very low quality.

The Suppliers responded that they bear the full cost of collecting this waste from the supply chain while at the same time they pay for the acquisition of these

materials. In addition, they answered that the recycling process is more environmentally friendly compared to producing new materials, in terms of energy and natural resources. As already described above approximately $\frac{1}{4}$ of waste collected is sent for disposal because of its unsuitability²³ or its low quality. Although this seems to be an important obstacle in increasing the proportion of paper recycled materials, the increased participation of households to the recycling process may result in increased collected materials from the supply chain and to a better overall recycling performance.

In addition, despite the fact that the Suppliers were informed about the European Packaging Directive 94/62/EC, they were negative in the implementation of any legislation that could increase their operational costs. In addition, they suggest that the implementation of the Directive is not going to contribute to a better environmental performance. Here the negative stance of the respondents on the implementation of the directive may echo their involvement to the issue and their fears for future governmental actions that may aggravate their operational costs. However, on the other hand, their negative stance is maybe relevant to their practices. As derived from the answers the Suppliers already collect a remarkable volume of waste from the supply chain using their own fleet of vehicles. Thus, it is not surprising of having their oppositions and being skeptical concerning the success of such environmental measures.

However, the respondents claimed that they do not intend to increase the prices of their products if the state implemented an environmental law. Usually the various environmental legislations aggravate the operational costs of the industry by importing relevant taxes or setting obligations for the companies concerning acts, infrastructure changes and investments in order to align with the various targets posed by the government. Although there is no reason to doubt about the intentions of the respondents it is risky to evaluate them before the implementation of such measures. The strength and gravity of the measures can only be evaluated after their implementation. In the same manner, it is not easy to forecast the final actions of the industry since (from an economic perspective) heavy measures may have different impact comparing to lighter measures. Additionally, it should be noted that while taxes reduce the welfare of consumers and sellers of a product, further deadweight losses²⁴ are created as a result of the reduced demand and reduced

²³ Some forms of paper packaging may be mixed or coated with non-recyclable substances that may affect the recycling process and downgrade the final products obtained.

²⁴ The fall in total surplus that results when a tax (or some other policy) distorts a market outcome is called the deadweight loss (Mankiw, 2003).

transactions that further shrink the size of the market (Mankiw, 2003). In that case, the actions of the producers or the sellers (on the specific tax-issue) cannot be predicted. On the other hand, the gravity of the measures is unknown and cannot be predicted too. Thus, the interactions between independent parts of the market, the consumers, the sellers, the producers or the state, that further influence their decisions on various issues, can hardly be forecasted as described above.

5.4. Packaging Manufacturers (PM)

5.4.1. Questionnaires: Packaging Manufacturers (PM)

The term Packaging Manufacturers refers to a broad range of companies manufacturing packaging made from different materials, destined for different uses. For this reason, in Question PM1, packaging manufacturers that participated in the research are classified into:

- Paper Packaging,
- Glass Packaging,
- Plastics Packaging, and
- Metal Packaging.

Question PM1, along with the comparison between: PM2, dealing with the amount of packaging produced and PM3, dealing with the amount of waste produced during the manufacturing process, provide evidence concerning the level of environmental friendliness of each separate packaging category. The above questions, along with the answers of PM4 dealing with the amount of the manufacturing waste sent for recycling and disposal, are going to further formulate a vision on the specific issue. In general, according to the literature, the recycling rate is: ~70% for the paper and board packaging, ~58% for glass packaging, and ~25% for plastic packaging (Eurostat, 2007). The results of the questionnaires helped to verify the above data.

Questions PM5 dealing with the issue of: “who pays for the reverse flow of the packaging materials (generated during the manufacturing process) to the recycling centers” and PM6 that investigates if the packaging manufacturing companies are getting paid by the recycling companies (Suppliers) for these materials, are indicative of the current situation in this supply chain. These questions, along with S7 and S8 (that ask in a similar way the recycling centers (Suppliers): “who pays for the reverse

flow” and if they pay for the packaging materials that they receive from the supply chain) were selected purposely, in order to check and verify the specific answers in these two sectors.

Questions PM7, PM9, PM11 are just informative, in order to understand if the companies know about the Directive and if they have considered the way that this Directive might affect their business. As already cited, Question PM11 is an open question, investigating the public opinion for the Directive and in general, what the companies believe about the Directive and its implementation.

Question PM10, inserts a new variable in the research. Its purpose is to investigate if the companies were able, ready and prepared to lighten their products, in order to reduce the amount of money paid in taxes (since most of the tax systems are weight – based) when the government implements the Directive²⁵. It also places groundwork for future research. For example, based on the answers of the Packaging Manufacturers and after the implementation of the Directive, somebody could investigate if finally the companies decided to lighten their products or not, forced by the increased cost generated by the taxes. In addition, since the general target of the environmental policy of the European Union (and thus of the Packaging Directive), is to minimise the overall aggravation of the environment by the industrial activity and not to collect taxes, further research could be carried out to investigate the power of the consumers in pushing companies to produce lighter or more environmental friendly products.

The outcomes of Question PM10 along with:

- Question IC12 asking the Industrial Customers if they intend to ask their suppliers (Packaging Manufacturers), to provide them with lighter packaging in case that the Directive is implemented, and
- Question WR12 asking Wholesalers and Retailers if they have ever thought of asking their suppliers to change the packaging of their products in order to be more environmental friendly,

are very important questions for this research because they will provide evidence concerning the intentions of the industry to use lighter and maybe more

²⁵ Weight-based measures are common in environmental legislations among different countries and mainly concern the weight of materials delivered to landfill sites. However such measures require data to be kept and analysed for tax purposes (Fullerton et.al, 2008). In addition according to a Danish environmental newsletter (Danish Ministry of the Environment, 2002) it has been observed that weight-based measures in Denmark resulted in more waste deposited illegally at recycling stations and road lay-bys (main road rest areas for drivers).

environmental friendly packaging. However, the purpose here was not to prove the “sensitivity” of the industry with relevance to the environment but to investigate another important issue: “If the industry, decides to use lighter packaging in the future, in order to reduce the taxes (in case where the taxes are generated based on the weight of packaging), what is going to happen in the quality of the packaging and further in the quality of the products circulating in the supply chain”. For this reason, this issue, is compared with the outcomes of: WR2, C6 and C7 asking the Wholesalers, the Retailers and the Customers, if they have ever received a damaged product or if they have destroyed it, due to improper handling. This multi-level comparison, underlines a serious issue that the industry as whole needs to protect the environment without downgrading the packaging quality.

Question PM8, was selected in order to measure the level of acceptance of the Directive by the Packaging Manufacturers, asking them if they believe that the Directive and its consequences are going to be affordable by the individual companies.

As already cited, the research tries to identify how companies deal with the cost issue. For this reason, Question PM8 combined with PM12, dealing with the push of cost down to the final consumer and combined further with the answers of the other participants of the supply chain in the same question (S14, IC13, WR13), are undoubtedly important sources for the cost issue. It was expected that in the case where the Packaging Manufacturers were surcharged with:

1. the increases in the prices of raw materials (increased prices of the raw materials by the Suppliers, due to the implementation of the Packaging Directive)

and at the same time,

2. the taxes generated by the Directive,

they were going to increase their prices, pushing these costs to the next link of the Supply Chain, meaning in this case the Industrial Customers. The results were finally a bit different to what was expected. Here again, although there is no reason to doubt about the intentions of the respondents it could be risky to evaluate them before the implementation of such legislation since we can only make hypotheses concerning the severity of the measures and the reaction of the manufacturers to them.

5.4.2. Results of the Questionnaires: Packaging Manufacturers (PM)

PM1: In which sector does the company belong?

Here the respondents had to choose between the four major categories of packaging: Paper, Glass, Plastics and Metal. The question was used as a mean of categorisation of the sample.

100% of the respondents of the sample come from the paper packaging sector.

As already described, the questionnaire is built as a general questionnaire, in order to be used in any other case. However, the responses to this question (PM1) will be omitted from the analysis, since all of the respondents are coming from the same packaging sector (paper packaging).

PM2: Amount of packaging produced per month?

The respondents produced between 100 and 1000 tonnes of packaging on a monthly basis. The proportions are shown below.

Table 5.4. Amount of packaging produced per month

Amount of packaging produced per month (in tonnes)	Percentage
101-150	50%
601-700	25%
1000 and over	25%

PM3: Amount of waste produced during the manufacturing process per month?

75% of the respondents produce 0-50 tonnes of waste on a monthly basis, during the manufacturing process. The remaining 25% produce 101-150 tonnes of waste monthly.

Table 5.5. Amount of waste produced during the manufacturing process per month

Amount of waste produced during the manufacturing process per month (in tonnes)	Percentage
0-50	75%
101-150	25%

PM4: What amount of this waste is sent for recycling and what amount goes for disposing (in tonnes)?

Table 5.6. Amount of waste sent for recycling

Amount of waste sent for recycling (in tonnes)	Percentage
0-50	75%
101-150	25%

Table 5.7. Amount of waste sent for disposing

Amount of waste sent for disposing (in tonnes)	Percentage
-	0%

The respondents answered that 100% of the waste they produce during the manufacturing process is sent for recycling.

Table 5.8. Amount of waste sent for recycling or disposing

Amount of waste sent for recycling (in tonnes)	Amount of waste sent for disposing (in tonnes)
100%	0%

PM5: Who pays for the reverse flow of these materials to the recycling centers? (transportation cost)

All of the respondents (100%) answered that the recycling centres are paying for the transportation cost of these materials to their recycling centers.

PM6: Do you sell your manufacturing waste to the recycling companies?

All of the respondents (100%) answered that the recycling centres are paying for these materials thus they sell all of the waste materials they produce during the manufacturing process.

PM7: Have you ever heard about the Packaging and Packaging Waste Directive (94/62/EU)?

Of the respondents $\frac{3}{4}$ were aware of the Packaging Waste Directive (94/62/EU) while $\frac{1}{4}$ had never heard of it (Table 5.9.).

Table 5.9. Have you ever heard about the Packaging and Packaging Waste Directive (94/62/EU)?

Yes	No
75%	25%

PM8: Do you think that if the Directive, obligates the companies to set up take-back programmes, in order to collect their packaging from the supply chain or instead, to pay a tax to the government, is going to be affordable by the individual companies?

25% answered that the Directive is going to be affordable for the companies. The majority of the respondents believe that the companies affected by the Directive are going to have difficulties (mostly economic based) by its implementation.

Table 5.10. Is the Directive affordable for the companies?

Yes	No
25%	75%

PM9: Comment the way, in which you think this directive, is going to affect your business.

There were no comments by the respondents.

PM10: Most of the tax systems are weight based. Would you lighten your products in order to reduce the amount of money that you will be called to pay?

All of the respondents (100%) answered that they would change their products using lighter materials in order to reduce the amount of taxes that they will be expecting to pay.

PM11: In your opinion, do you consider that the European Packaging Directive, is going to contribute in a better environmental performance?

All of the respondents (100%) answered that according to their opinion, the directive is going to result in a better environmental performance.

PM12: Do you think that the implementation of this Directive is going to affect the prices of your products reflecting the increase of cost?

The majority of the respondents (75%) answered that the implementation of the Directive will not affect the prices of their products even if new costs occur increasing their operating costs.

Table 5.11. Do you think that the implementation of this Directive is going to affect the prices of your products reflecting the increase of cost?

Yes	No
25%	75%

The same post – survey arrangements that applied to suppliers were to be applied here.

5.4.3. Discussion of the Questionnaires: Packaging Manufacturers (PM)

The Packaging Manufacturers that participated in the research were from the paper packaging sector. Fifty percent (50%) of the respondents, produce 100-150 tonnes of (paper) packaging per month, twenty five percent (25%) of the respondents produce 600-700 tonnes of packaging, while the other twenty five percent (25%) produce 1000 tonnes and over. At the same time, the amount of waste produced per month, by the 75% of the respondents, did not exceed the weight of 50 tonnes, while just one of the respondents produced 100-150 tonnes of waste per month. According to the respondents the waste produced during the manufacturing process corresponds to the total amount of packaging production and cannot be avoided by the manufacturers.

The respondents answered that 100% of the waste paper they produced during the manufacturing process is sent for recycling. In addition, all of the respondents answered that the recycling centres are paying for the transportation cost of the waste from their facilities to the recycling centres and they all admit that they sell this waste paper to the recycling companies. Considering the responses given on the particular issue, it is concluded that the paper waste produced during the manufacturing process is valuable for the Suppliers (S), since not only do they take charge of recovering the paper, using their own means, but also pay the manufacturers for its acquisition.

Seventy five percent (75%) of the respondents were aware of the existence of the Packaging and Packaging Waste Directive (94/62/EU), while the same proportion answered that the implementation of this Directive in the Greek market, is not going to be affordable for the individual companies. However, all of them admit that the existence of an environmental law is going to contribute to a better environmental performance.

In addition, all of the respondents answered that they are inclined to change their products using lighter materials –in the case of implementation of a weight based law by the government- in order to reduce the amount of taxes that they will be required to pay.

Finally, seventy five percent (75%) of the respondents claimed that they do not intend to increase the prices of their products if the state implemented an environmental law, increasing their operating costs. New costs include new taxes that would eventually increase a company's operating costs. Surprisingly only ¼ of the respondents answered that they intend to pass new costs (if any) generated by the implementation of the Directive to the prices of their products. However this could be easily changed especially if new costs fall disproportionately with the total operating costs.

5.5. Industrial Customers (IC)

5.5.1. Questionnaires: Industrial Customers (IC)

This sector, the third link in the supply chain, represents the first consignee of the packaging in its final form (after it has been manufactured). In Question IC1, the participants were asked in which sector they belonged. Question IC1 combined with IC2 and IC3, helps to make this categorisation more specific, since in IC2 the different sectors of the Industrial Customers, are asked to state the volume of packaging that they use during a time-period, per material and in IC3, to show the proportion of packaging that they use during the same time-period per material. However, IC2 was expected not to be answered precisely, due to the difficulty of recovering such data by the companies (especially by those that do not operate an Electronic Requirement Planning system) and furthermore, due to the hesitation of companies to provide sensitive data relevant to their operations.

The answers in IC2 would have helped to validate the data concerning the packaging materials in circulation, comparing the results in different sectors (mainly

between Suppliers, Packaging Manufacturers and Industrial Customers). Nevertheless, for the above reason and because of the fact that the research could proceed without having the exact numbers in the specific issue, IC3 was included as an alternative question, providing general data that at the same time were sufficient enough to make meaningful conclusions.

Question IC4, investigated what amount of packaging that the Industrial Customers use, is recyclable (in total or per material). The purpose of this question was to identify if the industries know about the specifications of the packaging they use and which sector (if there were any), that uses the most environmentally friendly packaging. In addition, the results were indicative of the present situation and gave evidence if there is ground for future improvements in the issue. For example, if a high proportion of companies don't use recyclable packaging, then the government could force these companies (mainly using taxes), to substitute their packaging with that produced with more environmental friendly materials.

Questions IC5 and IC6 were included in order to ascertain cases of packaging failure. The participants, in Questions IC5 and IC6, are asked if they had noticed any packaging waste due to improper handling and what proportion of the total packaging they use ends up in waste.

The purpose of the above two questions was to underline the importance of keeping high standards in the quality of packaging produced. Furthermore, these questions along with questions:

- WR2 asking Wholesalers and Retailers if they have ever noticed damages and in what frequency in the products due to improper handling, that happened either in their facilities or during transportation, and
- C6 and C7, asking Customers if they had ever destroyed a product due to improper handling of its packaging and if they had ever bought a damaged product due to an improper or destroyed packaging,

would show the importance of packaging in the protection of goods and products. Packaging quality constitutes an important issue for the market. According to Behmanesh (Iran Daily, 2006), a lot of the exported Iranian agro products are wasted due to improper or low packaging quality. Wood *et. al.* (2002), harmonising with the above aspect, state that ineligible packaging, undermines the quality of the products and thus large amounts of food (and other goods as well) becomes unserviceable.

In Question IC7, Industrial Customers were asked if they have ever thought of using – where possible - only recycled packaging materials. The purpose of this question, was to understand if the Industrial Customers had ever thought of acting in a more environmentally friendly way, without being forced by the government or other external factors. This question, could constitute an important source for future research, examining the main factors that mainly force the companies to proceed with serious changes in their operations.

Questions IC8, IC9, IC10 and IC11, are informative in order to understand – once again- if the participants knew about the Directive, if they think that the implementation of the Directive is going to be affordable –in terms of cost or taxes-, if the use of take back programmes can result in source reduction and a more environmentally friendly way of doing business and finally, if they believe that their operations are going to be affected and in what way.

As already cited, questions concerning the public opinion on the specific Directive, have been included in all questionnaires in order to understand if there will be acceptance or opposition in the (Greek) market, when the government decides to implement the Directive. It was expected, that the Industry would not be open in such a process, especially when it is expected that the law is going to generate new costs and aggravate their operations. For this reason in Question 13, industries were asked what they intended to do with the extra cost that the new taxes are going to generate. In most of the cases, it was expected that the industries intended to push that cost down to the next link of the supply chain (and finally to the final consumer).

Question IC12, asking the Industrial Customers whether they intended to require suppliers to provide them with lighter packaging (where possible), in order to reduce the amount of money that they will be called to pay, combined as already cited with PM10 and WR12, shows the intentions of the industry to use –under some conditions- lighter and maybe more environmental friendly packaging. However, packaging quality –as already discussed- is crucial, since an eventual downgrading of the quality, could result in defective, non usable and inappropriate products. For this reason, it combined the outcomes of IC12 with Questions IC5 and IC6, along with WR12, C6 and C7, asking the same question to all of the participants and different links of the supply chain (except from the Suppliers and Packaging Manufacturers, that do not use packaging in the same manner for their products), if they had ever destroyed or received a damaged product, due to improper handling or unsuitable packaging of the product.

Question IC13, investigated the main issue, discussing the possibility of the participants to push (to the next link of our supply chain), the cost generated by the implementation of the Directive. In a hypothetical situation, where the other links of the supply chain have already increased the prices of their products (after the implementation of the Directive), it was expected that the link of the Industrial Customers would do the same and push that cost to the next link, namely Wholesalers and Retailers. But here is where the problem begins. The Wholesalers and Retailers are thought to have the strength to push their suppliers to keep prices down. So, how will the industry incorporate the extra cost into their prices, since they struggle under the competition? Is it here, where there is a serious problem, where the whole supply chain pushes the cost down to the next link, but this cost is – expected to be- absorbed by the Industrial Customer, that due to the competition, in most of the cases is forced not to push it down to the powerful Retailers and Wholesalers? And what if Wholesalers and Retailers, decide to increase their imports from countries outside of the European Union, where they don't implement similar environmental laws or if their environmental taxes are disproportionately lower, compared with the domestic European market?

In the present global economy, where stable, consistent and trustworthy supply chains operate, it is now more easier than ever for a trader to expand and start doing business with companies operating on the other side of the world. Developing countries can provide the rest of the world with low cost products. As Norman F. Klopp Jr. executive vice president of investment research for an investment firm in Cleveland, USA, cites: *“The inability to raise prices in large part is the result of tough global competition, which now is a permanent fact of life in manufacturing”* (Prizinsky, 1997).

On the other hand, in cases where the link of the Wholesalers and Retailers do not intercept between the Industry and the Final Consumer, then it is easier for the Industry to incorporate this cost, into the price of its product. This will be discussed later in the “Consumers” section below.

In Question IC14, participants were asked to say what process they think is better (recycle, reuse, incineration or disposing) concerning the most common packaging materials: paper, plastic, metal and glass. This question was included in order to be compared with S9 (where the Suppliers were asked: *“Is it more environmental friendly to recycle the waste or to produce new raw materials, in terms of energy and natural resources?”*). The comparison, along with the results of WR14 and C13, where Wholesalers-Retailers and the Consumers were asked the same

question respectively, was expected to reveal if the consumers and those parts of the supply chain that do not participate direct in the packaging manufacturing process, are well informed concerning the environmental effects from the final manipulation of the used packaging. If the Wholesalers and Customers believe that the plastic packaging should be recycled, but instead the Suppliers, answered that plastic recycling is not environmental friendly in terms of natural resources, then the view of the public that packaging should be recycled in order to protect the environment, is wrong.

5.5.2. Results of the Questionnaires: Industrial Customers (IC)

IC1: In which sector does the company belong?

Here the respondents had to choose between different business sectors such as Food and Beverage, Clothes, Oil and Lubricants etc. The question was used as a mean of categorisation of the sample.

Table 5.12. In which sector does the company belong?

	Frequency	Valid Percent
Food & Beverage	33	37,1
Packaging	8	9
Lubricants	5	5,6
Constructing Materials	4	4,5
Clothes	12	13,5
Plastics	1	1,1
Electronic Equipment	4	4,5
Chemicals & Pharmaceuticals	7	7,9
Industrial Automization	2	2,2
Services	1	1,1
Commerce	3	3,4
Decoration	1	1,1
Metal Products	1	1,1
Candle Industry	1	1,1
Furnitures	1	1,1
Tissue Paper	1	1,1
Mechanical Parts	1	1,1
Other	2	2,2
Colours	1	1,1

Total	89	100
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As it shows, the sample consists of several different companies representing a wide range of sectors operating in the Greek market. Most of the companies are coming from the Food & Beverage sector (37,1%), while 13,5% are industries producing Clothes.

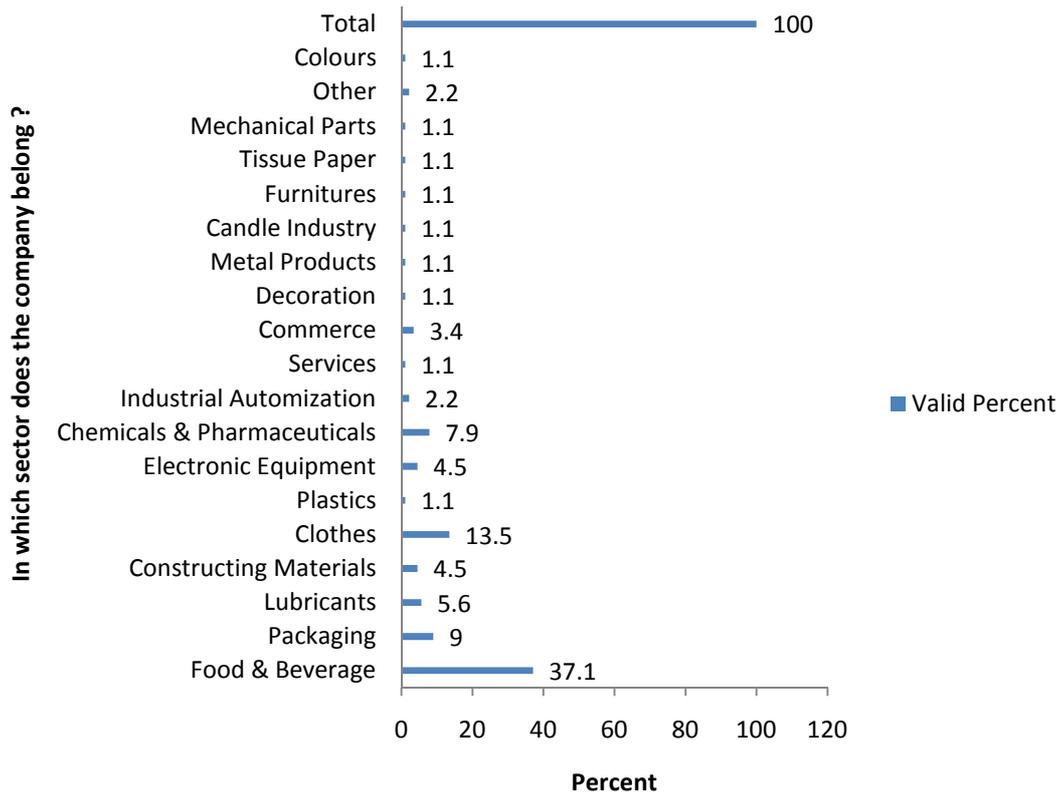


Figure 5.1. In which sector does the company belong?

IC2: What amount of packaging do you use every year?

A low percentage of the respondents (~10%) was able to provide data for this question. However, the remaining of the respondents were not in the position to provide accurate data. Due to the low percentage of the response rate, the answers to this question were not considered in the final analysis.

IC3: What is the proportion that your company uses per packaging material?

Here the respondents had to fill in the proportion of the different packaging materials they use. The categories of materials were: Paper, Plastic, Glass and Metal.

Table 5.13. What is the proportion that your company uses per packaging material?

Material	Proportion
Paper	94,4%
Plastic	78,7%
Glass	22,5%
Metal	23,6%

Most of the respondents used a combination of packaging materials for their products. 94,4% of the respondents used some kind of paper packaging, 78,7% used some kind of plastic packaging, 22,5% used some kind of glass packaging and 23,6% used some kind of metal packaging.

20 out of the 89 respondents, 22,5% were using just one packaging material and not a combination of two or more materials. Of the 89 respondents, 20,2% were using paper packaging and two or 2,3% were using just plastic packaging.

Use of Packaging Materials

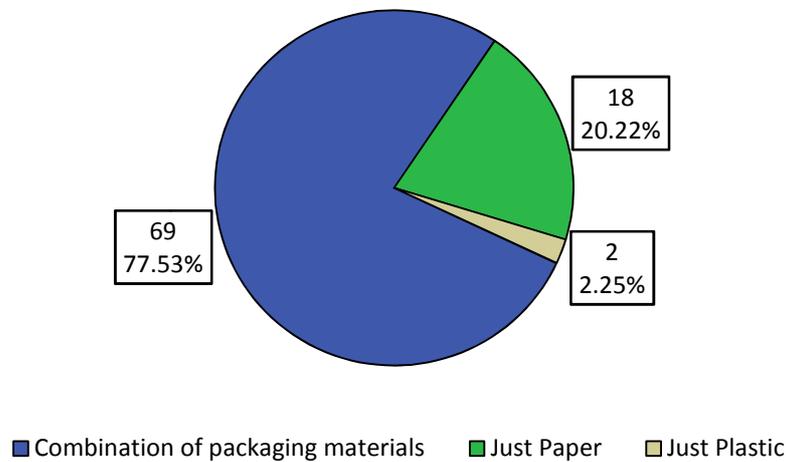


Figure 5.2. Use of packaging materials

IC4: What amount of the packaging that you use every year is recyclable in total or per material?

Of the 84 (out of 89 respondents), that were using paper packaging, 70 or 83,3%, answered the specific question.

In addition, of the 70 respondents that were using plastic packaging, 39 or 55,7% gave a valid answer.

Furthermore, of the 20 respondents, that were using glass packaging, nine or 45% answered the question and finally, of the 21 respondents, that were using metal packaging, six or 28,57% answered the question.

Table 5.14. Proportion of valid answers

Respondents using some kind of packaging	Paper	Answered	Plastic	Answered	Glass	Answered	Metal	Answered
84	83,3%	70						
70			55,7%	39				
20					45%	9		
21							28,6%	6

Concerning paper packaging, 81,4% or 57 out of the 70 of the respondents that both use paper and answered the question, state that 100% of the paper packaging they use is recyclable while on the other hand, 11,4% or 8 respondents, answered that 0% of the paper packaging they use is recyclable. 7,1% or 5 of the 70 respondents answered that the recyclability of the paper packaging they use ranges between 10%-80%.

Table 5.15. Paper Packaging and Recyclability

Respondents using paper	Respondents answered the question	Proportion of Recyclability	Number of Respondents	Proportion of Respondents
84	70	100%	57	81,4%
		80%	1	1,4%
		50%	1	1,4%
		30%	1	1,4%
		21%	1	1,4%
		10%	1	1,4%
		0%	8	11,4%

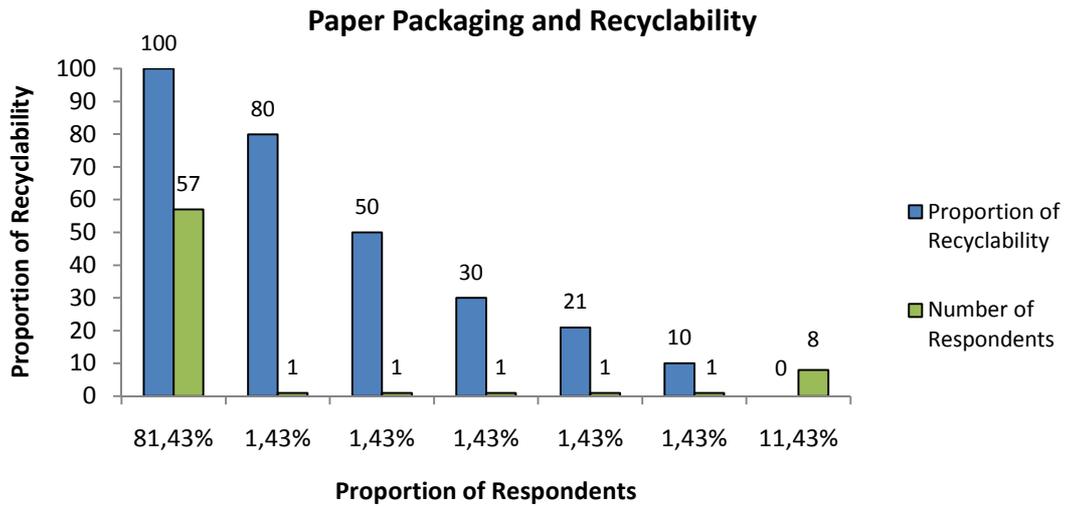


Figure 5.3. Paper Packaging and Recyclability

Concerning plastic packaging, 30,8% or 12 out of the 39 respondents that both use plastic packaging and answered the question, stated that 100% of the plastic they use is recyclable. On the other hand, 59% or 23 respondents, answered that 0% of the plastic packaging they use is recyclable. 10,3% or four of the 39 respondents answered that the recyclability of the plastic packaging they use ranges between 10%-30%.

Table 5.16. Plastic Packaging and Recyclability

Respondents using plastic	Respondents answered the question	Proportion of Recyclability	Number of Respondents	Proportion of Respondents
70	39	100%	12	30,8%
		30%	1	2,6%
		20%	2	5,1%
		10%	1	2,6%
		0%	23	59%

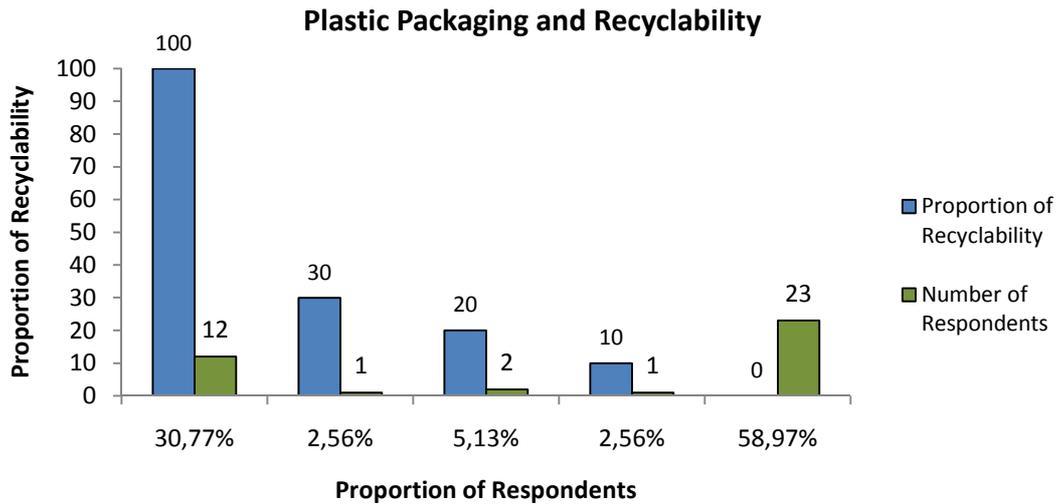


Figure 5.4. Plastic Packaging and Recyclability

Concerning glass packaging, 66,7% or six out of the nine respondents that both use glass packaging and answered the question, state that 100% of the glass they use is recyclable. The results are shown below:

Table 5.17. Glass Packaging and Recyclability

Respondents using glass	Respondents answered the question	Proportion of Recyclability	Number of Respondents	Proportion of Respondents
20	9	100%	6	66,7%
		83%	1	11,1%
		35%	1	11,1%
		0%	1	11,1%

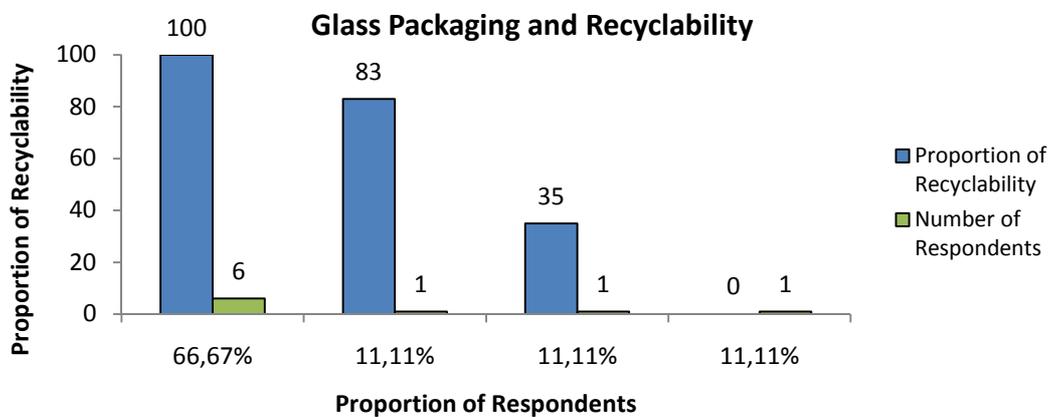


Figure 5.5. Glass packaging and recyclability

Concerning metal packaging, 66,7% or four out of the six respondents that both use metal packaging and answered the question, stated that 100% of the metal they use is recyclable. On the other hand, 33,3% or two respondents, answered that 0% of the metal packaging they use is recyclable.

Table 5.18. Metal Packaging and Recyclability

Respondents using metal	Respondents answered the question	Proportion of Recyclability	Number of Respondents	Proportion of Respondents
21	6	100	4	66,7%
		0	2	33,3%

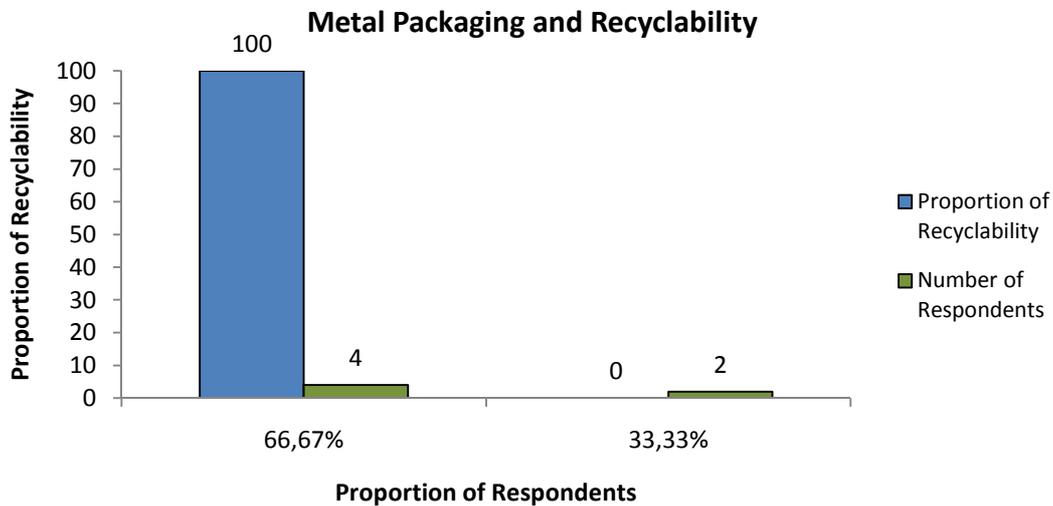


Figure 5.6. Metal Packaging and Recyclability

IC5: Do you produce any waste due to improper handling?

This question was designed to measure the waste produced during various handling processes of the products and to underline the importance of packaging in the market. Nearly 70% of the respondents answered that they experience various problems resulting from improper handling of a product’s packaging.

Table 5.19. Do you produce any waste due to improper handling?

	Frequency	Percent	Valid Percent
Yes	60	67,4%	68,2%
No	28	31,5%	31,8%
Missing	1	1,1%	-

Total	89	100%	100%
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IC6: What is the proportion of this waste, with respect to the total packaging you use?

This question is directly related with IC5. The respondents were asked to describe the proportion of the waste produced due to improper handling of the products.

As seen in the previous question, 31,8% or 28 of the respondents answered that they don't produce any waste due to improper handling of the products. In the same manner in question IC6, of the 88 respondents (out of 89) that gave a valid answer, 28 or 31,8% produce 0% of waste during handling.

It is interesting that 56,7% of the 60 respondents that produce waste during handling processes, produce waste that ranges between 0%-2%, while 30% produce waste that ranges between 2,5%-4% and 13,3% produce waste that ranges between 5%-6%.

Table 5.20. Proportion of Waste

Proportion of Waste	0%	0%-2%	2,5%-4%	5%-6%	Total respondents producing waste	Total Valid Answers
No of respondents	28	34	18	8	60	88
% of respondents that produce waste	-	56,7%	30%	13,3%	100%	-
% of the total respondents	31,8%	38,6%	20,5%	9,1%	100%	100%

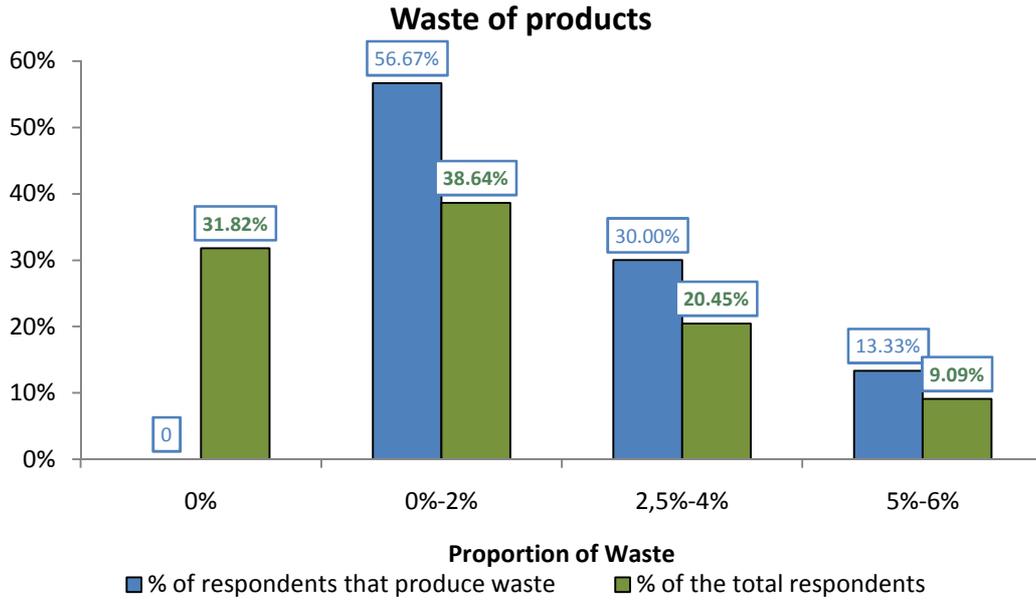


Figure 5.7. Waste of products

IC7: Have you ever thought of using only recycled packaging materials?

~60% of the respondents had never thought of using only recycled packaging materials.

Table 5.21. Have you ever thought of using only recycled packaging materials?

	Frequency	Percent	Valid Percent
Yes	37	41,6%	42,0%
No	51	57,3%	58,0%
Missing	1	1,1%	-
Total	89	100%	100%

IC8: Have you ever heard about the Packaging and Packaging Waste Directive (94/62/EU)?

A big proportion of the Industrial Customers (61%) had never heard of the Packaging and Packaging Waste Directive.

Table 5.22. Have you ever heard about 94/62 EU?

	Frequency	Percent
Yes	35	39,3%
No	54	60,7%
Total	89	100%

IC9: Do you think that if the Directive, obligates the companies to set up take-back programmes, in order to collect their packaging from the supply chain or instead, to pay a tax to the government, is going to be affordable by the individual companies?

The Industrial Customers were asked if they believe that the environmental regulations and any cost generated will be affordable by the individual companies. Nearly 2/3 of the respondents gave a negative answer.

Table 5.23. Do you think that the companies can afford the legislation?

	Frequency	Percent
Yes	33	37,1%
No	56	62,9%
Total	89	100%

IC10: Do you think that the use of the above take back programmes, can result in source reduction and a more environmental friendly way of doing business?

Nearly 70% of the respondents believed that the collection of the (used) packaging materials was going to help the environment.

Table 5.24. Do you think that the collection of packaging is going to improve the environment?

	Frequency	Percent
Yes	61	68,5%
No	28	31,5%
Total	89	100%

IC11: Comment the way, in which you think this directive, is going to affect your business.

There were no comments by the respondents.

IC 12: Most of the tax systems are weight-based. Would you ask your packaging suppliers to provide you with lighter packaging, in order to reduce the amount of money that you will be called to pay?

Most of the respondents (63%) would ask for lighter packaging if this was the case to pay less taxes.

Table 5.25. Would you ask for lighter packaging in order to pay less taxes?

	Frequency	Percent	Valid Percent
Yes	54	60,7%	62,8%
No	32	36,0%	37,2%
Missing	3	3,4%	-
Total	89	100%	100%

IC 13: Do you think that the implementation of this Directive is going to affect the prices of your products reflecting the increase of cost?

The vast majority of the respondents answered that any costs generated by the implementation of the legislation are going to be passed on the prices of their products.

Table 5.26. Do you think that the prices of the products you sell are going to be affected by the legislation?

	Frequency	Percent	Valid Percent
Yes	75	84,3%	86,2%
No	12	13,5%	13,8%
Missing	2	2,2%	-
Total	89	100%	100%

IC14: What process do you think is better concerning the following materials, in order to protect the environment?

Here the respondents had to answer, with respect to each one of the following packaging materials: Paper, Plastic, Metal and Glass, with one of the following most common processes: Recycle, Reuse, Incineration or Disposing. The results are presented below:

Paper

Table 5.27. What is the best process concerning paper?

	Frequency	Percent	Valid Percent
Recycle	68	76,4%	79,1%
Reuse	10	11,2%	11,6%
Incineration	2	2,2%	2,3%
Land Filling	6	6,7%	7,0%
Missing	3	3,4%	-
Total	89	100%	100%

Plastic**Table 5.28. What is the best process concerning plastic?**

	Frequency	Percent	Valid Percent
Recycle	43	48,3%	50,0%
Reuse	15	16,9%	17,4%
Incineration	11	12,4%	12,8%
Land Filling	17	19,1%	19,8%
Missing	3	3,4%	-
Total	89	100%	100%

Metal**Table 5.29. What is the best process concerning metal?**

	Frequency	Percent	Valid Percent
Recycle	20	22,5%	25,3%
Reuse	22	24,7%	27,8%
Incineration	17	19,1%	21,5%
Land Filling	20	22,5%	25,3%
Missing	10	11,2%	-
Total	89	100%	100%

Glass**Table 5.30. What is the best process concerning glass?**

	Frequency	Percent	Valid Percent
Recycle	27	30,3%	34,2%
Reuse	16	18,0%	20,3%
Incineration	12	13,5%	15,2%
Land Filling	24	27,0%	30,4%
Missing	10	11,2%	-
Total	89	100%	100%

The same post – survey arrangements that applied to suppliers were to be applied here.

5.5.3. Discussion of the Questionnaire Responses: Industrial Customers (IC)

The Industrial Customers that participated in the research represent a wide range of sectors operating in the Greek market. Most of the respondents are coming from the Food & Beverage sector (37,1%), while the rest are companies producing Clothes (13,5%), Packaging (9%), Chemicals & Pharmaceuticals (5,6%) etc.

Most of the respondents used a combination of packaging materials for their products. 94,4% of the respondents used some kind of paper packaging, 78,7% used some kind of plastic packaging, 22,5% used some kind of glass packaging and 23,6% used some kind of metal packaging.

Approximately twenty two percent of the respondents, are using just one packaging material for their products and not a combination of two or more materials. Of the 89 respondents, twenty per cent are using just paper packaging for their products and two percent are using just plastic packaging.

Concerning paper packaging, eighty one percent of the respondents, state that 100% of the paper packaging they use is recyclable. On the other hand, for what is relevant to plastic packaging 59 percent of the respondents, state that 0% of the plastic they use is recyclable while just 31 percent answered that 100% of the plastic they use is recyclable. At the same time, concerning glass packaging, 67 percent of the respondents answered that 100% of the glass they use is recyclable. Finally, 67 percent of the respondents answered that 100% of the metal they use is recyclable.

68 percent of the companies answered that their employees destroy products due to improper handling. More than half of them answered that this waste ranges between 0%-2%, while 30% state that this waste ranges between 2,5%-4%. The rest produce waste that ranges between 5%-6%.

42 percent of the respondents answered that they have considered using only recycled packaging materials while the rest of the participants have never thought of this option. It is interesting that 61 percent of the companies have never heard about the Packaging and Packaging Waste Directive (94/62/EU) while nearly the same percentage answered that the implementation of this Directive in the Greek market is not going to be affordable by the individual companies. However, 68 percent of them, admit that the existence of an environmental law is going to result in a better environmental performance.

In addition, 63 percent of the respondents answered that they are inclined to ask their packaging suppliers to provide them with lighter packaging –in the case of implementation of a weight based law by the government- in order to reduce the amount of taxes that they will be called to pay.

As expected, the vast majority of the companies (86,2%) claimed that they intend to increase the prices of their products if the state implemented an environmental law, increasing their operational costs. Only a small percentage of the respondents (13,8%) answered that the prices of their products are going to stay unaffected.

Nearly eighty percent of the respondents state that recycling is the best process concerning paper packaging.

In addition, half of the respondents answered that the best process concerning plastic is recycling, while the processes of reusing (17,4%), incineration (12,8%) and land filling (19,8%) were less popular options.

For metal, the aspects are equally distributed between the four options: Recycle 25,3%, Reuse 27,8%, Incineration 21,5% and Land Filling 25,3%.

Finally, opinions differ concerning glass, since the most popular processes is Recycling and Land Filling, with 34,2% and 30,4% respectively, while Reuse and Incineration generates 20,3% and 15,2% respectively.

5.6. Wholesalers – Retailers (WR)

5.6.1. Questionnaires: Wholesalers – Retailers (WR)

Wholesalers and Retailers, are the most “powerful” link of this supply chain. By this, it is their ability to influence the prices of the products they buy. Jerry Polster, manager of a consulting company in the USA, underlines that because of the competition among the retailers, who can’t raise their prices due to consumer resistance to price increases at the retail level, distributors and manufacturers have trouble raising prices too, being pushed by their customers (retailers) (Prizinsky, 1997). At the same time, Wholesalers and Retailers, could easily substitute a product, with another product, offered at a slightly better price (Buss, 1994). This could mean a catastrophe for a manufacturer.

Question WR1, categorises the participants based on their annual turnover. The annual turnover helps to make a distinction between the small, medium and big

companies. In general, the bigger the company, the higher the volume of packaging it uses.

Question WR2, asked participants if they have ever noticed and in what frequency damage to the products, happened either internally or externally from their warehouses due to improper handling, as already described, combined with:

- IC5 and IC6 (production of packaging waste due to improper handling and what amount),
- IC12 (lighter packaging in the link of Industrial Customers),
- C6 and C7 (asked the Customers if they had ever received a damaged product or if they had caused a damage due to improper handling),

were going to show us the importance of packaging in the protection of goods and products. In general, the quality of packaging should not be downgraded (in order for the different links of the supply chain to decrease their debts to the government), because this could cause other, bigger problems such as aggravation of the environment with more waste and damaged products, before they will be even used. However, it is expected that the problem of packaging quality downgrading –if it happens- is going to be solved by the mechanisms of the market.

Questions WR3 and WR4, dealing with the amount of each packaging material sent for recycling and disposal by the participants of this link, were included in order to inform about the procedure that the participants follow concerning packaging and furthermore to make a distinction between the environmentally friendly materials (sent for recycling) and those that aggravate the environment (sent for disposing). Questions WR3 and WR4 could also act as a verification tool, compared with the S4 (asking the suppliers the volume of waste that they receive from the reverse flow) and PM4 (asking the packaging manufacturers what amount of waste generated during the manufacturing process is sent for recycling and disposing). Purposely, the Industrial Customers, were not asked this specific issue, since they use packaging as a medium to send their products and not as customers of the packaged product itself.

The purpose of Questions WR5 and WR6, asking the Wholesalers-Retailers how they send these packaging materials to the recycling centres and who pays for the transportation, was to check the data already collected in Questions S6, S7 and S8, dealing with the same issue at the Suppliers level. In addition, it was included to see if there was already a reverse system concerning packaging materials. The

results were planned to validate the intentions of the government evaluating the measures that are planned to be taken.

Question WR7, was designed to verify the answers of Suppliers in Question S8 (asking them if they pay anything for the wasted packaging materials that they collect from the supply chain). In addition, it would help to strengthen conclusions on this matter and to understand (along with Question S8), the way that the reverse channel of distribution –if there was any- is structured and how it operates.

Question WR8, investigated if the participants knew about the existence of the Directive and -as described above- this has been included in all five different questionnaires.

The following questions:

- WR9 (asking the participants if they think that the implementation of the Directive is going to be affordable by the companies),
- WR10 (prompting them to comment on the way in which they think that the Directive is going to affect their business), and
- WR11 (asking them if they think that the Directive is going to contribute in a better environmental performance),

were once again included in the Questionnaire, in order to evaluate the level of acceptance of the Directive by the Wholesalers and Retailers. The possibility of increased costs due to environmental taxes, that would cause further increases in the prices of the products they sell, was expected to cause opposition from the participants, especially nowadays, where competitive forces in the market keeps prices down. It is described that “...*the days of having customers walk in the store because of a lot of foot traffic are gone*” (Anonymous 1, 1995).

In Question WR12, where participants were asked if they have ever thought of asking their suppliers to change the packaging of their products in order to be more environmentally friendly, the participants were asked if they have ever thought to push their suppliers to act in a more environmentally friendly way, providing them with products, packaged with recyclable materials, without being forced by external factors, such as the imposition of taxes. The results to this question, along with those in Question IC7 (asking the Industrial Customers if they have ever thought to use only recycled packaging materials), could be the basis for future research, examining the different factors that mainly force companies to proceed with serious

changes in their operations (e.g. the imposition of taxes or environmental conscience etc).

In Question WR13, participants were asked if they intend to pass the cost generated by the environmental law to their customers (Final Consumers). It was expected that most of the respondents were going to pass the cost generated by the law –when adapted by the government- to their customers. As already described, the study examined –among others- the cost issue. This cost-related question, has been included in all questionnaires of the participants of our supply chain, except from the final consumers, who were expected to be the final absorbing link in the supply chain.

Finally in Question WR14, participants were asked to say what in their opinion, was the most environmentally friendly process concerning the most common packaging materials: paper, plastic, metal and glass. The different options were:

- Recycle,
- Reuse,
- Incineration,
- Disposing.

Recycle and Reuse were expected to be the most popular answers. However, the process of Incineration, is also an important alternative to Recycle and Reuse of some materials. According to INCPEN²⁶, incineration is an effective process of recovering some of the energy from waste and reducing its weight and volume to a significant level. Furthermore, INCPEN underlines that: “...*incineration is a safe and efficient way to dispose of waste*”.

The purpose of this question (along with Questions IC14 and C13, where Industrial Customers and Final Consumers were asked the same question), was to see if the participants could evaluate the advantages of the different processes, concerning each one of the materials used in packaging. Deep knowledge of the issue could act as a pressure on the Industrial Customers and further to Packaging Manufacturers and lead to:

- the substitution of some (if not all) of the packaging materials with others that are more easy to recycle,

²⁶ The Industry Council for Packaging and the Environment (1998), ISBN 1 901576 00 0

- the circulation of more resistant packaging in order to increase the frequency of reuse, or
- the use of packaging made from such kind of materials that could be incinerated providing with energy the society.

5.6.2. Results of the Questionnaires: Wholesalers – Retailers (WR)

WR1: What is your annual turnover?

Here the respondents had to indicate their annual turnover. The purpose of the question was to make a categorisation of the different participants into small, medium and big companies.

Both of the respondents had annual turnover ranging between 2.000.000€ and 7.000.000€ (2-3 million € the first respondent and 5-7 million € the second one). Their turnover with relevance to the Greek market, is thought to be small to medium.

WR2: Have you ever noticed damages in the products, due to improper handling, that happened either in your facilities or during transportation?

Both of the respondents answered that they had noticed destroyed products many times in the past.

WR3: What amount of packaging that you originally unpack is sent for recycling every month (in tonnes)?

The respondents answered that the materials that they recycle on a constant basis, are as shown in the following table:

Table 5.31. Materials Sent for Recycling (in tonnes)

Respondents	Paper	Plastic	Glass	Metal
1	30	-	35	-
2	50	-	40	-

WR4: What amount of packaging that you originally unpack is sent for disposing every month (in tonnes)?

The respondents didn't provide any data on the amount of packaging sent for disposal.

WR5: What is the method of sending back for recycling the packaging materials?

Here the respondents had to describe if they sent the above materials to the recycling centers using their own vehicles or if the Recycling Centres undertake the sole responsibility to carry these materials.

Both of the respondents answered that the Recycling Centres collect these materials from their facilities using their own vehicles.

WR6: Who pays for the reverse flow of these packaging materials to the recycling centers?

This was used in combination with WR5 (**Method of sending back for recycling the packaging materials?**) and WR7 (**Are you getting paid for these materials that you send back for recycling?**) in order to show the way that the take back programmes are currently designed.

The respondents answered that the Recycling Centres undertake the cost for the collection of this waste.

WR7: Are you getting paid for these materials that you send back for recycling?

This one was to be combined with the WR5 and WR6 questions in order to understand the design of the reverse channel. Here the respondents had to answer if they sold these materials to the Recycling Centres.

Both of the respondents answered that they sell these materials to the recycling centers.

WR8: Have you ever heard about the Packaging and Packaging Waste Directive (94/62/EU)?

The respondents were asked if they were aware of the Packaging and Packaging Waste directive. Both of them answered that they were informed about the specific Directive.

WR9: Do you think that if the Directive, obligates the companies to set up take-back programmes, in order to collect their packaging from the supply chain or instead, to pay a tax to the government, is going to be affordable by the individual companies?

Here, both of the respondents were negative to the implementation of the specific directive and the enactment of legislation that would increase their

operational costs. They both support that relevant legislation is not affordable by the individual Greek companies.

WR10: How do you think that your business is going to be affected by the Directive in the future?

This was a subjective question in an effort to collect more information on the issue. Unfortunately, none of the respondents gave additional information.

WR11: In your opinion, do you consider that the European Packaging Directive is going to contribute in a better environmental performance?

None of the respondents believe that the implementation of the Directive was going to result in a better environmental performance.

Table 5.32. Do you think that the European Packaging Directive is going to contribute in a better environmental performance?

	Percent
Yes	0%
No	100%

WR12: Have you ever thought of asking your suppliers to change the packaging of their products in order to be more environmental friendly?

Here one of the respondents answered that he had thought in asking its suppliers to use more environmental friendly packaging. While the other one, gave a negative answer.

WR13: Do you think that the implementation of this Directive, is going to affect the prices of your products reflecting the increase of cost?

Both of the respondents admitted that in case of a cost increase due to the implementation of the Directive and the generation of relevant taxes, they intend to increase the prices of their products, pushing the cost down the supply chain.

WR14: What process do you think is better concerning the following materials, in order to protect the environment?

Here the respondents had to answer, associating each one of the following packaging materials: Paper, Plastic, Metal and Glass, with one of the following most common processes: Recycle, Reuse, Incineration or Disposing. The results are presented below in Table 5.33.:

Table 5.33. What is the best process concerning the following materials?

Materials	Recycle	Reuse	Incineration	Land Filling	No of answers
Paper	2	-	-	-	2
Plastic	-	-	1	1	2
Metal	2	-	-	-	2
Glass	-	2	-	-	2

The same post – survey arrangements that applied to suppliers were to be applied here.

5.6.3. Summary of the Questionnaires: Wholesalers – Retailers (WR)

The Wholesalers-Retailers that participated in the research had annual turnover ranging between 2.000.000€ and 7.000.000€ (2-3 million € the first respondent and 5-7 million € the second one). Both of them answered that many times in the past, they had noticed damages in the products they trade due to improper handling.

The participants answered that they send for recycling 30-50 tonnes of Paper and 35-40 tonnes of Glass on a monthly basis. Both of the respondents stated that the Recycling Centres collect these materials from their facilities using their own vehicles and furthermore that they (Recycling Centres) fully undertake the cost for the collection of this waste. In addition, they both admit that they sell this waste to the recycling centers.

Both of the respondents were aware about the existence of the Packaging and Packaging Waste Directive (94/62/EU), while they support that the implementation of relevant legislations in the Greek market is not going to be affordable by the individual Greek companies. Moreover, none of the respondents believed that the implementation of the Directive was going to result in a better environmental performance.

One of the companies answered that it had thought in asking its suppliers to use more environmentally friendly packaging although no further information was provided on this issue. Both of them claimed that they intend to increase the prices of their products -pushing the cost down to the supply chain- if the government implemented an environmental law, thus increasing their operational costs.

Finally, both of the participants believed that in order to protect the environment, Recycle is the best process concerning Paper and Metal, while Reusing Glass is the best environmental option. However, they have different opinions concerning Plastic materials, since one of them believed that the best process is Incineration while the other one stated that Land Filling is a better option.

5.7. Consumers (C)

5.7.1. Questionnaires: Consumers (C)

The Final Consumer is the most vulnerable link in this investigation. It was expected that the (possible) total cost generated by the implementation of the Packaging and Packaging Waste Directive in the Supply Chain, was going to be pushed to this link in the supply chain.

Each one of the consumers represented themselves (in contrast with the other links, where each one of the respondents represented a company). In Questions C2 and C3, Consumers were asked if they participated in any environmental organisation and if they are aware of environmental problems.

These questions were included in order to measure the sensitivity of the participants and their level of awareness concerning environmental problems. In a second stage, C2 and C3 would act as a barometer for all of the following questions. The comparison of these questions is with C14, where the participants were asked to state the most common factor affecting their buying decisions. This shows that the more informed consumers are the more their consuming decisions are based on the environmental friendliness of a product. Furthermore, it could be concluded that a well informed customer could impact (using consuming power), on the use of environmental friendly materials, so reducing in this way the environmental impact.

Questions C4 and C5 asked participants if they recycled the packaging they use. Answers are based on a Likert scale to categorize them from the most common to the least common material that they recycle. This will show the trend in the habits of the consumers and furthermore, to verify –comparing them with the results of the other questionnaires-, what is the most common material sent for recycling.

When interviewing the final consumers, it was decided not to ask them anything concerning reuse or incineration of packaging but instead to use recycling as a broad measure of environmental protection. This was for three main reasons:

1. in Greece there are no incinerating centres for energy production,

2. recycling is the most well known process in Greece,
3. the final consumers –in most of the cases- carry their waste materials to the “recycling bins” placed near their homes. So, they don’t know whether these materials are sent for recycling, reusing, disposing or incineration. They just refer to the process with the general term “recycling”.

Questions C6 and C7 asked consumers if they had ever destroyed a product due to improper handling of its packaging and if they have ever received a damaged product due to improper packaging. These questions were selected in order to underline the importance of packaging. As already cited, packaging is very important in the protection of goods and products. Improper or unsuitable packaging can cause various problems, from destroyed or inconvenient products to environmental aggravation (e.g. through disposing, energy consumption for the manufacturing of new products etc.).

In addition, C6 and C7 were going to be combined with the outcomes of PM10 and IC12 where Packaging Manufacturers and the individual Industrial Customers were asked if they tend to lighten their packaging in order to reduce the costs that they will be called to pay after the implementation of the Packaging Directive by the government, based on the principle that the taxes will be weight-based. It was expected that the Packaging Manufacturers and the Industrial Customers would be positive in doing whatever they could do to decrease their costs (in this case, to lighten the packaging). However the outcomes of C6 and C7 (in case where the answers would show high percentages of damage to products due to improper packaging), would be the alert that the packaging quality should be unaffected in such cases, in order to avoid destruction of the product itself that could cause further environmental aggravation.

The purpose of Questions C8, C9 and C11 was to evaluate the level of awareness of the Directive and the acceptance of such measures by individual consumers. It was expected that initially the consumers would be positive to the Directive. This, would be especially underlined by the answers to Question 10, where they were asked if they thought that the implementation of the measure would be affordable by the companies and it was expected that most of the answers would be either positive or “I don’t care”. However, we expected that when the consumers would come to answer C14, (dealing with the basic element affecting their buying habits), they would pick the “Price” element (in most of the cases) and not the “Environmental Friendliness” of the product. This, would show a contradiction and a

possible consuming-attitude of substituting the products surcharged with environmental taxes, with others costing less money to the consumer.

Here again, the issue of the competition from non-European Union companies would emerge and result in a real problem for the domestic (European) companies. This is especially true for countries such as Greece, located in Southern Eastern Europe, far away from the centre of the EU and the main mass of the consumers and surrounded by other countries (outside of the European Union) such as: Albania, Serbia, FYROM, Turkey, where the protection of the environment is still at an infant level (and the environmental taxes as well).

Question C12 asked Consumers the cost-related question, as already cited above. It was expected that most of the participants would reply that after the implementation of the Directive and the new taxes imposed by the government, the prices of the products would be increased. (The specific issue has been described above).

In Question C13, consumers were asked what process they thought was better, concerning the four basic materials used in packaging, after the completion of its purpose: recycling, reuse, incineration or disposing. This question was selected in an effort to evaluate the opinions of the consumers for what is relevant to these available processes and measure the trends in their willingness, in pushing for environmentally friendly measures. The process of Recycle was expected to be the most popular answer.

In general, consumers as a whole are forcing the market one or the other way, so they constitute the most powerful link that could drive the market in a more environmentally friendly way of doing business.

Furthermore, investigating the level of awareness of the civilians and the way that this knowledge affects the market and its progress in environmental issues, could use the results of this question in order to compare them with those of the future and prove if there was progress in the way that the future supply chain operates and at what level.

5.7.2. Results of the Questionnaires: Final Consumers (FC)

FC1: What is your name?

The respondents were assured for the confidentiality of their personal information.

This question seeks to categorise the respondents per gender. As it has already been described above, the questionnaire was constructed as a general questionnaire, so as to be used for other similar cases. The outcome of this question could be applied to a second stage to measure the difference in the environmental answers between males and females. However, the responses given to this question (FC1) will be omitted from the analysis, since this distinction is beyond the scope of this investigation.

Of the answers, the genders of the respondents were as follows:

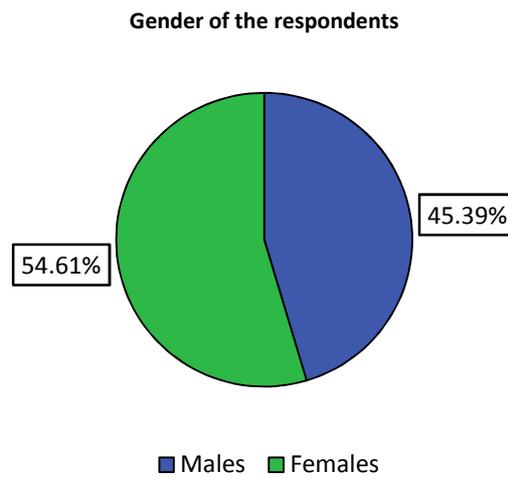


Figure 5.8. Gender of the respondents

FC2: Do you participate in any environmental organization?

Of the 271 respondents, 255 did not participate in any environmental organisation. 94% is big and clearly describes the situation concerning the specific field in Greece. The results are presented below:

Table 5.34. Do you participate in any environmental organization?

	Frequency	Percent
Yes	16	5,9%
No	255	94,1%
Total	271	100%

FC3: How do you rate your knowledge concerning the environment and the various environmental problems?

The respondents were asked to rate their knowledge concerning the various environmental problems. 60% of the consumers rate their knowledge as Excellent

and Good while 40% of the respondents answered they have an average knowledge concerning the environment.

The results are shown below:

Table 5.35. How do you rate your knowledge concerning the environment and the various environmental problems?

	Frequency	Percent
Excellent	25	9,2%
Good	134	49,5%
Average	108	39,9%
Insufficient-Zero	4	1,5%
Total	271	100%

FC4: Do you recycle the packaging you use?

The consumers were asked to reply if they recycle the packaging they use. The majority of the respondents answered that they recycle some of the packaging they use while $\frac{1}{4}$ answered that they don't recycle anything. Only 12% answered that they recycle all the packaging they use.

Table 5.36. Do you recycle the packaging you use?

	Frequency	Percent
Yes. I recycle all the packaging I use.	32	11,8%
Yes. I recycle some of the packaging I use.	170	62,7%
No. I don't recycle anything.	69	25,5%
Total	271	100%

FC5: What kind of packaging do you most recycle?

Here the respondents had to place in order, the packaging materials they recycled, from the most common material to the least common material.

The most common material appears to be paper since 145 out of 271 respondents (53,5%), answered that paper is the most common material they recycle. The 2nd most common material, was Plastic with 103 respondents (38%), while Glass is the third most common material, with 110 respondents (40,6%),

followed by Metal as the fourth most common material, with 114 respondents (42,1%).

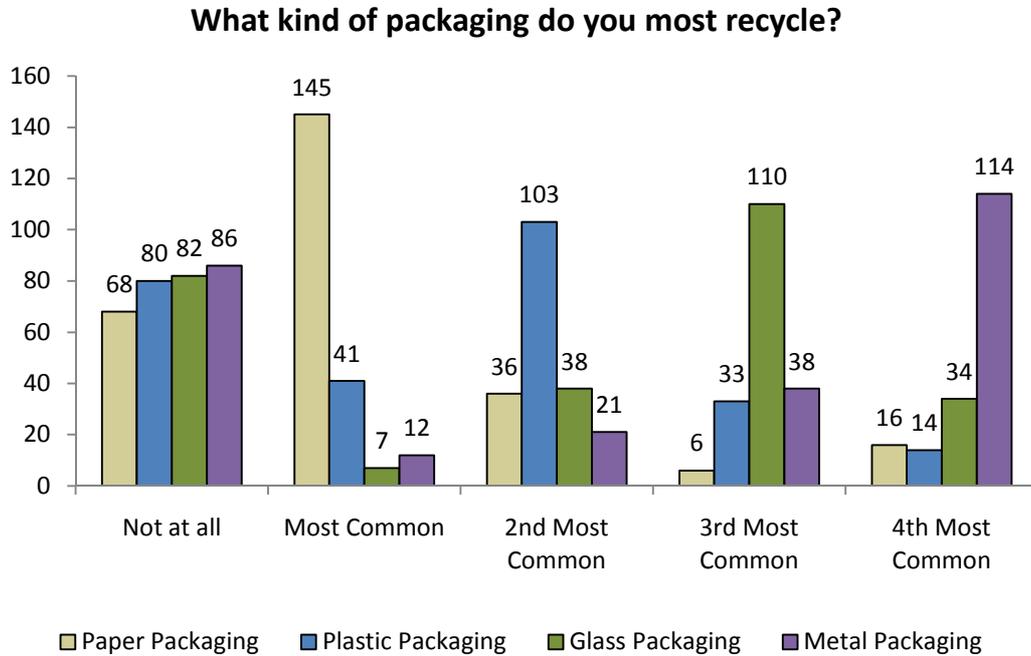


Figure 5.9. What kind of packaging do you most recycle?

Of the respondents:

- 68 (25,1%) did not recycle Paper at all,
- 80 (29,5%) did not recycle Plastic at all,
- 82 (30,3%) did not recycle Glass at all, and
- 86 (31,7%) did not recycle Metal at all.

FC6: Have you ever destroyed a product due to improper handling of its packaging?

Most of the respondents (~75%) answered that they have caused damage to a product due to improper handling of its packaging, at least once in the past.

Table 5.37. Have you ever destroyed a product due to improper handling of its packaging?

	Frequency	Percent
Yes	202	74,5%
No	69	25,5%
Total	271	100%

FC7: Have you ever received – bought a damaged product due to an improper or destroyed packaging?

It was interesting to see if the consumers had ever experienced situations such as damage to a product they bought caused by improper or destroyed packaging. Not surprisingly the majority of the consumers (75%) had at least once experienced a similar situation as shown below.

Table 5.38. Have you ever received – bought a damaged product due to an improper or destroyed packaging?

	Frequency	Percent
Yes	206	76%
No	65	24%
Total	271	100%

FC8: Have you ever heard about the Packaging and Packaging Waste Directive (94/62/EU)?

The majority of the respondents (~85%) had never heard of the Packaging and Packaging Waste Directive.

Have you ever heard about the Packaging and Packaging Waste Directive (94/62/EU)?

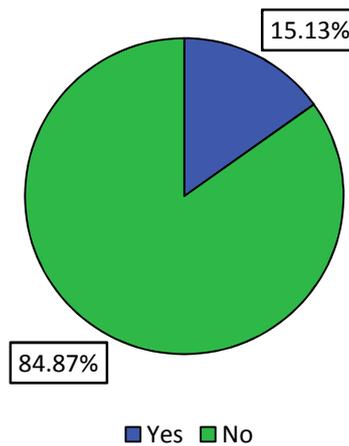


Figure 5.10.

FC9: What do you think about the Packaging and Packaging Waste Directive (94/62/EU)?

This was a subjective question in an effort to collect more information on the issue. Unfortunately, none of the 41 respondents (see question FC8) that according to their answers knew about the specific Directive gave additional information concerning their thoughts on the Directive.

FC10: Do you think that if the Directive, obligates the companies to set up take-back programmes, in order to collect their packaging from the supply chain or instead, to pay a tax to the government, is going to be affordable by the individual companies?

Consumers were asked if (according to their opinion) the companies could afford to pay taxes or organise take-back programmes in order to collect the packaging from the supply chain. While 41% of the respondents answered positively, 26% were negative and 1/3 (32%) had no opinion on the issue.

Table 5.39. Do you think that the companies can afford the legislation?

	Frequency	Percent	Valid Percent
Yes	111	41%	41,3%
No	72	26,6%	26,8%
I don't know	86	31,7%	32%
Missing	2	0,7%	-
Total	89	100%	100%

FC11: Do you think that the use of take back programs can result in source reduction and a more environmental friendly way of doing business?

The majority of the respondents (79%) were positive to the introduction of measures such as the collection of packaging materials from the supply chain. A very small percentage of 13% were negative or neutral to the institution of such measures.

Table 5.40. Do you think that the use of take back programs can result in source reduction and a more environmental friendly way of doing business?

	Frequency	Percent
Yes	213	78,6%
No	11	4%
Nothing will happen	24	8,9%

I don't know	23	8,5%
Total	271	100%

FC12: After the implementation of the Packaging and Packaging Waste Directive (94/62/EU) and the taxes that are going to be generated, do you think that the prices of the products that you buy are going to be affected?

The consumers were asked if they expect that the prices of the products were going to be increased in case the Directive incurs the operating costs of the companies involved in this legislation. The majority of the consumers answered that the prices of the products they consume are going to be increased in such a case. On the contrary only 13% of the respondents answered that the prices of the products are going to stay unaffected.

Table 5.41. Implementation of the Directive and prices of the products

After the implementation of the Packaging and Packaging Waste Directive (94/62/EU) do you think that the prices of the products that you buy, are going to be affected?		
	Frequency	Percent
Yes they will	197	72,7%
No they wont	35	12,9%
I dont know	39	14,4%
Total	271	100%

FC13: What process do you think is better concerning the following materials, in order to protect the environment?

Here the respondents had to answer, for each one of the packaging materials: Paper, Plastic, Metal and Glass, with one of the following most common processes: Recycle, Reuse, Incineration or Disposing. The results are presented below:

Paper

The majority of the respondents (84%) believe that Recycle is the best process concerning paper. As shown below, the remaining processes gather very low rates.

Table 5.42. What is the best process concerning paper?

	Frequency	Percent
Recycle	228	84,1%
Reuse	33	12,2%
Incineration	7	2,6%
Land Filling	3	1,1%
Total	271	100%

What is the best process concerning paper?

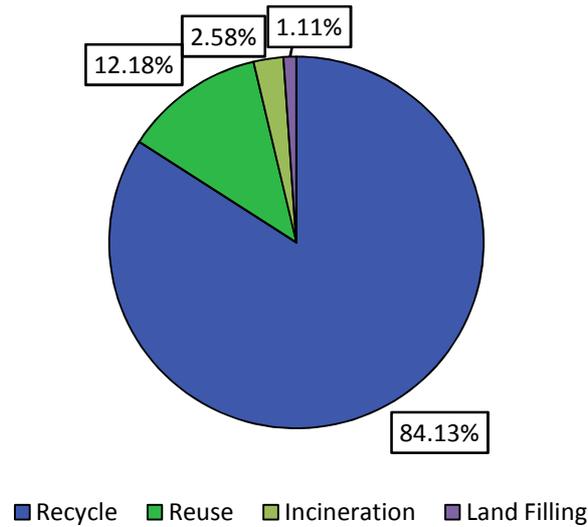


Figure 5.11.

Plastic

As shown below nearly half of the respondents believe that plastic is better to be recycled while a quarter (26%) believe that it is better to Reuse plastic.

Table 5.43. What is the best process concerning plastic?

	Frequency	Percent	Valid Percent
Recycle	130	48%	48,2%
Reuse	70	25,8%	25,9%
Incineration	25	9,2%	9,3%
Land Filling	45	16,6%	16,7%
Missing	1	0,4%	-
Total	271	100%	100%

What is the best process concerning plastic?

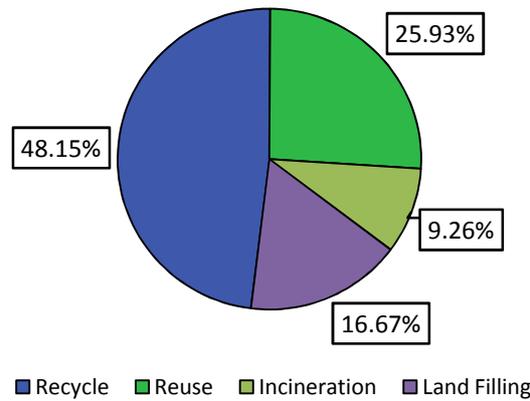


Figure 5.12.

Metal

Concerning Metal, the respondents were equally divided between Recycling and Reusing (41% each). The percentages are shown below.

Table 5.44. What is the best process concerning metal?

	Frequency	Percent	Valid Percent
Recycle	112	41,3%	41,6%
Reuse	111	41%	41,3%
Incineration	22	8,1%	8,2%
Land Filling	24	8,9%	8,9%
Missing	2	0,7%	-
Total	271	100%	100%

What is the best process concerning metal?

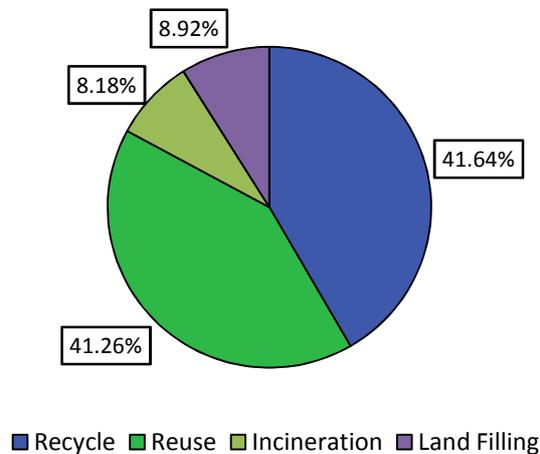


Figure 5.13.

Glass

For what is relevant to Glass, Recycling and Reusing are again (according to consumers) the best practices. The answers are shown below in detail.

Table 5.45. What is the best process concerning glass?

	Frequency	Percent	Valid Percent
Recycle	120	44,3%	44,4%
Reuse	119	43,9%	44,1%
Incineration	17	6,3%	6,3%
Land Filling	14	5,2%	5,2%
Missing	1	0,4%	-
Total	271	100%	100%

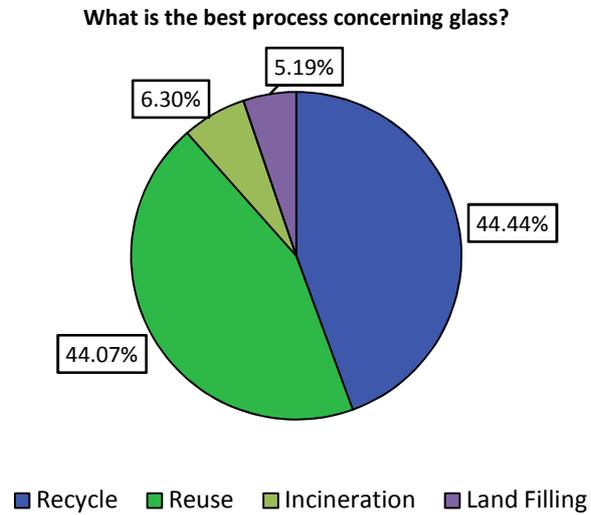


Figure 5.14.

FC14: What is the main factor in order to buy a product?

Consumers were asked concerning the main factor affecting their buying decisions. Half of the respondents thought price as the most important factor while another 40% answered that quality was the most important factor for them. In total, the vast majority (94%) considered the combination of Price and Quality as the most important factors concerning their buying decisions. The answers are clearly shown below in Table 5.46.

	Frequency	Percent
Price	145	53,5%
Quality	108	39,9%
Place of Origin	11	4,1%
Environmental Friendliness	6	2,2%
Other	1	0,4%
Total	271	100%

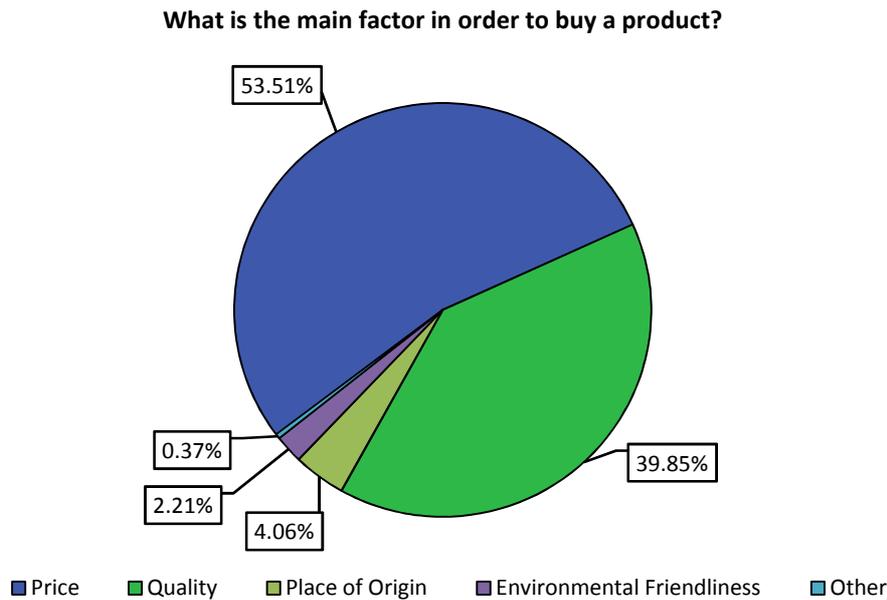


Figure 5.15.

5.7.3. Summary of the Questionnaires: Final Consumers (FC)

With a response rate of 93,45%, 271 questionnaires were finally returned. Of the 271 Final Consumers who participated in the research, 123 (45,4%) were males and 148 (54,6%) were females. It is interesting that 94 percent of the respondents did not participate in any environmental organisation. At the same time, nearly fifty per cent of them, rate their knowledge concerning the environment and the various environmental problems as Good, forty percent as Average and only nine percent felt that their knowledge is Excellent.

Nearly 2/3 of the respondents answered that they recycled some of the packaging they used, 12 per cent recycled all the packaging they used, while one quarter did not recycle anything.

The respondents were asked to place in order the packaging materials they recycled, from the most common to the least common material. 145 out of 271 respondents (53,5%) put paper in the first place as the most popular material. The second most common material appears to be Plastic, with 103 respondents (38%), while Glass is the third most common material, with 110 respondents (40,6%), followed by Metal as the fourth most common material, with 114 respondents (42,1%).

It is interesting that one quarter of the respondents did not recycle Paper at all, 29,5% did not recycle Plastic at all, 30,3% did not recycle Glass at all and 31,7% did not recycle Metal at all.

Nearly seventy five per cent of the respondents answered that they have destroyed a product due to improper handling of its packaging, at least once in the past and approximately the same percentage, stated that they have bought a damaged product due to an improper or destroyed packaging, at least once in the past.

A very small percentage of the participants (15,1%) were informed about the existence of the Directive 94/62/EU. Forty one per cent of the consumers answered that the companies can afford any cost that the legislation might generate while 27 per cent gave a negative answer. However, nearly 80 per cent believed that the use of take – back programmes could result in resource reduction and a more environmental friendly way of doing business.

Nearly 73 per cent of the participants, expect that the implementation of the Directive was going to affect the prices of the products they buy. This fact underlines their belief that in any case the companies are going to push this cost down to final consumers.

Finally, 84,1% of the respondents believed that in order to protect the environment, Recycle is the best process concerning Paper. For Plastic, 48,2% believed that Recycle was the best process while Reuse and Land Filling gained 25,9% and 16,7% respectively.

Recycle and Reuse are the most popular answers concerning Metal, with 41 per cent in both cases respectively. Finally for what is relevant to Glass, 44,4% of the respondents answered that Recycle is the best process while another 44,1% believed that Reuse is a better environmental option.

The vast majority of the respondents (93,4%) said that Price (53,5%) and Quality (39,9%) are the most important factors driving their purchasing decisions. This fact underlines the importance of price for the consumers and the significance of quality for the products they choose to buy. This means that on the one hand products produced in a place where environmental taxes aggravate their prices, lose their competitive advantage when compared with products produced in countries with no environmental laws in place.

It should be noted that although it was expected that a very high percentage (80%) to be linked to price, the research revealed that just 53,5% think of price as the most important factor in their buying decisions. This big difference can be explained if somebody analyses the conditions that occurred in the Greek market during the last decade, where Chinese products have swarmed into the market, offering cheap solutions of lower quality. Initially, these products gained a big amount of the consumers, however the popularity of the Chinese products gradually declined and nowadays, they are equivalent to the low price but at the same time to the very low quality. This fact maybe explains why the cumulative percent of Price and Quality is so high: 93,4%.

Furthermore, the importance of quality in their purchasing decision restricts the participants in the supply chain and limits the change to lighter packaging. Price and Quality contradict each other as such a reduction in the quality of the product packaging could reduce the quality of the product content while on the other hand, the push of cost from the supply chain to the consumers, cuts competitive advantages of local products over imported e.g. from an Asian country that does not have environmental laws.

5.8. Summary

The purpose of this chapter has been to provide an overview of the investigations based on the total data collected. For this reason, the chapter includes an analysis of the data collected, as well as a discussion about the answers regarding the different links of the examined supply chain. The answers, having been given by the following participants: Suppliers, Packaging Manufacturers, Industrial Customers, Wholesalers/Retailers and Final Consumers, are presented and discussed separately and in conjunction with all the others.

The main issues investigated, among others, are the environmental consequences of packaging and the level of packaging recycling in the Greek

market, as well. In addition, the four major packaging materials, i.e. glass, plastic, paper and metal, and their recycling rate are separately presented and analysed. Furthermore, an evaluation of the consumers' environmental behavior along with the level of acceptance of an environmental legislation by the citizens, are also discussed in the chapter. Another important issue investigated above is the possibility for the costs, arising by an environmental legislation, to be pushed down to the final consumers, while the factors influencing the consumers' purchasing decisions (e.g. price, quality, origin of the product etc) and their effects on the market are thoroughly presented and analysed.

The present chapter has also provided an understanding of the broad framework of this research through the discourse conducted using these data, which are considered to be representative of the current situation.

As a conclusion, the contribution of this research does not only concern the above-mentioned issues. Having examined all the above issues based on the data collected by the links of the supply chain, this investigation provides an overall evaluation of the paper packaging situation in Greece, in relation to the barriers generated to the market by the implementation of the 94/62/EC Packaging and Packaging Waste Directive. In addition, the discussion of the results provides strong evidence to the reader concerning the need or not for the establishment of a reverse channel for the paper packaging manufacturers. This very last issue is of great importance since the notion of sustainability has become popular in the recent years.

CHAPTER 6

DISCUSSION - OVERPACKAGING INVESTIGATION – ALTERNATIVE PACKAGING SUGGESTIONS

6.1. Introduction

This chapter contains a discussion of the results of the data collected and presented to Chapter 5. The issues derived from the investigation are presented and analysed in detail in section 6.2. Furthermore, in subchapter 6.3., using two different case studies, a number of alternative suggestions are discussed, in order to establish a more sustainable packaging supply chain. The cases under investigation were selected randomly among a wide range of products:

- The first case study includes the investigation of a product called 2TMIX²⁷ where three alternative packaging solutions are presented, analysed and finally compared in order to reveal the issues derived from the analysis.
- The second case study concerns the investigation of a 750 ml wine product. Two alternative packaging solutions are analyzed, compared and discussed. In this analysis, the proposed packaging solutions do not only refer to the rearrangement of the products in the package (as in the first case study), but also to the total change in the type of packaging itself. The aim is to highlight the specificity of the redesigning process, through the evaluation of the analysis outcome.

Section 6.4. includes the analysis of the overpackaging issue. At this point a third case study has been used in which two options of the same corrugated box are investigated in terms of: quality and cost followed by a detailed comparison between them, in order to show the strengths and weaknesses involved. However, in order to gather more data and further improve the analysis, the results from the study of four more corrugated boxes are also presented in the investigation. Multi Pack advised the researcher to do so, in order firstly to make a complete analysis of all corrugated boxes of the customer and make sure that redesigning could offer significant ameliorations to a company's packaging and secondly to ensure that the case investigated was not the most extreme scenario, which could lead to erroneous conclusions.

²⁷ 2TMIX is an oil product used for the lubrication of two-stroke engines. The oil must be mixed with the fuel to lubricate the engine and avoid any damages due to overheating.

Finally, section 6.4.2. includes the presentation and discussion of multiple conclusions and suggestions for further work concerning the overpackaging issue.

The researcher, through his experience, as being the manager in Multi Pack, contributed significantly in realising this research. His technical knowledge, as well as the necessary information he gave, has been taken into account in order to conduct the analyses and the technical tests, which made the completion of this research as extensive as possible. The technical knowledge of the researcher is extended due to his constant occupation with packaging on a professional level. Furthermore, his knowledge, covering a broad range of packaging issues, applies both to designing matters and the use of packaging, throughout the supply chain. The researcher puts his knowledge into use, while at the same time his access in relevant data offers the matrix for the conduct of the present research, the analyses completion and the drawing of conclusions.

6.2. Discussion of the results

The previous detailed analysis of the data collected from the six different links, revealed a number of significant issues that occur throughout the supply chain. The participants provided relevant information, the analysis of which, contributed to an understanding of the problems in the reverse paper packaging supply chain system. The following issues are combined, presented and discussed below:

- the contradictory aspects concerning the success of environmental legislation,
- the differences between the companies and the final consumers concerning the legislation and affordability of such measures in economic terms,
- the push of cost to the next links of the supply chain,
- the effectiveness of the reverse channel and take back programmes,
- the use of lighter packaging and its implications and the demand for environmental-friendly packaging.

6.2.1. Issue No 1: Contradictory aspects concerning the success of environmental legislation

The overall analysis showed that none of the suppliers believed that the Directive was going to contribute to a better environmental performance of the market, while on the other hand, all packaging manufacturers believed that the

legislation was going to affect the environment in a positive way (see Figure 6.1). Although there is no concrete evidence concerning the reasons for this disparity in aspects between the Suppliers and the Packaging Manufacturers, it could be assumed that Suppliers have a different overall viewpoint of the current situation since it is their responsibility to collect the waste packaging materials from the supply chain. This could possibly be the reason that to their mind any change would not add anything new to the current system.

In the same vein, nearly 70% of the industrial customers support the positive impact of legislation for the environment. In addition, Wholesalers and Retailers suggest that the legislation is not going to help the environment, while nearly 80% of the Final Consumers believed that the legislation is good for the environment and that it is going to contribute further in resource reduction.

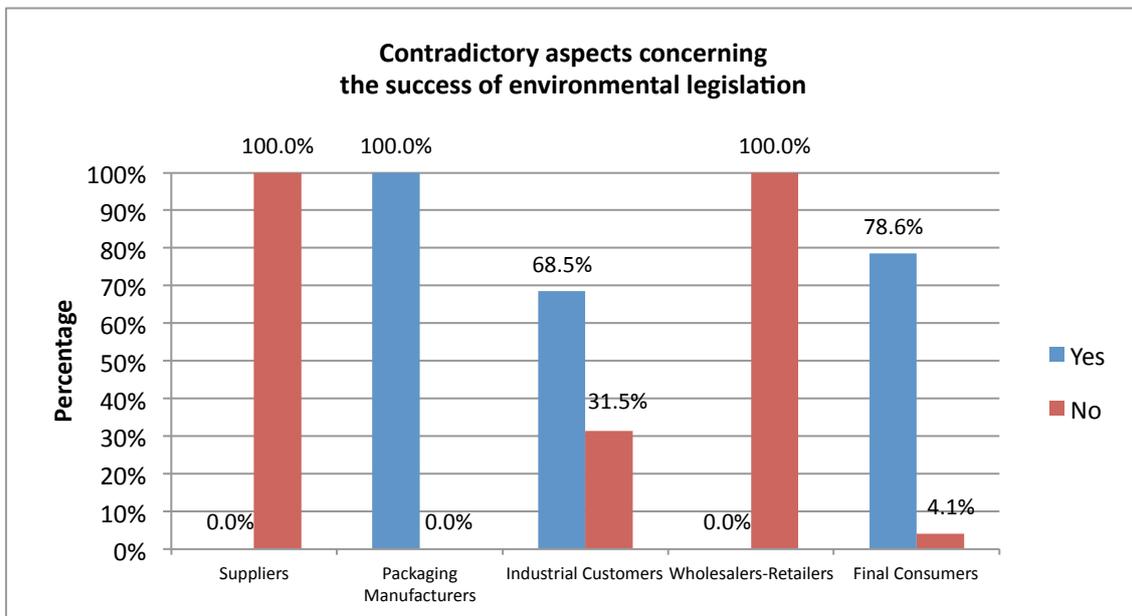


Figure 6.1. Legislation and environmental performance

It is interesting that both links appear not to believe in the success of legislation: Suppliers and Wholesalers-Retailers, have a strong participation to the recycling process of packaging materials. These two links, seem to realise that the legislation doesn't offer anything new to the previous situation. This consideration is in general true for these two links, since as seen in the analysis, according to their view, most of the packaging materials they handle, end up in recycling centres based on an already structured reverse channel of distribution.

However, despite the significance of this finding, the relatively low number of participants in each of the two links, weakens the strength of the result and restricts its validity.

6.2.2. Issue No 2: Legislation and affordability

Both Suppliers were negative towards the implementation of the specific Directive. They supported that in general, the operational costs that such legislation generated, would not be affordable for Greek companies. Of the Packaging Manufacturers, just 25% were positive in the affordability of the legislation in the Greek market. For what is relevant to the Industrial Customers, the results are a bit different with 37% of the respondents supporting that the legislation will be affordable by the individual Greek companies. All of the Wholesalers and Retailers were negative towards the legislation. However, 41% of the Final Consumers were positive to the affordability of the Directive with just a small proportion (~27%) supporting that the legislation was financially prohibitive for Greek companies.

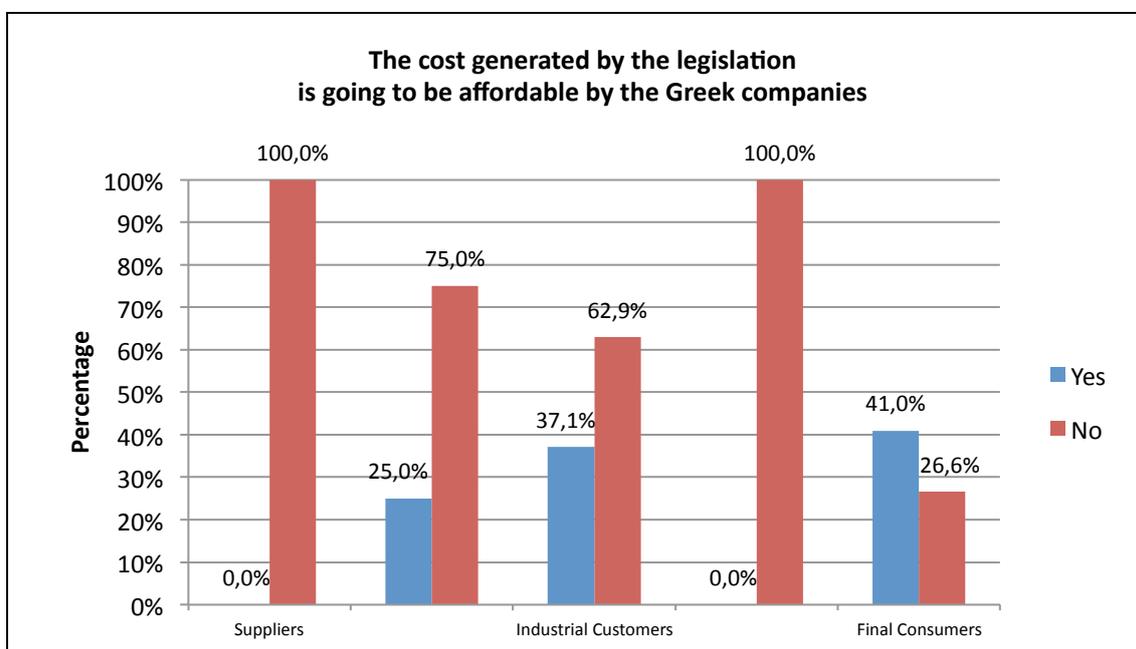


Figure 6.2. Legislation and affordability

The majority of the Greek industries are negative towards the implementation of the Directive believing that such procedures will increase their operational costs. On the other hand, the Final Consumers seem to have a different view of the subject with only a small proportion of them, supporting the aspect that the legislation is going to be overwhelming for the Greek companies. Here, it should be underlined that one third of them gave an “I don’t know” answer.

6.2.3. Issue No 3: Push of Cost

The push of cost to the next links of a supply chain has always been an important issue for the industry. The results of the investigation showed that the

situation was pretty much close to what was expected (see Figure 6.3). The Suppliers answered that it is not into their interests to push the cost down the supply chain by increasing their prices. Similarly, 75% of the Packaging Manufacturers answered that they do not intend to increase the prices of their products. The situation seems to be different for what is relevant to the Industrial Customers. 86% of them answered that a price increase is going to be inevitable in such a case. It is interesting that the Wholesalers and Retailers also answered that they would be open to a price increase in case of a cost increase due to the implementation of the Directive.

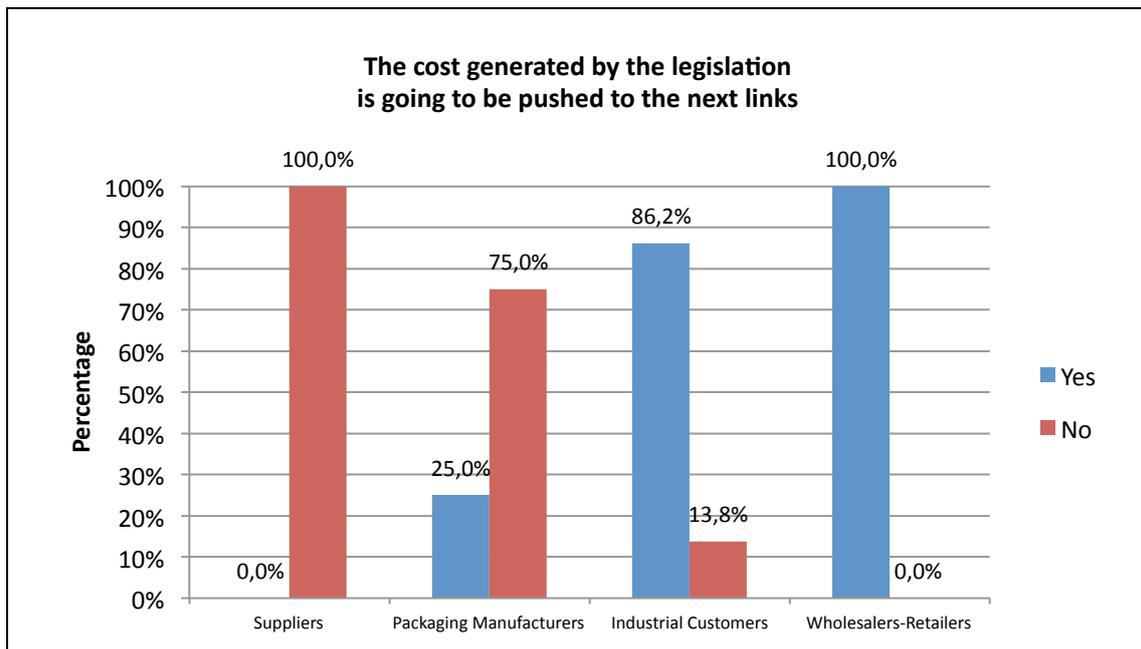


Figure 6.3. Push of cost

It can be argued that the answers given by the Suppliers, stating that they will not push the cost down to the supply chain is valid. However, this is not a strange outcome. The Suppliers, representing the recycling centres, collect the used packaging from the market. Their profits, come (as for every company) from the balance between their costs and their revenue. However, although they do not intend to increase the prices of their products, pushing the cost to the next link, they have the chance to decrease their costs. A significant cost for these companies is the cost of raw materials namely the waste packaging that they buy from the supply chain. Since there is not a specific framework, they can set the value of the waste packaging they buy, through lower prices and take advantage, balancing in this way, the increased cost generated by the directive. Using this potential method, the cost will not be pushed to the next links of the supply chain but instead will be shifted to the previous ones. In such a case, the push of cost is just changing direction.

The most serious outcome is coming from Packaging Manufacturers where the vast majority (75%), answered that they were not intending to push the cost to the next link. Given that the specific link had no other way to cover this cost, it can be assumed that the companies are going to absorb it. The reason for this could be explained by the words of one of the Packaging Manufacturers, who stated that:

“The Greek market presents high competition in the Paper Packaging sector, due to the existence of a large number of corrugated packaging industries compared to the size of the market. For this reason, even in cases of increases in the prices of raw materials, the companies strive to pass part of this increase to their customers and at the same time retain their market shares.”

From this point of view, the absorption of the legislation-related cost by Packaging Manufacturers seems to be reasonable.

A final issue that should be underlined is that Wholesalers and Retailers unpack and collect waste packaging, as part of their operations, (e.g. handling, product placing etc.) while at the same time sell paper packaging to the Suppliers, which means that they sell packaging that the consumer is going to pay but not actually receive. Moreover, they are not ready to undertake a part of the Directive’s cost. On the contrary, their intention is to push that cost down to the final consumer (see Figure 6.3.).

6.2.4. Issue No 4: Packaging and the environment

- **Amount of paper waste during the manufacturing process (Suppliers)**

The specific issue is going to be more helpful if data collected on the amount of waste per volume, produced during the manufacturing process of different materials, is combined. According to the data collected, the paper waste produced during the manufacturing process per month is between 0-50 tones. However, at this point one cannot make a firm comment on the specific issue, due to the limited number of responses.

- **Amount of collected waste materials destined for recycling or disposing (Suppliers)**

A large proportion of paper packaging materials collected from the supply chains are finally recycled. As a result, only a maximum of 25 to 30 percent of the waste paper collected, is sent for disposal since, according to the suppliers, it cannot be further recycled (e.g. because of low quality).



Figure 6.4. Paper Packaging Materials either Recycled or Disposed by Recycling Centers

However, the fact that for the Industrial Customers, paper packaging is the most common kind of material they use (94.4% of them used some kind of paper packaging), draws a high rate of environmental friendliness of the supply chain. On the other hand, for a better view of the environmental friendliness of the supply chain, more data concerning other packaging materials should be collected in the future.

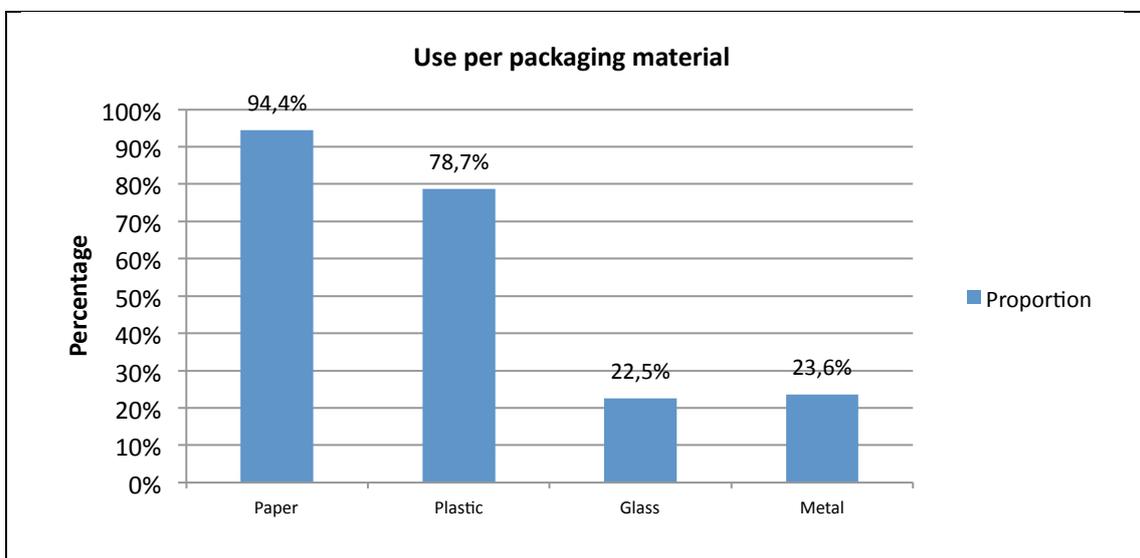


Figure 6.5. Use per packaging material (Industrial Customers)

According to the analysis, only a small proportion of the Industrial Customers used just one packaging material. The results are graphically presented below.

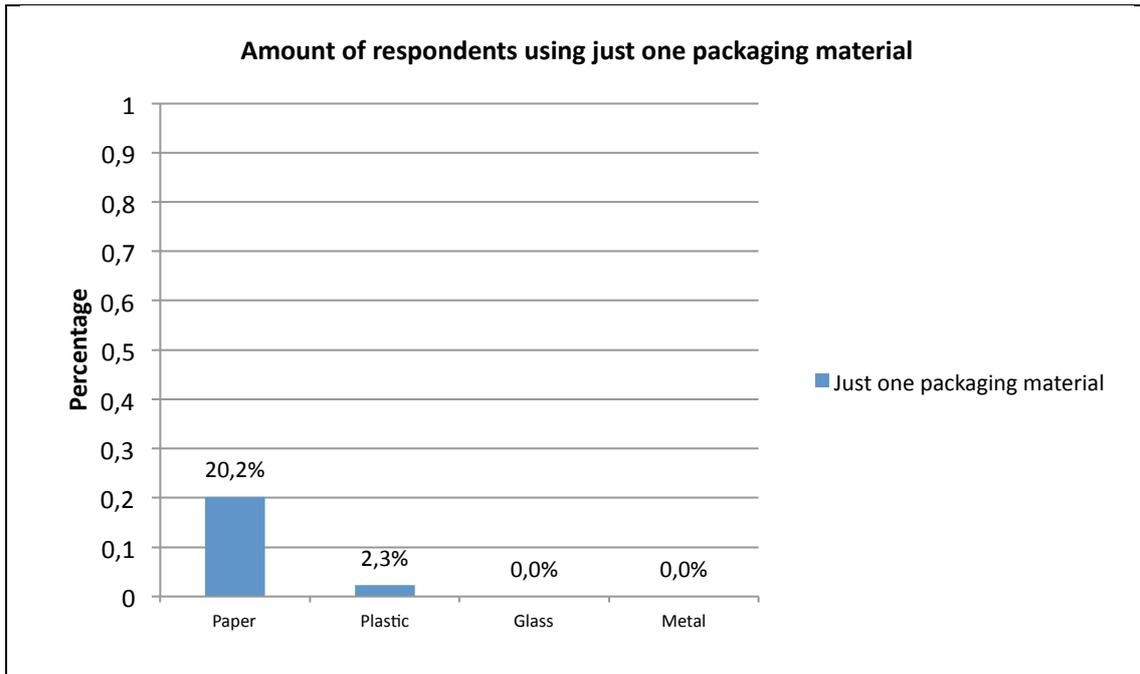


Figure 6.6. Use per packaging material (Industrial Customers)

As shown in Figure 6.6, paper is the most popular packaging material, considering that 20.2% percentage of the respondents use exclusively paper materials for their packaging operations. Plastic was found to be the second (and last) material of this categorisation, occupying a mere 2.3% percentage of the respondents, who choose to use only plastic as a packaging material for their products. Although it is difficult to define the mentality of this trend, it could be assumed that paper remains the main packaging material because of its basic function that allows it to act both as main (primary) packaging, as well as a subsidiary (secondary) packaging.

6.2.5. Issue No 5: Reverse Channel and Take Back Programmes Effectiveness

The data collected concerning the structure and the general function of the reverse channel has left no doubts about the harmony and normality of the current system. The answers collected by all participants, were consistent. The main findings are:

- The recycling centres (Suppliers) use their own vehicles to collect the waste paper packaging materials from the supply chain.
- The recycling centres (Suppliers) absorb all the cost for the collection of these materials.

- The recycling centres (Suppliers) pay a prearranged amount of money (price per kg) to acquire these materials from the supply chain.

The data showed that the reverse channel of paper packaging, is already designed, structured and operating in an effective way. According to the DG Environment²⁸(2011), around 80% of the total packaging waste generated in Greece, is recycled. As already discussed, the recycling centres already collect all these materials from the Greek market, and for this reason, the effectiveness of the system is further strengthened by such official published data.

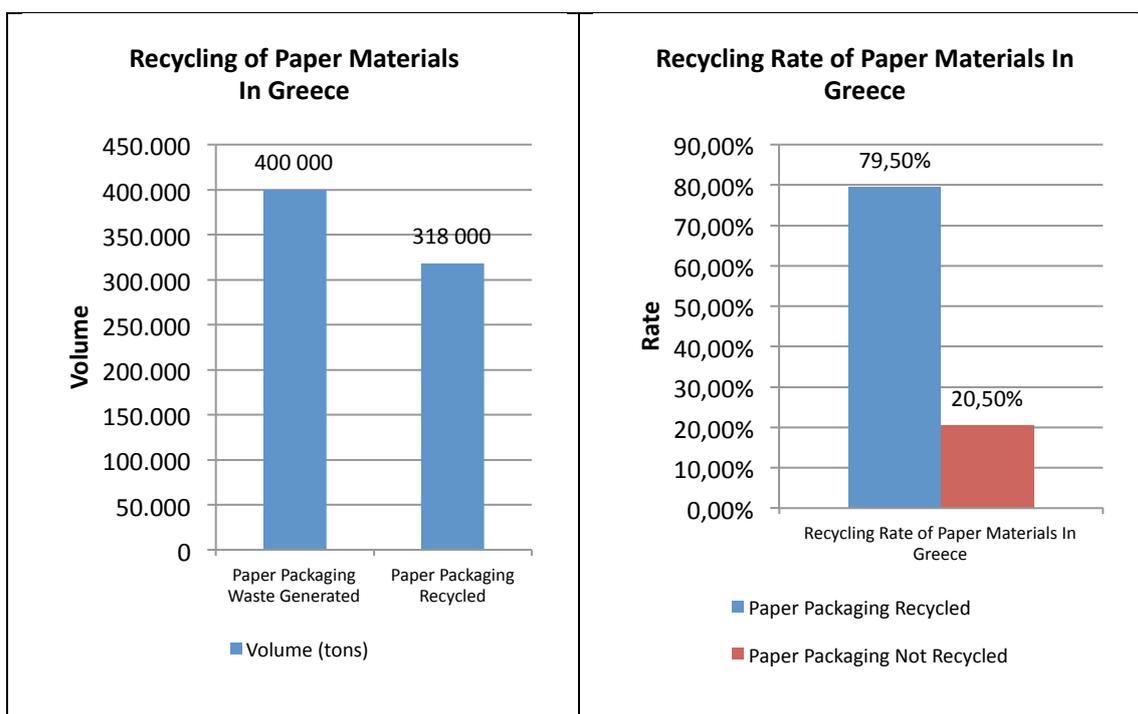


Figure 6.7. Recycling Rate of Paper Materials in Greece
(Data Source: DG Environment, 2011)

In addition, the other packaging materials have lower recycling rates, making the paper packaging supply chain, even more effective for the environment compared to all other materials. The results (including paper materials, for a better comparison) are presented below in Figure 6.8.

²⁸ The **Directorate-General for the Environment** is one of the more than 40 Directorates-General and services that make up the European Commission. Commonly referred to as **DG Environment**, the objective of the Directorate-General is to protect, preserve and improve the environment for present and future generations.

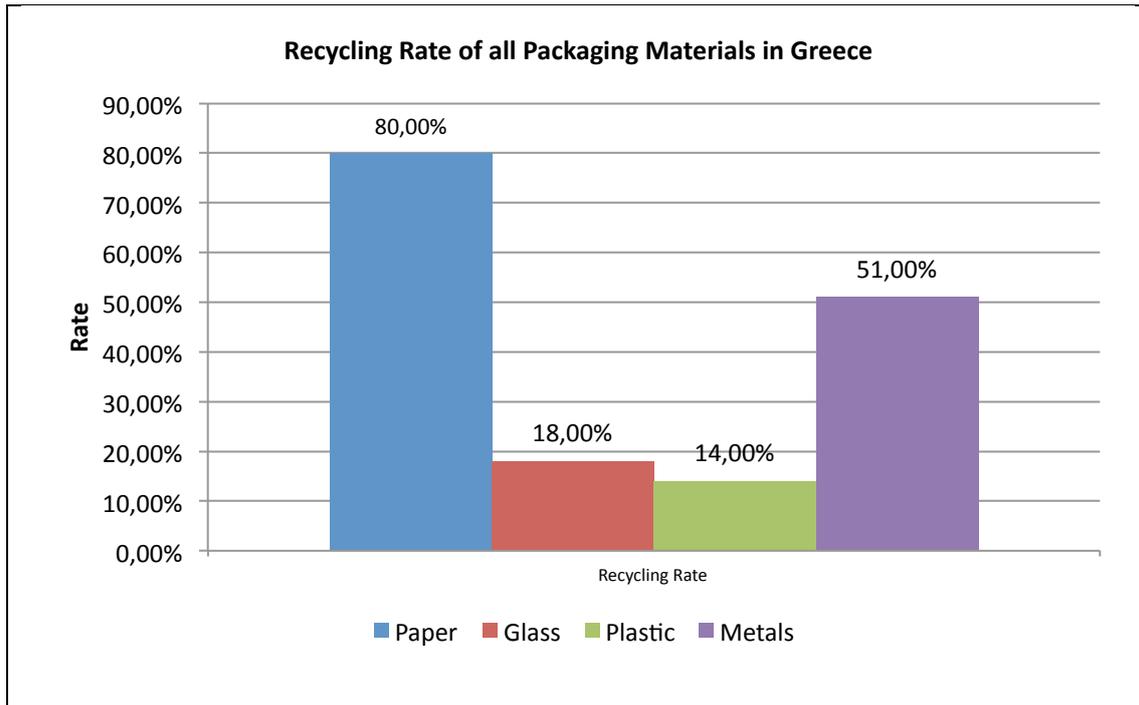


Figure 6.8. Recycling Rate of all Packaging Materials in Greece (Data Source: DG Environment, 2011)

6.2.6. Issue No 6: Lighter Packaging and Implications

An important issue investigated by the research was the intention of the participants to ask for lighter packaging in order to reduce the amount of money paid in taxes²⁹ when the government implements the Directive. The two links mostly involved in this issue are:

- The Packaging Manufacturers who decide on the kind of raw materials used in the manufacturing process, and
- The Industrial Customers who decide for the kind of packaging they are going to use for their packaging operations.

The results are shown in Figure 6.9.

As shown, 100% of the Packaging Manufacturers and ~63% of the Industrial Customers answered that they have no problem in reducing the weight of the packaging they produce or use by using lighter materials. Yet, there are individual elements that should be further discussed.

²⁹ Most of the tax systems are weight-based.

Technically, the reduction of paper packaging weight means that the different paper layers composing the paper board, should be lighter in order to give a lighter piece of packaging. The paper Packaging Manufacturer Multi Pack S.A. gave a better understanding of the above issue, by providing an estimate of the weight of packaging in two different cases:

1st Case: A Single Wall Corrugated Board having the following inside dimensions:

400x300x300 (mm)

Consisting of the three following paper grades:

- **130 gr/m²**
- **127 gr/m²**
- **110 gr/m²**

Would weight: **~450 gr/m²** or **399 gr/sheet**. Cost of paper per kg: **0.42€** - Cost of paper per piece: **0.167€**

2nd Case: The same Single Wall Corrugated Board, consisting of the three following paper grades:

- **110 gr/m²**
- **90 gr/m²**
- **100 gr/m²**

Would weight: **~368 gr/m²** or **325 gr/sheet**. Cost of paper per kg: **0.42€** - Cost of paper per piece: **0.137€**

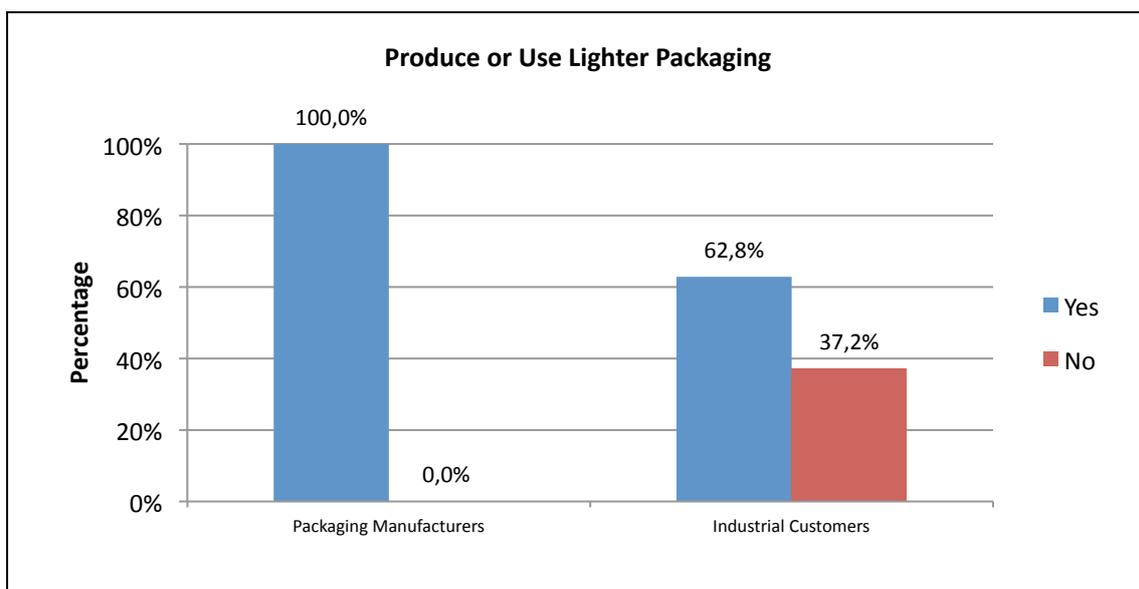


Figure 6.9. Produce or Use Lighter Packaging

- The reduction of sheet weight from the 1st Case to the 2nd Case, is 18.6%.
- Paper cost per kilo is the same in the two cases since we assume that the same kind of paper is used. In general, the cost per kilo remains the same for the same kind of paper, even if the gr/m² changes.
- The cost per unit is changing because the weight per unit is different in the two cases.

Still, it should be noted that:

- The protection offered by the packaging is different in the two cases. In general, lighter packaging offers less protection compared to heavier packaging.
- The cost between the two cases is significantly different (lighter paper packaging is always cheaper than the heavier sort if using the same quality of paper, since price is estimated based on the weight of the paperboard).

On the other hand, the protection that paper packaging is offering to the product is not of minor importance. 68.2% of the Industrial Customers answered that improper handling is responsible for packaging or product damages while 100% of the Wholesalers-Retailers and ~75% of the Final Consumers, answered that they have incurred damages to a product due to improper handling of its packaging at least once in the past. At the same time, 76% of the Final Consumers answered that they have received (at least once in the past) a damaged product due to an improper or destroyed packaging.

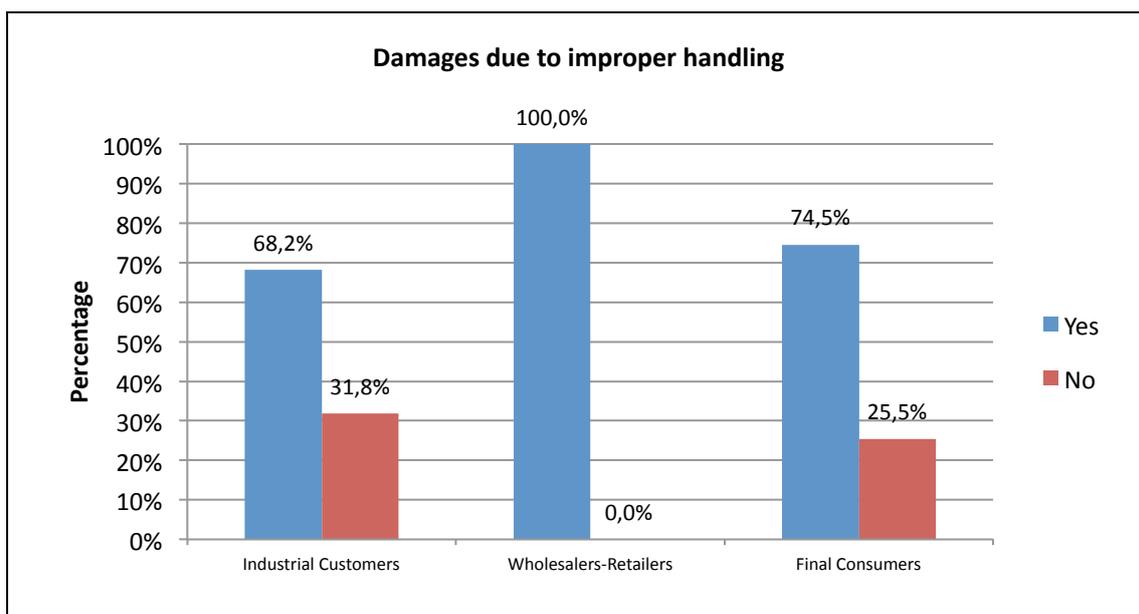


Figure 6.10. Damages due to improper handling

The answers are indicative of the importance of packaging quality for the normal function of the market. Damages in the packaging or moreover of the product itself, lead to a waste of natural resources, additional labour costs and increased handling, transportation and industrial costs that should be considered and estimated by users.

In most of the cases, the quality of packaging is strongly connected with product safety throughout the supply chain. According to a Packaging Manufacturer: *“If we change the paper grades using lighter materials, we may achieve a lighter packaging but at the same time the stacking strength of the packaging is further downgraded, taking the risk to increase product damages throughout the supply chain”*. Although there are relevant packaging strength tests that can be performed (Edge Crush Test, Box Compression Test etc) there are some limitations:

- a. Strength tests are conducted in the lab (ideal conditions) and cannot fully simulate original conditions. Furthermore, small fluctuations to a single factor (e.g. relevant humidity or storage time etc.) may affect the outcome.
- b. Strength tests are costly.
- c. Strength tests are conducted using a packaging item, manufactured in a specific batch, using materials (paper) with certain qualifications. Different paper characteristics (such as paper thickness or gr/m^2), however, may fluctuate and the manufactured product may have different physical strength between different productions (batches).

For all these reasons and despite the fact that strength tests are an important tool on some occasions, they can only provide a general theoretical view concerning the packaging strength and should be used with caution.

6.2.7. Issue No 7: Demand for environmental friendly packaging

The data collected showed that 58% of the industrial customers have never thought of using only recycled packaging materials and half (50%) of the Wholesalers-Retailers answered that they have thoughts of asking their suppliers to use more environmentally friendly packaging.

On the other hand, a very small percentage, 2.2% of the Final Consumers, rate Environmental Friendliness as the most important factor in order to buy a product. For them, the most important factor affecting their buying decision is the Price of the Product. Some of the Final Consumers mentioned that the increase of

the prices during the recent years has reduced their purchasing power, underlining that the other factors such as place of origin and environmental friendliness is of minor importance for their buying decisions.

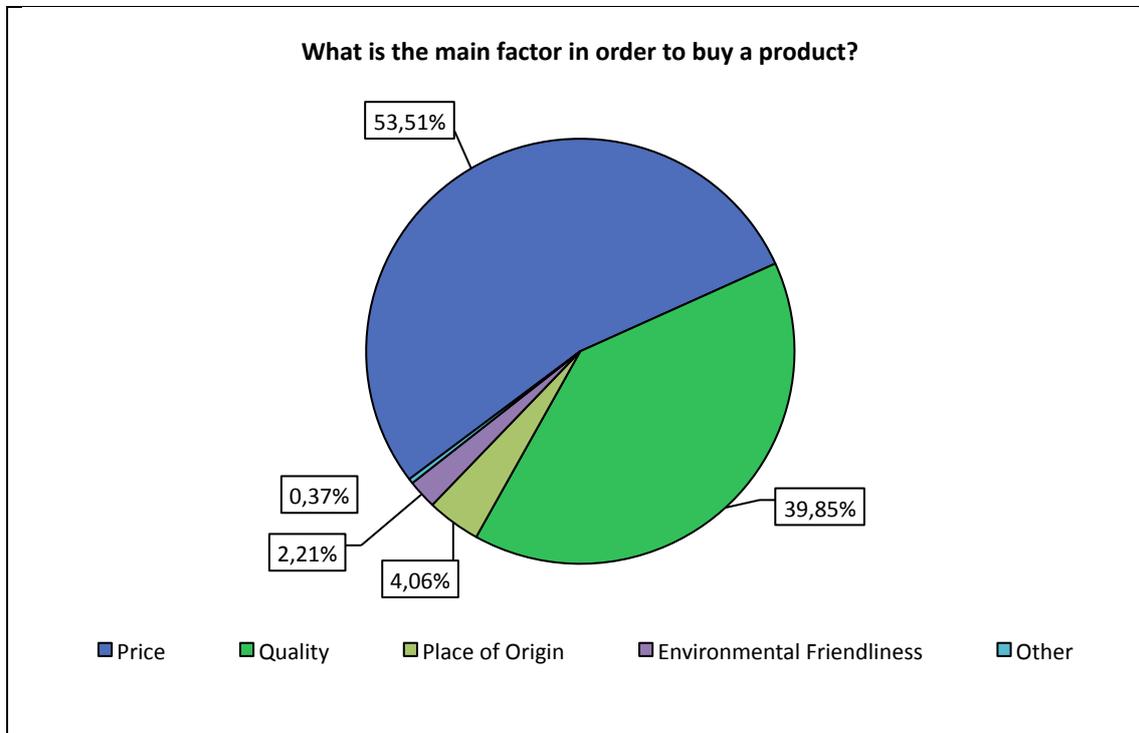


Figure 6.11. Main factors in buying a product

Issues No 7 and No 3 (Push of Cost):

The above results make clear that protection of the environment is not enough to force the market to use more environmental friendly packaging. The most important factor is money-based:

- cost for the industry-market, and
- price for the consumers.

Thus, it should be deduced that the only way to lead the market towards a more environmental friendly way of doing business is to give incentives in order to promote the shift of packaging materials to recyclable ones, such as for instance, evidence that doing so would potentially decrease the costs or charges weighing on the participants.

For what is relevant to the Industrial Customers and Wholesalers-Retailers, it could be predicted that the way to use only recyclable packaging materials (where possible) is for the government to give money-based incentives (e.g. tax exemption).

This would eventually contribute to the broader use of environmentally friendly packaging materials by the market.

Consumers on the other hand, need a better price motive in order to ask for “green” packaging from the supply chain. A consumer commented that: “*The present economic conditions leave no space for environmentalism or such acts since citizens are primarily seeking ways to reduce their family burdens*”, leaving the factor of “green products” last, for what is relevant to their buying decisions. This issue if further combined with the “*Push of Cost Issue*” discussed above, strengthens the following view that derives from the data collected and the relevant analysis:

“Products imported from countries with no environmental legislation enacted have more advantages if compared to equivalent domestic European products, on which European Environmental Regulations are imposed by the European Union, to be further implemented by the Member States”. Such measures and regulations establish mechanisms and create cost that all parties involved are called to undertake. It is apparent that products coming from areas with no such legislation in force are free of such charges, thus their cost is not further aggravated. As a consequence, they appear more attractive to the consumer.

In such a market environment competition seems both unfair and unstable. Moreover it doesn't seem likely to operate. It seems that the only way for the competition to operate well and fair is the adoption of environmental legislation on an international level and the mandatory adoption by all countries. In this case no manufacturer is going to be more favoured than another and the products are going to begin from the same base at least for what is relevant to their environmental obligations.

6.3. Alternative suggestions for a more sustainable packaging supply chain

An alternative suggestion to improve the performance of the current Packaging Supply Chain would be to redesign completely or partially the existing packaging practices applied to the protection of a product. Many researchers support that packaging sustainability is currently going through some kind of redesigning. As Eubanks (2009) supports, it is common ground for packaging engineers to seek innovative ways of enhancing the existing packaging characteristics of a product, in order to achieve further cost reduction, as well as performance improvement. According to Johnson (2009), many a company, including Natural Resources Inc. and Starbucks Coffee Company, is striving to

reduce packaging expenditure, while improving the packaging design of their products along with enhancing their environmental performance. Considering the above as the cardinal notion of the investigation on the specific issue, the following cases are presented accordingly.

The two case studies (A and B) investigate the advantages of redesigning the corrugated (secondary) packaging for two different products. The selection for the investigation of the specific type of packaging (secondary) was based on the following assumptions:

- i. The primary packaging involves serious marketing elements (e.g. shape, size etc.) and potential changes could influence the consumption of the product.
- ii. The transport packaging (e.g. pallets) is in general predetermined by specific factors (e.g. warehousing operations) and furthermore potential changes could be costly for the user.

The main idea following the redesign of the secondary packaging can be summarised as follows:

- i. To achieve a better utilization of vehicle space during transportation, which if realized would further decrease various transportation costs, through increasing the volume of the carried products. Calver (2004) supports that a detailed packaging redesign can result in reduction of the space which a product occupies during transportation or warehousing. In addition, according to Bix et. al. (2009), intermediaries such as fillers or transporters require that packaging should be easy to process, handle, store, ship and track in order to maximize product efficiency without increasing associated expenditure.
- ii. To achieve a better distribution of the total packaging weight per piece. This could be succeeded by an increase in the volume of products carried during transportation, caused by redesigning the secondary packaging.
- iii. To improve the quality of secondary packaging, in order to decrease damage during transport or handling operations. According to Calver (2004), the redesigning process should be examined in such a way, so as to discern if any adjustments can be made to reduce product wastage owing to improper handling.

In order to investigate the redesigning process and the advantages that may be derived from conducting it, two products (2TMIX and glass wine bottles of 0.75lit)

were selected randomly in order to be analysed. Multi Pack has provided all the necessary information concerning these products, including their technical characteristics (size, weight), as well as the packaging type currently used for each of the products, in order to help the researcher proceed with the investigation.

Tops Pro software³⁰, was used for the investigation.

Case Study A: Description

As shown below, the analysis includes three (3) different variations. **Case A1** is the actual, current packaging situation. After redesigning the secondary packaging (single wall corrugated packaging) two suggested Cases were derived. **Case A2** and **Case A3** that follow are the advanced, alternative packaging solutions. Multi Pack provided all the required information in order to proceed with the investigation.

A liquid product named as **2T Mix**, is currently packaged into a plastic bottle (primary packaging) with specific dimensions. In all of the following three Cases, the primary packaging (bottle), remains the same. In addition the type of the corrugated secondary packaging used: **Single Wall Corrugated Board**, remains the same in all three Cases. The pallet used in all three Cases below is a Europallet (800x1200mm) weighing 25kg/piece. Furthermore, the pallets are assumed to be returned and for this reason, their cost is not included in the case study. It should be noted that pallet double stacking is not allowed.

The vehicle used has the following dimensions:

Net Length	13600mm
Net Width	2420mm
Net Height	2400mm

Payload (Maximum Carrying Weight) of the vehicle in all three Cases has been determined to be: 25000kg.

³⁰ *“TOPS Pro is a packaging design software developed to assist packaging professionals in creating optimal package designs and pallet patterns.”* The software has been developed by TOPS Software Corporation.

Restrictions

- Shelf Height Restriction defined by the Warehouse is (\leq) less or equal to 2100mm. The pallet should not exceed the given maximum height of 2100mm.
- Transportation Height Restriction: \leq 2300mm. The pallet should not exceed the given maximum height of 2300mm due to given vehicle's dimensions.
- Unit Load: Includes paper corrugated boxes which are strictly corresponding accordingly to each of the three cases studied. All products carried by the vehicle are the same: 2TMIX packaged as shown in each Case.
- Pallet Overhang: 0mm. This means that overhang³¹ is not allowed.

³¹ According to Multi Pack's warehouse director, overhang is the term used to describe the exceeding portion of a unit occupying the dimensions of a pallet, i.e. its length and/or width, which is likely to lead to loading, unloading and storage difficulties, thus reducing the performance of the unit and causing damage. Another case of ineffectiveness could be attributed to Underhang, which means that the conveyed containers are not fully occupying the dimensions of the pallet, leaving unoccupied space.

CASE A1 – 2T MIX

Primary Packaging (Bottle)	 <p>Figure 6.12. Primary Packaging</p>	Type:	Plastic Bottle
		Net Weight (Product):	200gr.
		Gross Weight (Product+Bottle):	220gr.
		Bottle Weight:	20gr.
		Cost/Bottle:	0.0543€

The primary packaging is a plastic bottle weighing 20gr (Figure 6.12). Its gross weight (bottle and included product) is 220gr. The cost per bottle is 0,0543€.

Secondary Packaging (Shipper)	 <p>Figure 6.13. Secondary Packaging</p>	Type:	Corrugated Box
		Pieces of primary/secondary packaging:	50
		Corrugated box weight:	329gr.
		Net Weight (Product):	10000 gr.
		Gross Secondary Packaging Weight (Product+Packaging):	11329 gr.
		Total Packaging Weight/shipper (Bottles+Shipper):	1329 gr.
		Cost/Secondary Packaging:	0.2656€
		Total Packaging Cost/Shipper (Primary+Secondary Packaging):	2.9806€

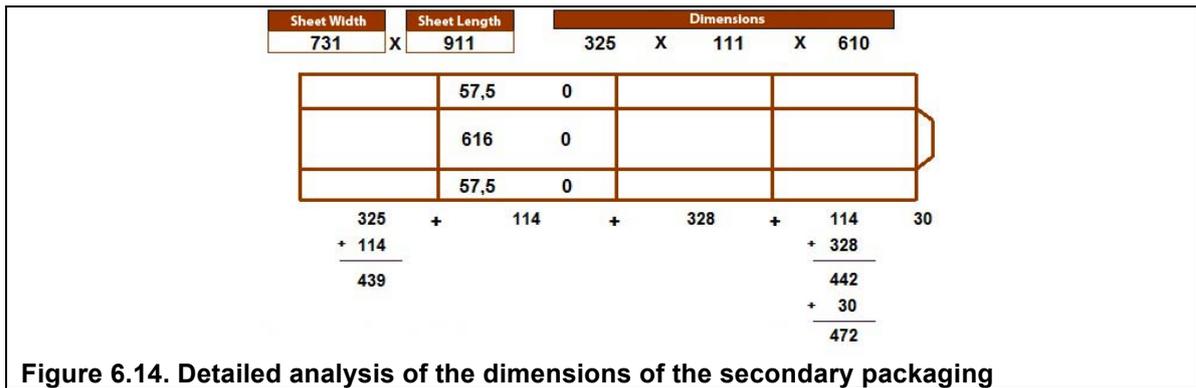


Figure 6.14. Detailed analysis of the dimensions of the secondary packaging

As shown above in Figure 6.13, the secondary packaging (shipper) is a paper corrugated box, weighing 329gr. The inside dimensions of the shipper are (Length x Width x Depth in mm): 325x111x610 (see Figure 6.14). The outside dimensions of the shipper are (Length x Width x Depth in mm): 333x119x625 (technical information provided by Multi Pack). In this case (Case A1) each corrugated box contains 50 pieces of primary packaging and the gross weight per shipper (product and total packaging) is 11329gr. The total packaging weight per shipper is 1329gr.

Each shipper costs 0.2656€. The total packaging cost per shipper (primary and secondary packaging) is 2.9806€.

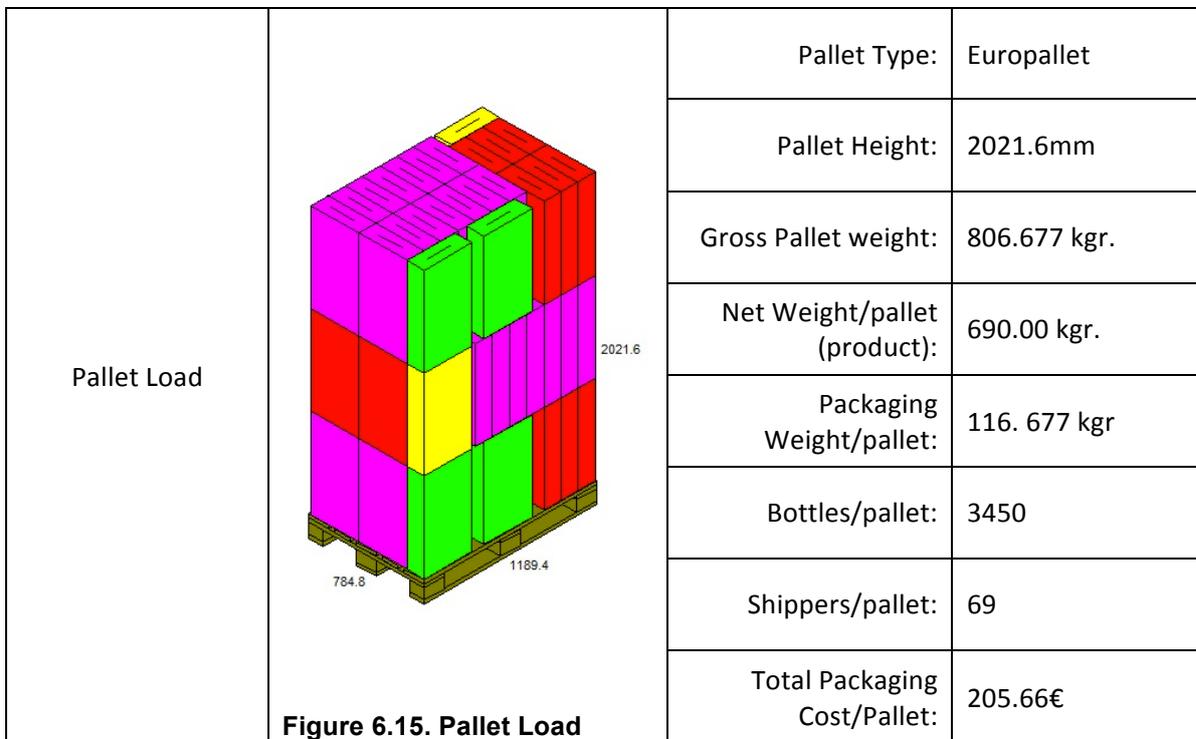


Figure 6.15. Pallet Load

As shown in Figure 6.15, the shippers are stacked onto Europallets (dimensions of a Europallet: 800x1200mm). In this case, each pallet contains 69 shippers (thus 3450 bottles). Pallet height is 2022mm. The gross pallet weight is ~807kgr (pallet weight included). The product weight per pallet is 690kgr while the total packaging cost comes up to 205.66€.

Vehicle Load	Vehicle Type:	Semi-trailer (13600x2420x2400)
	Gross LoadWeight:	24200.31 kgr.
	Net Load Weight (product):	20700.00 kgr.
	Total Packaging Weight/ Vehicle Load:	3500.31 kgr.
	Bottles/Vehicle:	103500
	Shippers/ Vehicle:	2070
	Pallets/ Vehicle:	30
	Total Packaging Cost/ Vehicle Load:	6169.84€

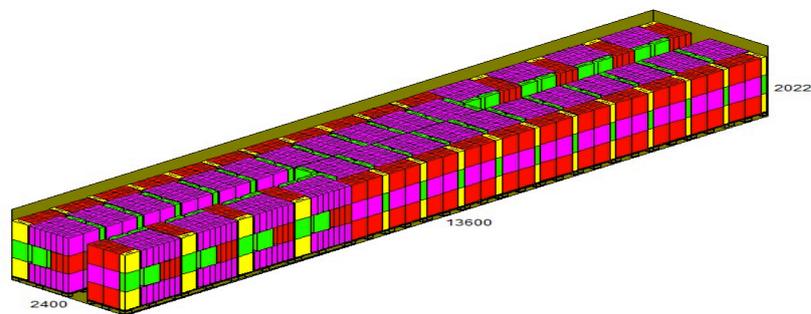


Figure 6.16. Vehicle Load

Finally, as shown in Figure 6.16 the pallets are placed into a semi-trailer (Length x Width x Depth in m: 13.6 x 2.42 x 2.4). Each vehicle contains 30 pallets (thus 2070 shippers and 103500 bottles) and the gross load weight is 24201kgr (pallet weight included). The total product weight per vehicle load is 20700kgr thus the total packaging weight per vehicle load is 3500kgr. The total packaging cost per vehicle load is 6169.84€.

Table 6.2. Data Summary Case A1

Data Summary				
	Primary Packaging (Bottle)	Secondary Packaging (Shipper)	Pallet (Unit load)	Vehicle Load
Inside Dimensions				
Length (mm)	-	325	-	13600
Width (mm)	-	111	-	2400
Height (mm)	-	610	-	2022
Outside Dimensions				
Length (mm)	59	332.94	1189.4	-
Width (mm)	59	118.94	784.8	-
Height (mm)	122	625.88	2021.6	-
Weight				
Net Weight	200 gr	10.00 kgr	690.00 kgr	20700 kgr.
Gross Weight (gr)	220 gr	11.329 kgr	806.70 kgr <i>(pallet weight included)*</i>	24201 kgr. <i>(pallet weight included)*</i>
Total Packaging Weight (gr) per:	20 gr	1.329 kgr	116.70 kgr <i>(pallet weight included)*</i>	3501 kgr. ^(a) <i>(pallet weight included)*</i>
Pieces of Packaging				
Pieces of bottle per:	-	50	3450	103500 ^(b)
Pieces of shipper per:	-	-	69	2070
Pallets per:	-	-	-	30
Cost				
Cost per:	0.0543€	0.2656€	-	-
Total Packaging Cost	0.0543€	2.9806€	205.66€	6169.84€
Total Packaging Weight/Bottle Equivalence ^(c)	33.83gr			

*Pallet Weight = 25 kgr

** Weight of Packaging Equivalent to each bottle (c) = Total Packaging Weight
per Vehicle load (a)/Bottles per Vehicle (b)

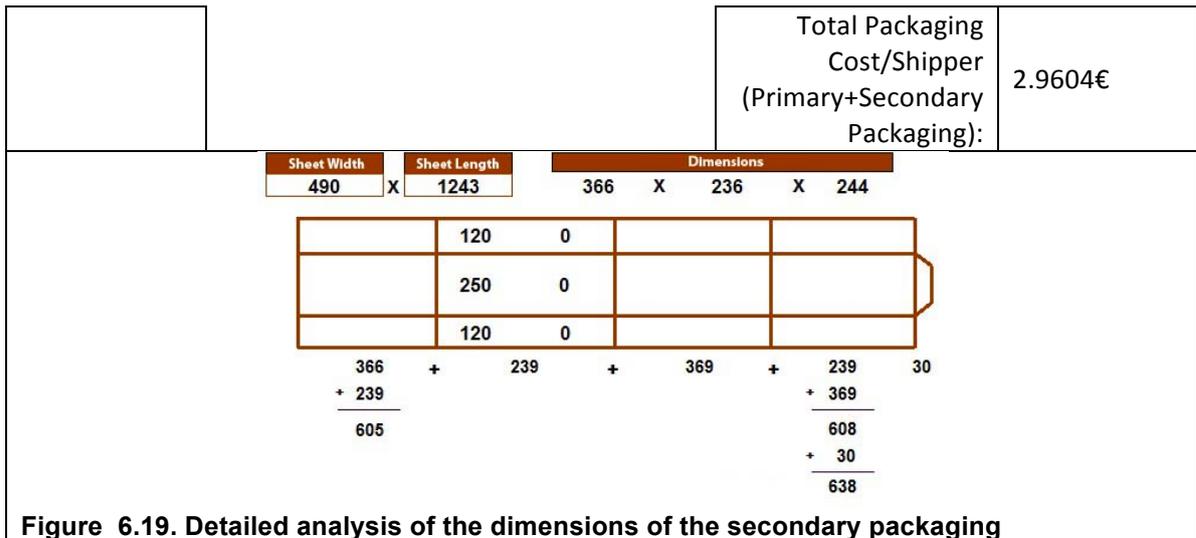
CASE A2 – 2T MIX

Primary Packaging (Bottle)	 <p>Figure 6.17. Primary Packaging</p>	Type:	Plastic Bottle
		Net Weight (Product):	200gr.
		Gross Weight (Product+Bottle):	220gr.
		Bottle Weight:	20gr.
		Cost/Bottle:	0.0543€

The primary packaging is the same as in Case A1 (see Figure 6.17). It is a plastic bottle weighing 20gr and its gross weight (product and bottle included) is 220gr. The cost per bottle is 0.0543€.

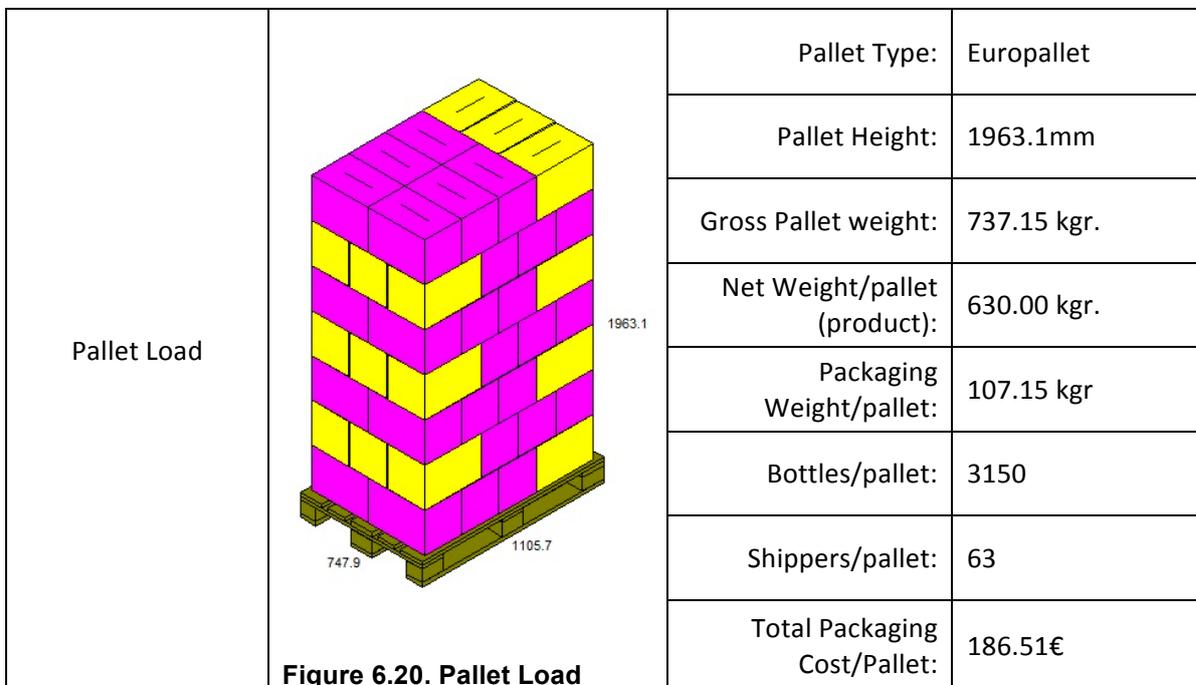
In this Case (Case A2) the secondary packaging was redesigned in order to investigate an alternative to Case A1 solution. While the number of the contained products remains the same as in Case A1 (50 bottles), in this case the shipper design changes, causing changes to pallet and vehicle load, to the total number of bottles carried per vehicle and to the total number of shippers carried per vehicle as described below.

Secondary Packaging (Shipper)	 <p>Figure 6.18. Secondary Packaging</p>	Type:	Corrugated Box
		Pieces of primary/secondary packaging:	50
		Corrugated box weight:	304gr.
		Net Weight (Product):	10000 gr.
		Gross Secondary Packaging Weight (Product+Packaging):	11304 gr.
		Total Packaging Weight/shipper (Bottles+Shipper):	1304 gr.
		Cost/Secondary Packaging:	0.2454€



As shown in Figure 6.19, the secondary packaging (shipper) is a paper corrugated box with inside dimensions (Length x Width x Depth in mm): 366x236x244, weighing 304gr. The outside dimensions of the shipper are (Length x Width x Depth in mm): 374x244x260 (technical information provided by Multi Pack). In this case (Case A2) each shipper contains 50 pieces of primary packaging and its gross weight (product and total packaging) is 11304gr. The total packaging weight per shipper is 1304gr.

Each shipper costs 0.2454€. The total packaging cost of the shipper (contained bottles and secondary packaging) is 2.9604€.



In this case (Case A2), similar with Case A1, the shippers are stacked onto Europallets with net dimensions 800x1200mm (see Figure 6.20). Each pallet contains 63 shippers and 3150 pieces of primary packaging. Pallet height is 1963mm. The gross pallet weight is ~737kgr (pallet weight included). The net product weight per pallet is 630kgr and the total packaging cost comes up to 186.51€.

Vehicle Load	Vehicle Type:	Semi-trailer (13600x2420x2400)
	Gross LoadWeight:	24325.95 kgr.
	Net Load Weight (product):	20790.00 kgr.
	Total Packaging Weight/ Vehicle Load:	3535.95 kgr.
	Bottles/Vehicle:	103950
	Shippers/Vehicle:	2079
	Pallets/Vehicle:	33
	Total Packaging Cost/ Vehicle Load:	6154.67€

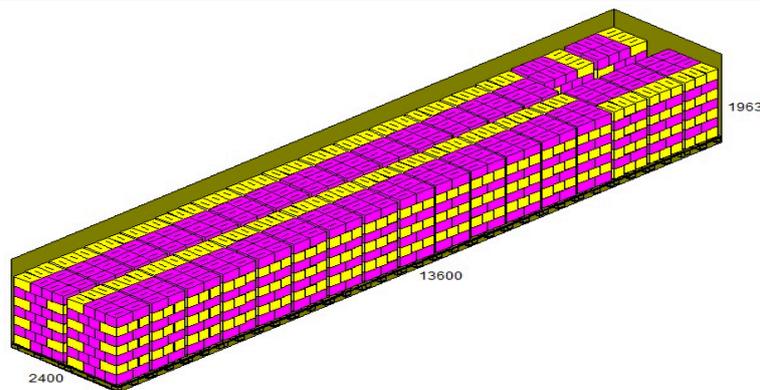


Figure 6.21. Vehicle Load

Similar with Case A1, in this case (Case A2) the same type of vehicle has been used, a semi trailer with dimensions (Length x Width x Depth in m): 13.6 x 2.42 x 2.4 (see Figure 6.21). Each vehicle contains 33 pallets (thus 2079 shippers and 103950 bottles). The gross load weight (with pallet weight included) comes up to 24325.95 kgr. thus the total packaging weight per vehicle load is 3535.95 kgr. The total packaging cost per vehicle load is 6154.67€.

Table 6.3. Data Summary Case A2

Data Summary				
	Primary Packaging (Bottle)	Secondary Packaging (Shipper)	Pallet (Unit load)	Vehicle Load
Inside Dimensions				
Length (mm)	-	366	-	13600
Width (mm)	-	236	-	2400
Height (mm)	-	244	-	1963
Outside Dimensions				
Length (mm)	59	373.94	1105.7	-
Width (mm)	59	243.94	747.9	-
Height (mm)	122	259.88	1963.1	-
Weight				
Net Weight	200 gr	10.00 kgr	630.00 kgr	20790 kgr
Gross Weight (gr)	220 gr	11.304 kgr	737.15 kgr (pallet weight included)*	24326 kgr (pallet weight included)*
Total Packaging Weight (gr) per:	20 gr	1.30kgr	107.15 kgr (pallet weight included)*	3536 kgr ^(a) (pallet weight included)*
Pieces of Packaging				
Pieces of bottle per:	-	50	3150	103950 ^(b)
Pieces of shipper per:	-	-	63	2079
Pallets per:	-	-	-	33
Cost				
Cost per:	0.0543€	0.2454€	-	-
Total Packaging Cost	0.0543€	2.9604€	186.51€	6154.68€
Total Packaging Weight/Bottle Equivalence ^(c)	34.02gr			

*Pallet Weight = 25 kgr

** Weight of Packaging Equivalent to each bottle(c) = Total Packaging Weight
per Vehicle load (a)/Bottles per Vehicle (b)

CASE A3 – 2T MIX

Primary Packaging (Bottle)	 <p>Figure 6.22. Primary Packaging</p>	Type:	Plastic Bottle
		Net Weight (Product):	200gr.
		Gross Weight (Product+Bottle):	220gr.
		Bottle Weight:	20gr.
		Cost/Bottle:	0.0543€

The primary packaging remains the same in all three cases. It is a plastic bottle weighing 20gr and its gross weight (product and bottle) is 220gr (see Figure 6.22). The cost per bottle is 0.0543€.

In this Case (Case A3) the secondary packaging was redesigned in order to provide an alternative to Case A1 packaging solution. The number of the contained products was increased to 54 (comparing with 50 bottles in Case A1). As a result the redesigning process caused changes to pallet and vehicle load as shown below.

Secondary Packaging (Shipper)	 <p>Figure 6.23. Secondary Packaging</p>	Type:	Corrugated Box
		Pieces of primary/secondary packaging:	54
		Corrugated box weight:	310gr.
		Net Weight (Product):	10800 gr.
		Gross Secondary Packaging Weight (Product+Packaging):	12190 gr.
		Total Packaging Weight/shipper (Bottles+Shipper):	1390 gr.
		Cost/Secondary Packaging:	0.2502€
		Total Packaging Cost/Shipper (Primary+Secondary Packaging):	3.1824€

Vehicle Load	Vehicle Type:	Semi-trailer (13600x2420x2400)
	Gross LoadWeight:	24582.00 kgr.
	Net Load Weight (product):	21092.00 kgr.
	Total Packaging Weight/ Vehicle Load:	3490.00 kgr
	Bottles/ Vehicle:	105462
	Shippers/ Vehicle:	1953
	Pallets/ Vehicle:	31
	Total Packaging Cost/ Vehicle Load:	6215.19€

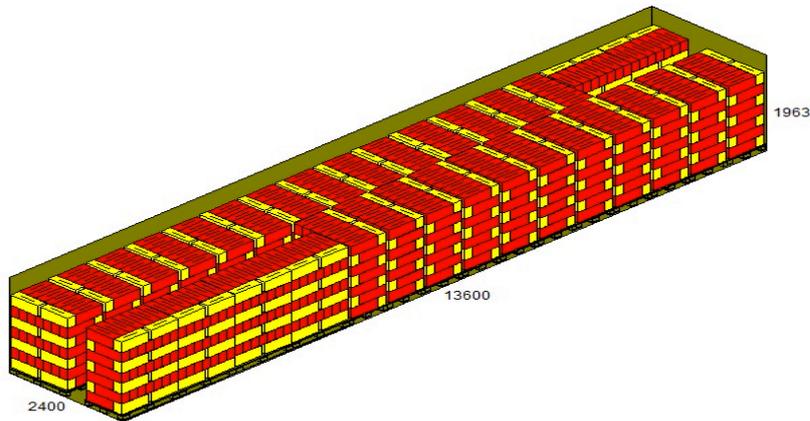


Figure 6.26. Vehicle Load

The pallets are placed into a semi trailer with dimensions (Length x Width x Depth in m): 13.6 x 2.42 x 2.4 (see Figure 6.26). Each vehicle contains 31 pallets (thus 1953 shippers and 105462 bottles). The gross load weight is 24582 kgr. (pallet weight included) while the total packaging weight per vehicle load comes up to 3490 kgr. The total packaging cost per vehicle load is 6215.19€.

Table 6.4. Data Summary Case A3

Data Summary				
	Primary Packaging (Bottle)	Secondary Packaging (Shipper)	Pallet (Unit load)	Vehicle Load
Inside Dimensions				
Length (mm)	-	561	-	13600
Width (mm)	-	162	-	2400
Height (mm)	-	244	-	1963
Outside Dimensions				
Length (mm)	59	568.94	1189.6	-
Width (mm)	59	169.94	738.9	-
Height (mm)	122	259.88	1963.1	-
Weight				
Net Weight	200 gr	10.80 kgr	680.40 kgr	21092 kgr
Gross Weight (gr)	220 gr	12.19 kgr	792.98 kgr <i>(pallet weight included)*</i>	24582 kgr <i>(pallet weight included)*</i>
Total Packaging Weight (gr) per:	20 gr	1.39 kgr	112.58 kgr <i>(pallet weight included)*</i>	3490 kgr ^(a) <i>(pallet weight included)*</i>
Pieces of Packaging				
Pieces of bottle per:	-	54	3402	105462 ^(b)
Pieces of shipper per:	-	-	63	1953
Pallets per:	-	-	-	31
Cost				
Cost per:	0.0543€	0.2502€	-	-
Total Packaging Cost	0.0543€	3.1824€	200.49€	6215.19€
Total Packaging Weight/Bottle Equivalence^(c)	33.09gr			

*Pallet Weight = 25 kgr

** Weight of Packaging Equivalent to each bottle(c) = Total Packaging Weight per Vehicle load (a)/Bottles per Vehicle (b)

CHAPTER 6 - Discussion – Overpackaging Investigation – Alternative Packaging Suggestions

Cases	Bottles/vehicle	% difference from Case 1	Shipper/Vehicle	% difference from Case 1	Pallets/Vehicle	Packaging Wgt/Vehicle	% difference from Case 1	Total Packaging Weight/Bottle Equivalence	% difference from Case 1
Case 1	103 500	-	2 070	-	30	3 501	-	33.83	-
Case 2	103 950	0.43%	2 079	0.43%	33	3 536	1.00%	34.02	0.56%
Case 3	105 462	1.90%	1 953	-5.65%	31	3 490	-0.31%	33.09	-2.19%

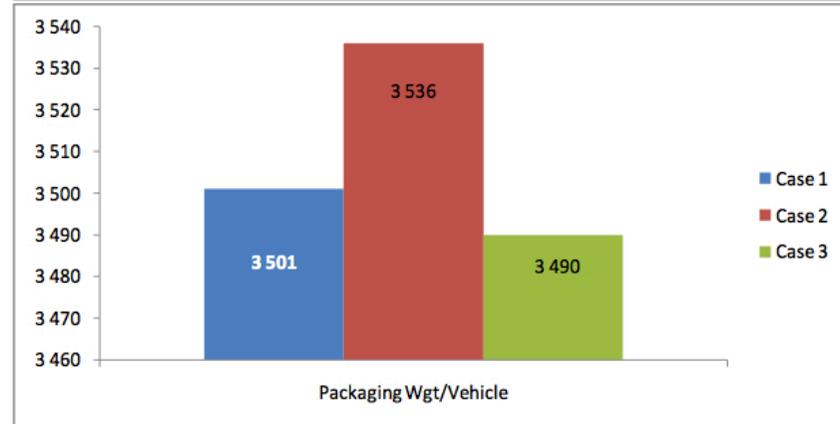
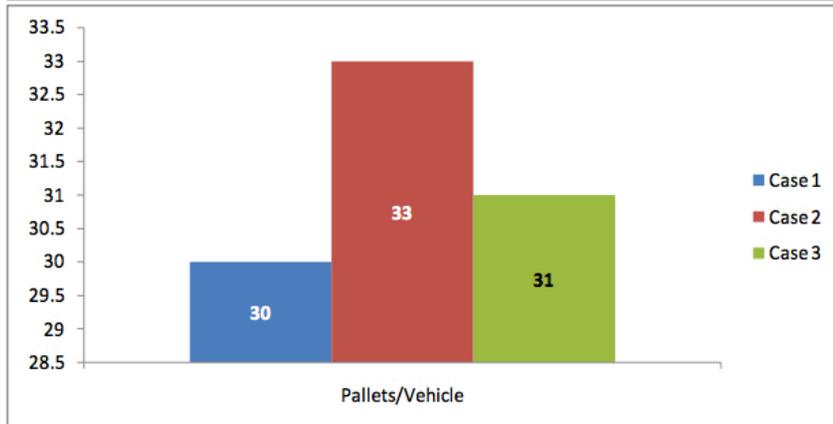
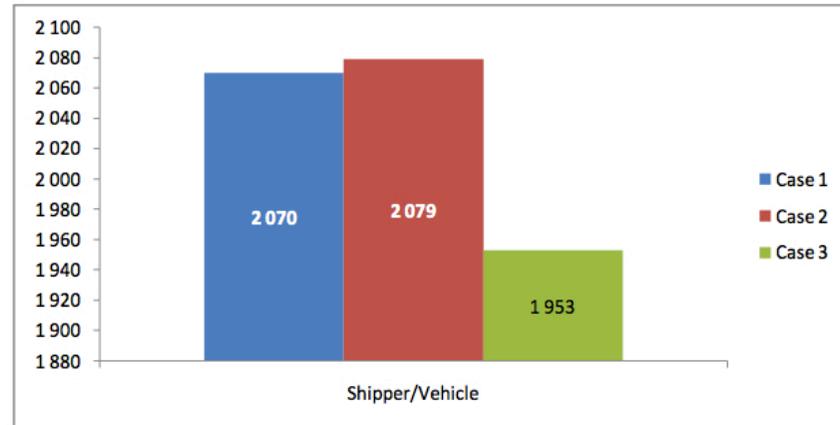
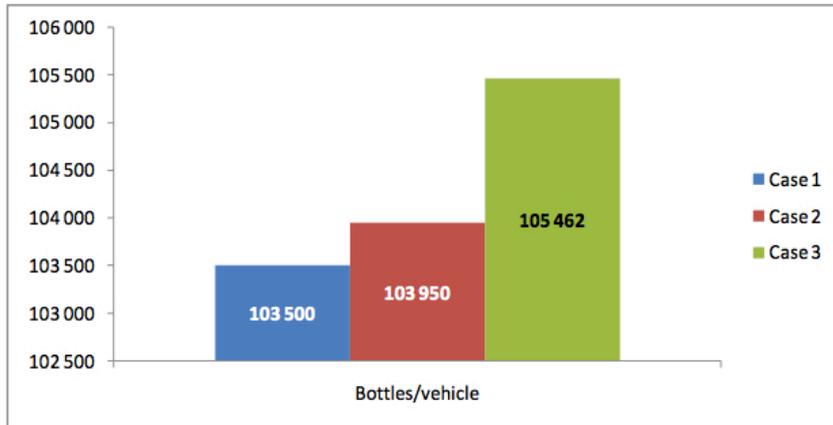


Figure 6.27. Cases comparisons

- As presented above, from a single redesign of the secondary packaging, a company could achieve an increase in the volume of total bottles carried per vehicle, of 0.43% from Case A1 to Case A2 and 1.9% from Case A1 to Case A3. The difference whilst small is not of minor importance since the industry always tries to optimise the supply chains and boost their sustainability.
- At the same time, despite of the fact that in Case A3, a company could carry nearly 2000 more bottles compared to Case A1, the company would need 117 less shippers/shipment (secondary packaging). In this case, there is a significant cost saving for the company that comes not only from the fewer shippers per shipment but from the bigger amount of bottles carried at the same transportation cost.
- The net packaging weight/vehicle, will be 1% more from Case A1 to Case A2 and 0.31% less from Case A1 to Case A3.
- The total packaging weight associated to a bottle would be 0.56% more, from Case A1 to Case A2 and 2.19% less, from Case A1 to Case A3.
- It should be noted that the packaging cost would be 0.25% less from Case A1 to Case A2 and 0.74% more from Case A1 to Case A3.

In general terms, except for the fact that the total cost of packaging would be increased ~45€ per vehicle load from Case A1 to Case A3, all the other elements advocate that the redesign would be advantageous for the company. The increase of the volume of total bottles carried per vehicle clearly boosts the sustainability of the supply chain and this fact, in combination with the decrease in the number of shippers needed to carry this larger amount of bottles, helps the company to save costs and stimulate its competitiveness.

It should be noted that the redesign of the packaging itself is a matter of great importance for a company. Many of them change the type or the shape of the packaging they use for different reasons that range from the aim to show a renewal of the product or to improve the performance of the packaging itself to aims such as to help the environment (or to show a more environmental friendly face to their customers) by using recycled or recyclable materials. For example, in 2013 Pepsi announced a new bottle shape initially available for sale in specific stores. According to Zmuda (2013), Pepsi's main aim was to provide a new, refreshed image for the brand through its innovative packaging. In addition, as described by Lindell (2013), in 2013 "Unreal", an American candy company decided to make serious changes to its packaging design. Changes were about to be applied not only to the shape but to

the graphics printed on the packaging, as well. According to the company's co-founder, Melonas: *"the changes are all just part of the company's mission to continually evolve"*.

In any case, the redesign is not as easy as it may sound since it requires the collaboration of individual departments of the company such as the:

- logistics – focused to the easiness of use of the new product throughout the supply chain (storage, transportation, handling),
- accounting – interested to the cost for the production of the new packaging,
- marketing – focused to the promotion or the appearance of the new product-packaging, etc.

However, the Case should be further examined in order to better ascertain if the redesign:

- Would be advantageous from an environmental perspective, regarding the fuel emissions from one case to another. The advantages could derive from the fact that the redesigning process would make it feasible for more products to be carried per vehicle. Accordingly, this would result in less fuel emissions per product carried.
- Would achieve any further profits for the company.

Case Study B: Description

In order to further investigate the redesigning process the following glass wine bottles of 0.75lit. were selected in Case B. Multi Pack provided all the required information in order to proceed with the investigation.

Case B1 is the current packaging situation. **Case B2** is the new, alternative packaging solution.

A glass wine bottle of 0.75lit. is currently used as a primary packaging. In the following two alternative packaging options, the primary packaging (bottle), remains the same. In a same manner the type of the corrugated secondary packaging: **Single Wall Corrugated Board**, remains the same in the two Cases. In addition, the corrugated box in any case should contain a specific number of bottles - 6X0.75lit. The pallet used in all Cases is a Europallet (800x1200mm) and is assumed to be returned. For this reason their cost is not included in the case study. The pallet weight is 25kg/piece. It should be noted that double stacking is not allowed.

The vehicle used (Semi-trailer) has the following dimensions:

Net Length	13600mm
Net Width	2420mm
Net Height	2400mm

- Payload (Maximum Carrying Weight) of the vehicle in both cases has been determined to be: 25000kg.

Restrictions

- Shelf Height Restriction defined by the Warehouse: $\leq 1800\text{mm}$. The pallet should not exceed the given maximum height of 1800mm.
- Transportation Height Restriction: $\leq 2300\text{mm}$. The pallet should not exceed the given maximum height of 2300mm due to given vehicle's dimensions.
- Unit Load: Includes paper corrugated boxes which are strictly corresponding accordingly to each of the two cases studied. All products carried by the vehicle are the same: Wine bottles of 0.75lit. packaged as shown in each Case.
- Pallet Overhang: 0mm. This means that overhang³² is not allowed.

³² According to Multi Pack's warehouse director, overhang is the term used to describe the exceeding portion of a unit occupying the dimensions of a pallet, i.e. its length and/or width, which is likely to lead to loading, unloading and storage difficulties, thus reducing the performance of the unit and causing damage. Another case of ineffectiveness could be attributed to Underhang, which means that the conveyed containers are not fully occupying the dimensions of the pallet, leaving unoccupied space.

CASE B1 – Wine Bottle 750ml

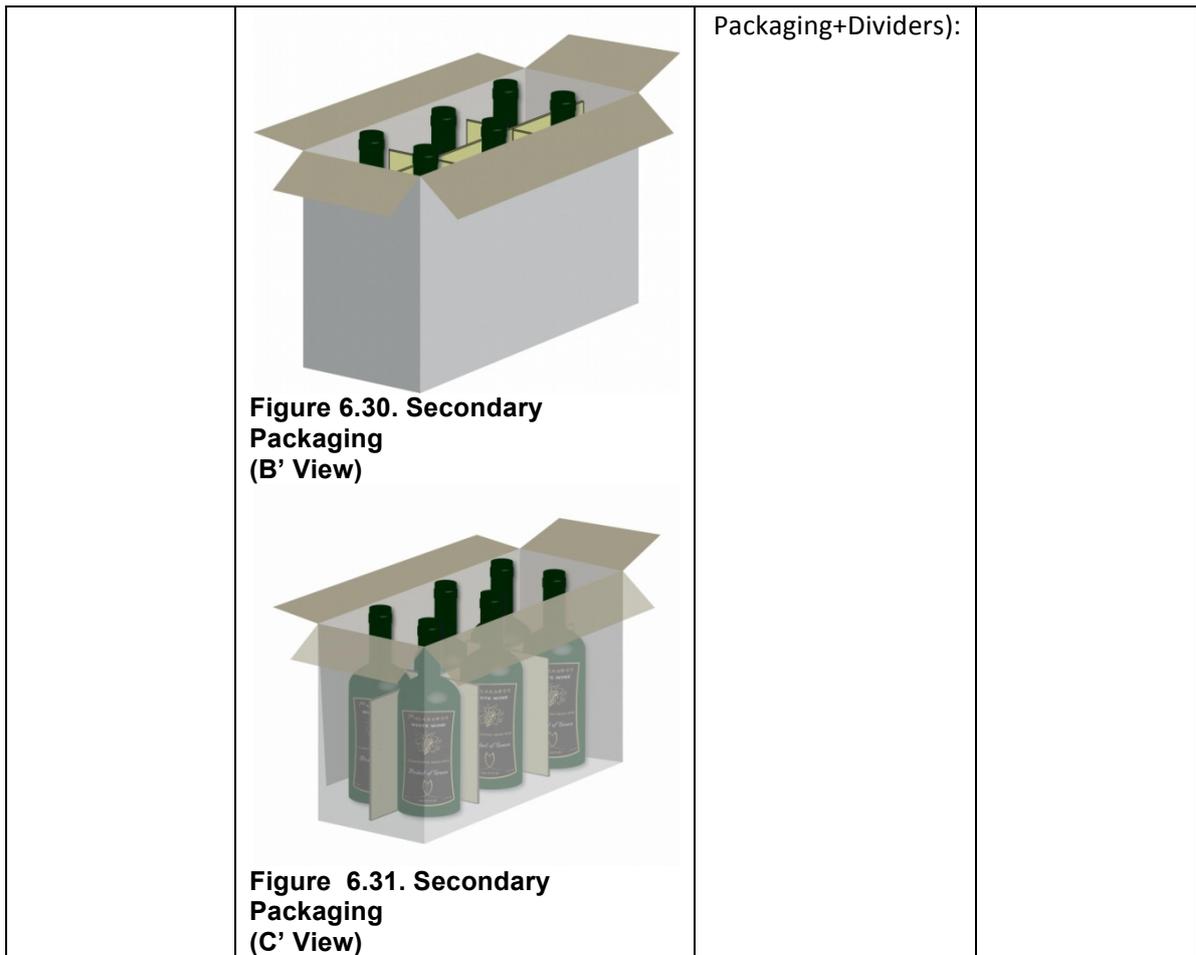
Primary Packaging (Bottle)		Type:	Glass Bottle
		Net Weight (Product):	716 gr.
		Gross Weight (Product+Bottle):	1158 gr.
		Bottle Weight:	442 gr.
		Cost/Bottle:	0.40€

Figure 6.28. Primary Packaging

The primary packaging is a glass bottle weighing 442gr. It's gross weight (bottle and product-wine included) is 1158gr. Each glass bottle-container, costs 0.40€.

Secondary Packaging (Shipper)		Type:	Corrugated Box
		Pieces of primary/secondary packaging:	6
		Corrugated box weight:	192 gr.
		Dividers weight:	100 gr.
		Net Weight (Product):	4296 gr.
		Gross Secondary Packaging Weight (Product+Packaging +Dividers):	7240 gr.
		Total Packaging Weight/shipper (Bottles+Shipper +Dividers):	2944 gr.
		Cost/Secondary Packaging:	0.1635€
		Cost/divider	0.1223€
		Total Packaging Cost/Shipper (Primary+Secondary)	2.6858€

Figure - 6.29. Secondary Packaging (A' View)



Packaging+Dividers):

Sheet Width	Sheet Length	Dimensions		
493	X 845	240	X 163	X 320

	83,5	0					
	326	0					
	83,5	0					
240	+	166	+	243	+	166	30
+ 166				+ 243			
406				409			
				+ 30			
				439			

Figure 6.32. Detailed analysis of the dimensions of the secondary packaging

The secondary packaging (shipper) is a paper corrugated box with outside dimensions (Length x Width x Depth in mm): 248x171x336 weighing 192gr. Each shipper contains a divider that splits the internal area of the shipper into 6 equal parts. Each divider weighs 100gr. Each shipper contains 6 bottles of wine and its gross weight (product and total packaging) is 7240gr. The total packaging weight per shipper (primary and secondary) is 2944gr. The total packaging cost per shipper (primary, secondary and dividers) is 2.6858€.

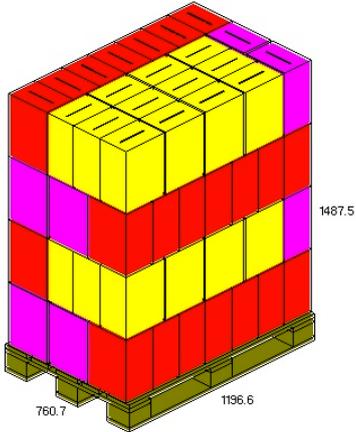
Pallet Load		Pallet Type:	Europallet
		Pallet Height:	1487.5mm
		Gross Pallet weight:	633.16 kgr.
		Net Weight/pallet (product):	360.86 kgr.
		Packaging Weight/pallet:	272.30 kgr.
		Bottles/pallet:	504
		Shippers/pallet:	84
		Total Packaging Cost/Pallet:	225.61€

Figure 6.33. Pallet Load

The shippers are stacked onto Europallets with net dimensions: 800x1200mm. Each pallet contains 84 shippers and 504 bottles. The pallet height is 1487.5mm. The packaging weight per pallet is ~272kgr while the gross pallet weight (product and total packaging) is ~633kgr with pallet weight included. The total packaging cost per pallet is 225.61€.

Vehicle Load	Vehicle Type:	Semi-trailer (13600x2420x2400)
	Gross LoadWeight:	21527.44 kgr.
	Net Load Weight (product):	12269.24 kgr.
	Total Packaging Weight/ Vehicle Load:	9258.2 kgr.
	Bottles/Vehicle:	17136
	Shippers/ Vehicle:	2856
	Pallets/ Vehicle:	34
	Total Packaging Cost/ Vehicle Load:	7670.74€

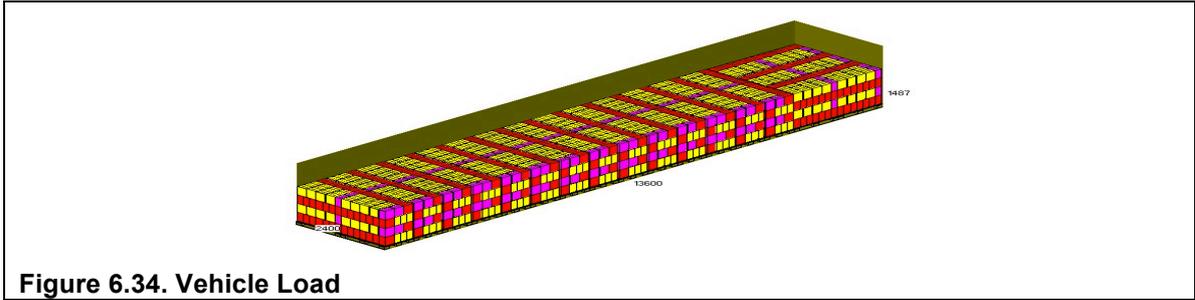


Figure 6.34. Vehicle Load

The pallets are placed into a semi trailer with dimensions (Length x Width x Depth in m): 13.6 x 2.42 x 2.4. Each vehicle contains 34 pallets (with 2856 shippers and 17136 bottles). The gross load weight is 21527.44 kgr with pallet weight included. The total packaging weight per vehicle load comes up to 9258.2 kgr (pallet weight included as a packaging weight). The total packaging cost per vehicle load is 7670.74€.

Table 6.6. Data Summary Case B1

	Primary Packaging (Bottle)	Secondary Packaging (Shipper)	Pallet (Unit load)	Vehicle Load
Inside Dimensions				
Length (mm)	-	240	-	13600
Width (mm)	-	163	-	2400
Height (mm)	-	320	-	1487
Outside Dimensions				
Length (mm)	75	247.94	1196.6	-
Width (mm)	75	170.94	760.7	-
Height (mm)	317	335.87	1487.5	-
Weight				
Net Weight	716 gr	4.296 kgr	360.86 kgr	12269.24 kgr
Gross Weight (gr)	1158 gr	7.240 kgr	633.16 kgr (pallet weight included)*	21527.44 kgr (pallet weight included)*
Total Packaging Weight (gr) per:	442 gr	2.944 kgr	272.30 kgr (pallet weight included)*	9258.2 kgr ^(a) (pallet weight included)*
Pieces of Packaging				
Pieces of bottle per:	-	6	504	17136 ^(b)
Pieces of shipper per:	-	-	84	2856
Pallets per:	-	-	-	34
Cost				
Cost per:	0.4000€	0.2858€ (divider cost included)	-	-
Total Packaging Cost	0.4000€	2.6858€	225.61€	7670.74€
Total Packaging Weight/Bottle Equivalence ^(c)	540.28 gr			

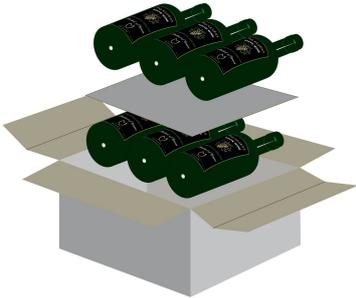
*Pallet Weight = 25 kgr

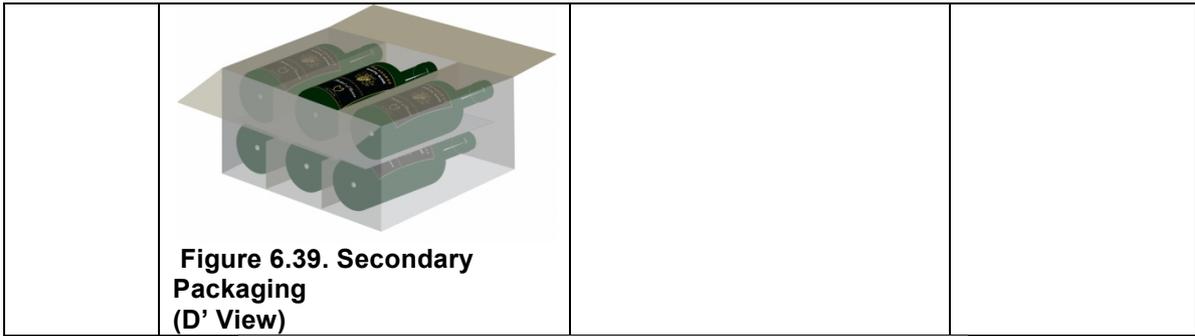
** Weight of Packaging Equivalent to each bottle(c) = Total Packaging Weight per Vehicle load (a)/Bottles per Vehicle (b)

CASE B2 – Wine Bottle 750ml

Primary Packaging (Bottle)	 <p>Figure 6.35. Primary Packaging</p>	Type:	Glass Bottle
		Net Weight (Product):	716 gr.
		Gross Weight (Product+Bottle):	1158 gr.
		Bottle Weight:	442 gr.
		Cost/Bottle:	0.40€

The primary packaging is the same as in Case B1. It is a glass container weighing 442gr. It's gross weight (product and bottle) is 1158gr. Each glass bottle-container, costs 0.40€.

Secondary Packaging (Shipper)	 <p>Figure 6.36. Secondary Packaging (A' View)</p>	Type:	Corrugated Box
	 <p>Figure 6.37. Secondary Packaging (B' View)</p>	Pieces of primary/ secondary packaging:	6
	 <p>Figure 6.38. Secondary Packaging (C' View)</p>	Corrugated box weight:	255 gr.
		Divider weight:	31.4 gr.
		Net Weight (Product):	4296 gr.
		Gross Secondary Packaging Weight (Product+Packaging +Divider):	7234.4 gr.
		Total Packaging Weight/shipper (Bottles+Shipper +Divider):	2938.4 gr.
		Cost/Secondary Packaging:	0.2095€
		Cost/divider	0.0229€
		Total Packaging Cost/Shipper (Primary+SecondaryPackaging+Dividers):	2.6324€



Sheet Width	Sheet Length	Dimensions					
482	X 1149	320	X 235	X 158			
	77						
	82						
	164						
	82						
	77						
320	+	238	+	323	+	238	30
<u>+ 238</u>				<u>+ 323</u>			
558				561			

Figure 6.40. Detailed analysis of the dimensions of the secondary packaging

The secondary packaging (shipper) is a paper corrugated box as in Case B1. However, in this case the design was changed and the 6 bottles are supposed to be lying on their side as shown in the above illustrations. The outside dimensions of the shipper are (Length x Width x Depth in mm): 328x243x174. The shape of the shipper is designed in such a way that the internal area is split into 6 parts so that the bottles are placed without touching each other. The weight of each shipper is 255gr while the divider's weight is 31.4 gr. The gross weight per shipper (product and total packaging) is 7234.4 gr. The total packaging weight per shipper (primary and secondary) is 2938.4 gr. The total packaging cost per shipper (primary, shipper and divider) is 2.6324€.

Pallet Load		Pallet Type:	Europallet
		Pallet Height:	1708.9mm
		Gross Pallet weight:	676.10 kgr.
		Net Weight/pallet (product):	386.64 kgr.
		Packaging Weight/pallet:	289.46 kgr.
		Bottles/pallet:	540

Figure 6.41. Pallet Load	Shippers/pallet:	90
	Total Packaging Cost/Pallet:	236.92€

The shippers are stacked onto Europallets (800x1200mm). Each pallet contains 90 shippers and 540 bottles. The pallet height is 1709mm. The packaging weight per pallet is ~290kgr and the gross pallet weight (product and total packaging) is ~676kgr (pallet weight included). The total packaging cost per pallet is 236.92€.

Vehicle Load	Vehicle Type:	Semi-trailer (13600x2420x2400)
	Gross LoadWeight:	22987.4 kgr.
	Net Load Weight (product):	13145.76 kgr.
	Total Packaging Weight/ Vehicle Load:	9841.64 kgr.
	Bottles/ Vehicle:	18360
	Shippers/ Vehicle:	3060
	Pallets/ Vehicle:	34
	Total Packaging Cost/ Vehicle Load:	8055.28€

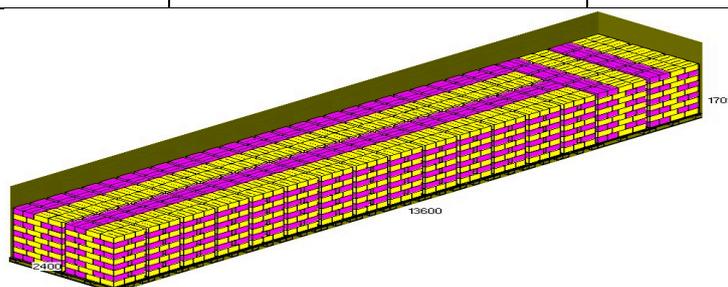


Figure 6.42. Vehicle Load

As in Case B1, the pallets are placed into a semi trailer with dimensions (Length x Width x Depth in m): 13.6 x 2.42 x 2.4. Each vehicle contains 34 pallets of products (thus 3060 shippers and 18360 bottles). The gross load weight is 22987.4 kgr with pallet weight included and in addition the total packaging weight per vehicle load comes up to 9841.64 kgr. The total packaging cost per vehicle load is 8055.28€.

Table 6.7. Data Summary Case B2

	Primary Packaging (Bottle)	Secondary Packaging (Shipper)	Pallet (Unit load)	Vehicle Load
Inside Dimensions				
Length (mm)	-	320	-	13600
Width (mm)	-	235	-	2400
Height (mm)	-	158	-	1709
Outside Dimensions				
Length (mm)	75	327.94	1141.7	-
Width (mm)	75	242.94	728.8	-
Height (mm)	317	173.87	1708.9	-
Weight				
Net Weight	716 gr	4.296 kgr	386.64 kgr	13145.76 kgr
Gross Weight (gr)	1158 gr	7234.4 kgr	676.10 kgr (pallet weight included)*	22987.4 kgr (pallet weight included)*
Total Packaging Weight (gr) per:	442 gr	2.938 kgr	289.46 kgr (pallet weight included)*	9841.64 kgr ^(a) (pallet weight included)*
Pieces of Packaging				
Pieces of bottle per:	-	6	540	18360 ^(b)
Pieces of shipper per:	-	-	90	3060
Pallets per:	-	-	-	34
Cost				
Cost per:	0.4000€	0.2324€	-	-
Total Packaging Cost	0.4000€	2.6324€	236.92€	8055.28€
Total Packaging Weight/Bottle Equivalence ^(c)	536.04 gr			

*Pallet Weight = 25 kgr

** Weight of Packaging Equivalent to each bottle(c) = Total Packaging Weight per Vehicle load (a)/Bottles per Vehicle (b)

CHAPTER 6 - Discussion – Overpackaging Investigation – Alternative Packaging Suggestions

Cases	Bottles/vehicle	% difference from Case 1	Shipper/Vehicle	% difference from Case 1	Pallets/Vehicle	Packaging Wgt/Vehicle	% difference from Case 1	Total Packaging Weight/Bottle Equivalence	% difference from Case 1
Case 1	17 136	-	2 856	-	34	9 258.2	-	540.28	-
Case 2	18 360	7.14%	3 060	7.14%	34	9 841.6	6.30%	536.04	-0.78%

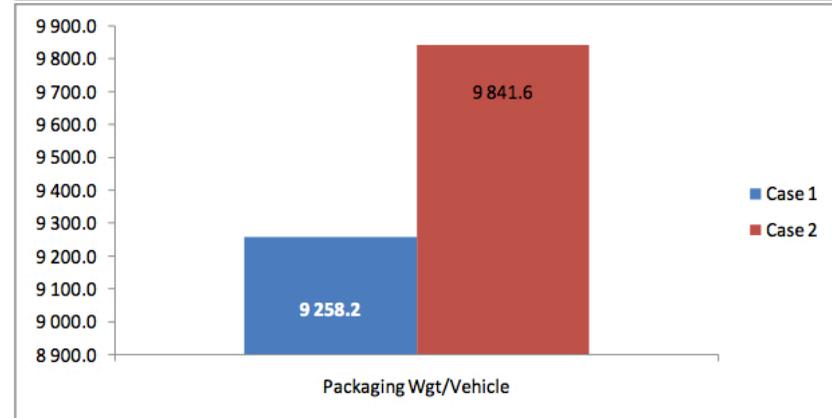
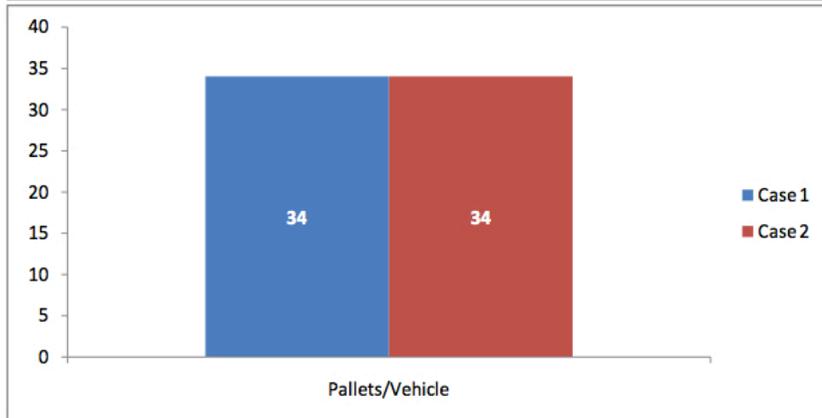
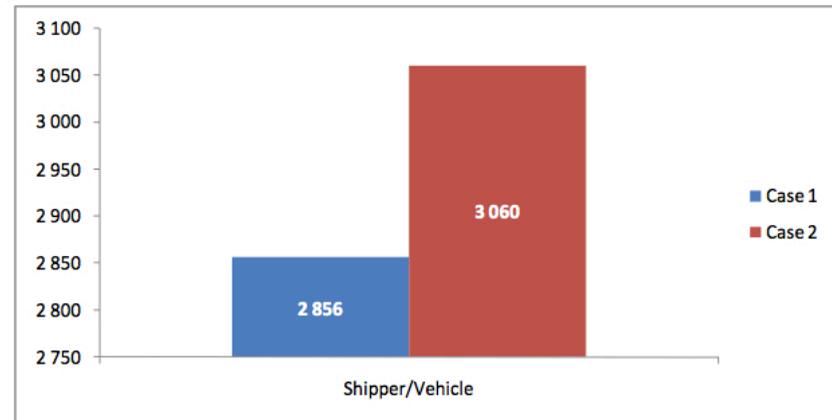
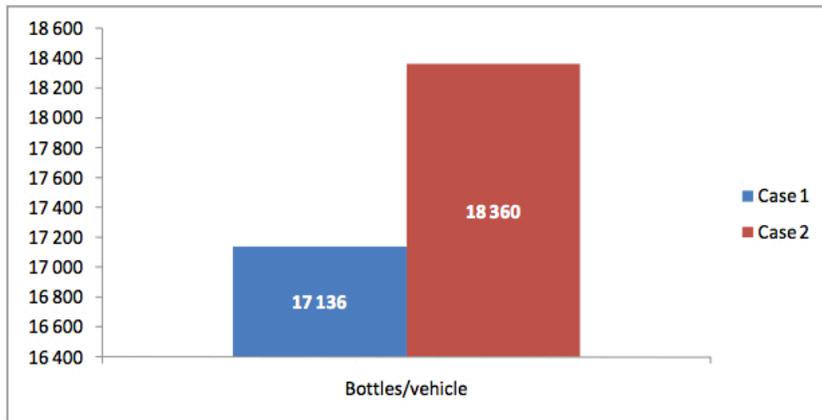


Figure 6.43. Cases comparisons

- As presented above, from a single redesign of the secondary packaging a company could achieve an increase in the volume of total bottles carried per vehicle, of 7.14% from Case B1 to Case B2.
- Another important issue is that because the dimensions of the vehicle remain the same in both cases and the number of pallets that can be carried is also the same (34), the 2nd Case is more advantageous in terms of weight carried and space utilisation. Payload (Maximum Carrying Weight) of the vehicle in both cases has been determined to be: 25000kg. Given all the other limitations (vehicle dimensions, shelf height, single pallet stacking), from a single redesign of the secondary packaging and without changing other factors such as the dimensions of the primary packaging or the number bottles per secondary packaging the company achieved an increase in the total weight carried from 21527kg to 22987kg. Although this increase is allocated not only to the net product but to the packaging as well, from a logistics perspective it is an important issue.
- From a cost perspective, the 2nd Case is more advantageous since it has almost 2% lower price than the 1st Case. From a first view, this difference maybe doesn't seem important but if it is combined with the higher volume of bottles carried per vehicle, clearly adds a serious advantage to the 2nd Case.

As already discussed in the previous Case Study (2T MIX), from a single redesign of the secondary packaging it is possible for a company to achieve an overall better performance of a product in the supply chain, both from a handling and cost perspective. An increase of the volume of total bottles carried per vehicle adds competitive advantages to the company, especially in cases where a product is exported and the constraint of transportation costs are of great importance.

However, the balance between logistics (e.g. easiness of use throughout the supply chain), accounting (cost) and marketing (e.g. appearance of the new packaging) should be considered during the packaging redesigning process.

Here again, the Case should be further examined in order to better ascertain if the redesign:

- Would be advantageous from an environmental perspective, concerning the fuel emissions from one case to another. The advantages might derive from the fact that more products can be carried per vehicle. This in turn results in less fuel emissions per product carried.
- Would achieve any further profits for the company.

In any case the redesigning process could prove to be an advantageous procedure offering cost, environmental, transportation and storage benefits. Furthermore, it may encompass the investigation of other related major issues, such as overpackaging which is being investigated below, and suggest constructive solutions.

6.4. The Overpackaging Issue

One of the most important issues concerning the packaging sector is the overpackaging issue. Similar to the previous section, the detailed analysis of the entire packaging or each one separately (primary, secondary, transportation) that an industrial consumer uses in its packaging operations, could reveal several weaknesses, problems or failures that, if addressed effectively, could offer multiple advantages to the user.

At this point, and for the needs of research, the factor of corrugated packaging quality was selected to be examined. Its basic elements as well as a related case study are presented below. The following figure (Figure - 6.44) that describes the overpackaging issue has been developed and provided to the researcher by Multi Pack S.A.

Multi Pack S.A. provided the researcher with all the required data for the completion of the following investigation.

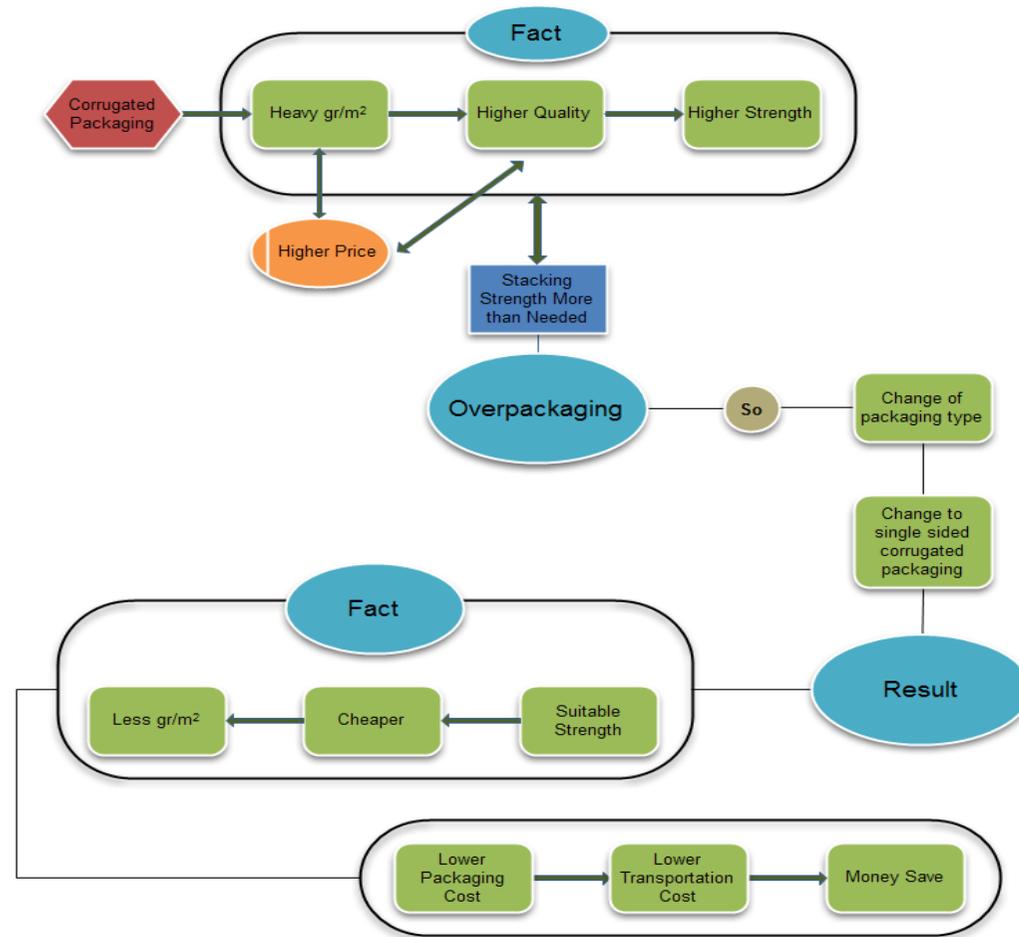


Figure 6.44. The overpackaging issue, (Multi Pack S.A., 2012)

The general idea behind the overpackaging issue for what is relevant to the paper corrugated packaging is that the use of paper of heavier gr/m² gives, in general, packaging of higher quality and higher strength and as a result of higher price. In addition, the use of paper of heavier gr/m² gives the packaging, stacking strength – usually- higher than needed. This fact produces the overpackaging issue that as soon as it is noticed should be faced in an effective way. Usually the problem is faced by changing the packaging type (shape, paper type, paper grade etc) that leads to the production of lighter packaging with suitable strength that in most cases is cheaper than the replaced packaging.

In the past, according to Multi Pack, it was common practice for packaging manufacturers to produce and sell corrugated boxes of higher resistance (ie. quality), since most customers used to require single wall containers³³ of high strength that would, in some cases, be 500 – 560gr/m². The cost however was modulated accordingly. Since the end of 1990's and the beginning of 2000's the market has begun to require low-cost packaging solutions. From that time on, the vast majority of single wall paper corrugated containers do not exceed 480gr/m². Minor exceptions occur when corrugated boxes of heavier weight and higher strength are imperative, which is subject to the features of the product included.

The general advantages behind the redesigning idea are: lower packaging cost, lower overall transportation cost and savings for the company.

6.4.1. The Case study

The following Case Study is an introduction to the overpackaging issue. Its purpose is to show that a detailed analysis of the packaging used by a company may reveal opportunities to improve packaging performance and contribute to further cost savings (e.g. storage, transportation), as well. Further indirect gains, as shown below, include a better overall environmental performance of packaging and lessened outlay to benefit the final consumer.

In this Case Study, the customer had been using an unsuitable packaging type for years when the company decided to change their packaging supplier. There upon, several problems had to be dealt with, some owing to the previous supplier's erroneous advice, a factor which is not to be examined here. What is going to be thoroughly explored, are the problems originating from using improper packaging,

³³ Single Wall paper corrugated boxes are comprised of 3 paper layers.

along with a comparative estimate of what should have been done instead in previous years.

The details of the annual packaging needs of the company, are shown in Table 6.8.

Table 6.8. Annual needs per packaging code

Packaging Code	Description	Inside Dimensions	Quantity (pcs)
No 1	4x2 kgr.	400x300x300	48000
No 2	8x1 kgr.	365X292X227	36000
No 3	6x1 kgr.	390X320X140	30000
No 4	8x1 ½ kgr.	390X305X230	43000
No 8	6x1 ½ kgr.	420X300X160	55000

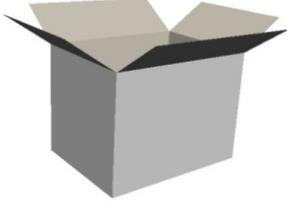
Code No 1 analysis:

Corrugated box No 1 is going to be examined below:

Table 6.9. Packaging Code No 1 analysis

Packaging Code	Description	Inside Dimensions	Quantity (pcs)
No 1	4x2 kgr.	400x300x300	48000

Table 6.10. Packaging Code No 1 illustration

Packaging Type	Inside Dimensions (mm)	Illustration
Corrugated Box	400x300x300	 <p>Figure 6.45. Corrugated Box</p>

As mentioned before, for a number of years the company was using an unsuitable packaging type. After a detailed analysis of the situation and the individual

needs of the customer by Multi Pack S.A., the company decided to replace the old packaging quality with the new, proposed one. The researcher developed this idea in his role as manager of Multi Pack S.A. The details of the packaging used by the company are cited below.

- Option A is what the company used to employ in its packaging operations.
- Option B is the alternative proposed solution (by the researcher).

Option A:

Table 6.11. Option A technical information

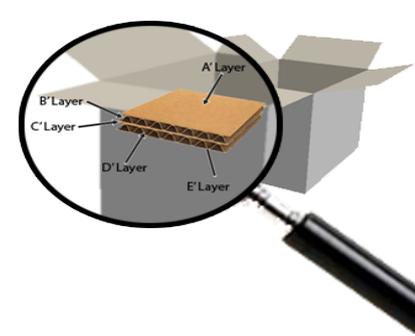
Layer	Paper Grade gr/m ²	Total gr/m ²	Sheet Weight (gr)	Illustration
A	120	700.52	634.11	
B	127			
C	100			
D	127			
E	100			
Type		Double Sided Layer		
Flute		BC		

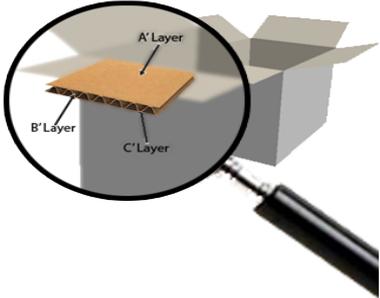
Figure 6.46. Layers

As shown in the above illustration (Figure – 6.46) the corrugated box No1 is a double sided container with ~701gr/m². The sheet weight is 634gr. The above double sided layer container is manufactured by using 5 different layers of paper with different grades (A:120, B:127, C:100, D:127, E:100).

Option B:

Table 6.12. Option B technical information

Layer	Paper Grade gr/m ²	Total gr/m ²	Sheet Weight (gr)	Illustration
A	130	470.34	416.02	
B	127			

C	130			 <p>Figure 6.47. Layers</p>
Type		Single Sided Layer		
Flute		C		

In this alternative proposed solution the previous double sided layer corrugated box of Option A, is replaced by a single sided layer corrugated container with $\sim 470\text{gr/m}^2$. The sheet weight is 416gr and it is manufactured by using 3 different layers of paper with different grades (A:130, B:127, C:130) as shown in Figure – 6.47.

Option A - Cost Review:

Table 6.13. Option A cost review

Layer	Kind of Paper	gr/m ²	Materials Cost/sheet
A	Recycled	120	0.2613€
B	Recycled	127	
C	Recycled	100	
D	Recycled	127	
E	Recycled	100	

In Option A the corrugated box is manufactured by using only recycled papers. The materials cost per sheet is 0.2613€.

Option B - Cost Review:

Table 6.14. Option B cost review

Layer	Kind of Paper	gr/m ²	Materials Cost/sheet
A	Recycled	130	0.1748€
B	Recycled	127	

C	Recycled	130	
----------	----------	-----	--

Here again, in Option B the corrugated box is manufactured by using only recycled papers. The materials cost per sheet is 0.1748€.

Comparison

Table 6.15. Comparison

	Kind of Paper	Cost/sheet	Estimated selling price by the packaging manufacturer	% cost reduction for the user
Option A	Recycled	0.2613€	0.5025€	~34.4%
Option B	Recycled	0.1748€	0.3297€	

As presented in Table – 6.15 the estimated selling price of the corrugated packaging by the packaging manufacturer is 0.5025€ for Option A and 0.3297€ for Option B. So the user of the packaging (customer) is going to pay 34.4% less money in order to acquire the replaced packaging (No 1).

In order to understand the stacking strength of each of the above Options, an Edge Crush Test was performed in the lab at 20°C. The specific test is conducted in the lab and is used to appraise the approximate compression strength of the corrugated board (Kirwan, 2005). The results are presented below:

Table 6.16. ECT and strength needs

Layer	Kind of Paper	ECT ³⁴	Strength Needs
Option A	Recycled	≤190kg	~96.4kg
Option B	Recycled	≤104kg	

For Option A, the Edge Crush Test (ECT) showed that the stacking strength of the packaging is ≤190kg. For Option B, the ECT showed that the stacking strength of the packaging is ≤104kg. The strength needs for the specific packaging code is ~96.4kg. The estimation of the strength needs is shown below.

³⁴ The results may vary based on many factors such as temperature, mode of transport, storage time and conditions etc.

The boxes are stacked on pallets. Each pallet contains six (6) layers of boxes. Each box weighs 8kg (4x2kg). There are five (5) layers of boxes over the bottom layer. The weight on each bottom box is:

$$x = 8kg/box * 5layers$$

$$x = 40kg$$

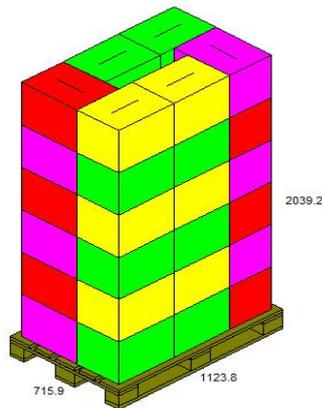


Figure 6.48. Palletizing

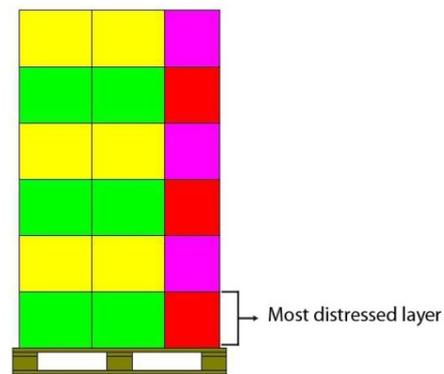


Figure 6.49. Palletizing. Most distressed layer

At this stage, the minimum needed strength of the bottom box should be estimated. Although the company provided the researcher with all the relevant information in estimating the minimum needed strength, the researcher decided to adopt a different method based on the method taught by the Michigan State University (<https://www.msu.edu/>).

According to the Michigan State University, an indicative strength measure of a corrugated box require that the packaging under investigation should be placed under a dynamic load in given experimental conditions to measure the dynamic box compression, thus deducing any potential failure.

$$BoxCompression = Load\ on\ bottom\ Box * Estimated\ Safety\ Factor^{35}$$

³⁵The “Estimated Safety Factor” affects the Box Compression outcome. In order to calculate the Estimated Safety Factor, a number of conditions should be included such as: storage time, humidity, stacking pattern, pallet overhang and handling losses.

$$EstimatedSafetyFactor = \frac{1}{ST * RH * PP * OH * HL}$$

ST = Storage Time Effect, **RH** = Relative Humidity Effect, **PP** = Pallet Pattern Effect, **OH** = Overhang Effect, **HL** = Handling Loss Effect

According to the customer:

- The load is going to be stored for an average of 10 days.
- The relative humidity is 55%.
- The box effectiveness factor is 0.7.
- It is assumed that the handling losses are going to be no more than 5%.

$$x = 40kg * 2.41$$

$$x = 96.4kg$$

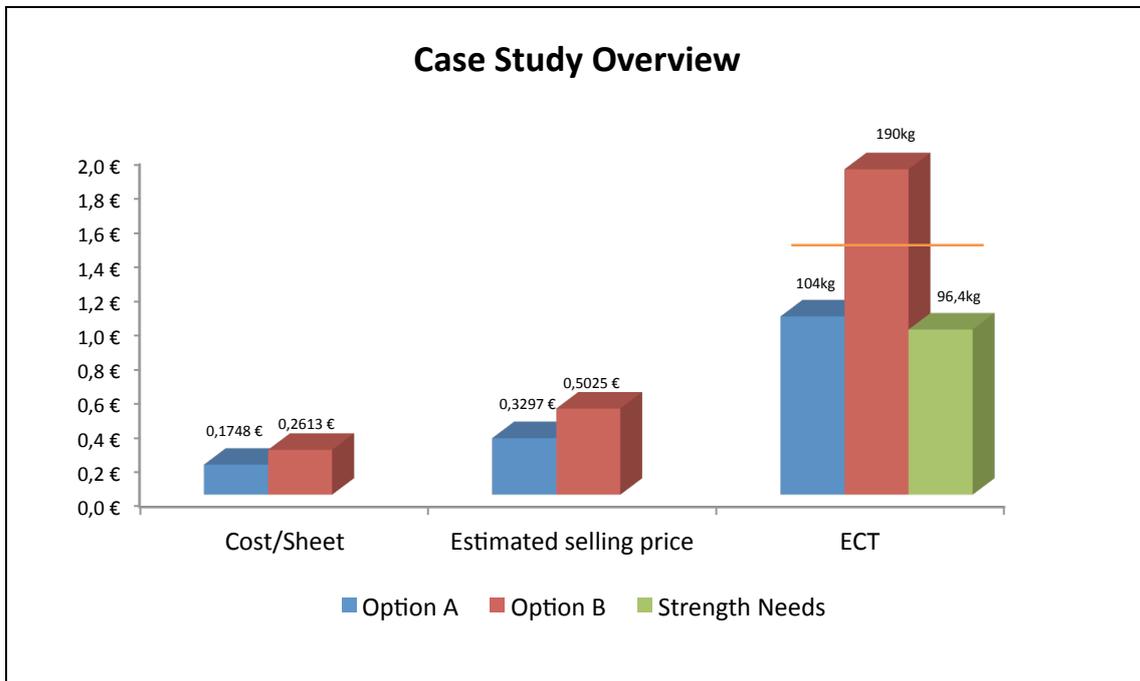


Figure 6.50. Case study overview

As it is clearly shown from the ECT test, the Option A provides much more resistance and protection than needed. Option B, is much closer to the protection needs of the company for the specific product. Hence, Option B is more suitable as a packaging solution, compared to Option A (if all other factors remain stable).

Based on the annual packaging needs of the company, the cost difference is formulated as follows:

Table 6.17. Cost difference between Option A and Option B

	Annual Needs (in pieces)	Cost/piece	Total Annual Cost (net)	Money Save
Option A	48000	0.5025€	24120€	8294€
Option B		0.3297€	15826€	

$$EstimatedSafetyFactor = \frac{1}{0.65 * 0.96 * 0.7 * 1 * 0.95}$$

$$EstimatedSafetyFactor = 2.41$$

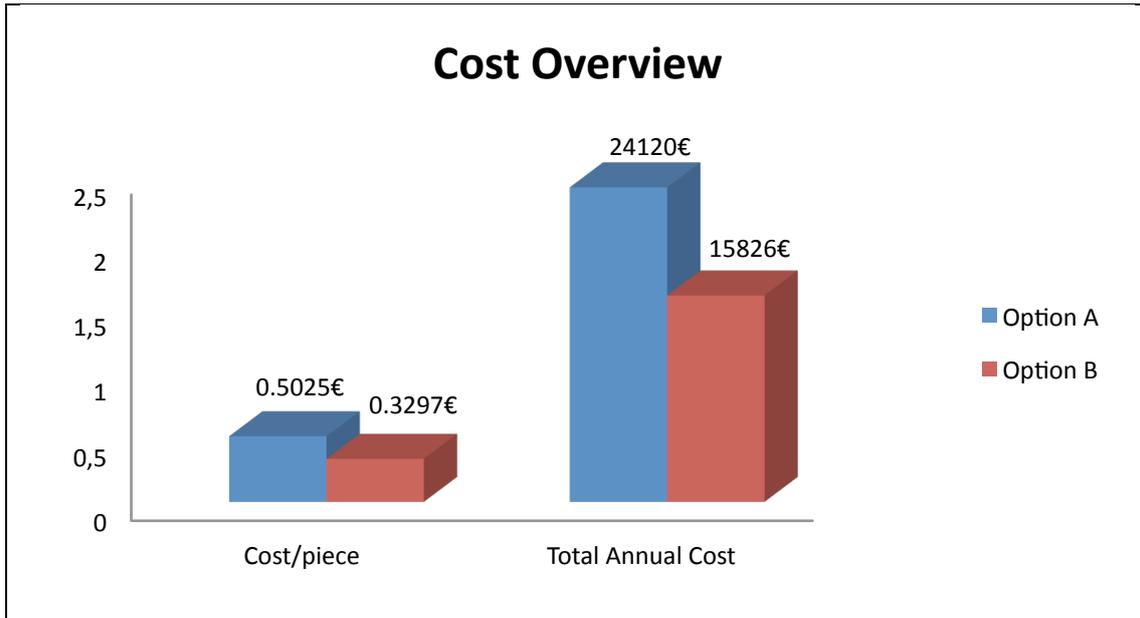


Figure 6.51. Cost overview

In the same manner the results for all other packaging codes were calculated and are presented below:

Table 6.18. Packaging Code No 2 results

Code: No 2						
	Annual Needs (in pieces)	Cost/piece	Total Cost (net)	Money Save	Strength Needs	ECT
Option A	36000	0.2179€	7844€	3146€	~96.4kg	≤196kg
Option B		0.1305€	4698€			≤105kg

Table 6.19. Packaging Code No 3 results

Code: No 3						
	Annual Needs (in pieces)	Cost/piece	Total Cost (net)	Money Save	Strength Needs	ECT
Option A	30000	0.2090€	6270€	2523€	~130.14kg	≤199kg
Option B		0.1249€	3747€			≤142kg

Table 6.20. Packaging Code No 4 results

Code: No 4						
	Annual Needs (in pieces)	Cost/piece	Total Cost (net)	Money Save	Strength Needs	ECT
Option A	43000	0.2368€	10182€	4080€	~173.52kg	≤234kg
Option B		0.1419€	6102€			≤190kg

Table 6.21. Packaging Code No 8 results

Code: No 8						
	Annual Needs (in pieces)	Cost/piece	Total Cost (net)	Money Save	Strength Needs	ECT
Option A	55000	0.2119€	11655€	4692€	~173.52kg	≤236kg
Option B		0.1266€	6963€			≤191kg

Limitations:

1. The strength needs for the examined containers were calculated based on specific conditions (e.g. time of storage=10days, relative humidity=55% etc). The results may vary if any of these factors are changed.
2. The Case Study investigates an extreme scenario but the outcomes are indicative. Still, the detailed analysis of the packaging needs of a company may reveal similar or even more significant problems.
3. In each packaging code, different paper combinations were used in order to provide the most suitable results. The different paper combinations for the production of the corrugated box may provide a different grade of protection or stacking strength and this affects the final packaging cost. Still, the above method of analysis is applicable to any case and maybe used to estimate individual costs.

6.4.2. Conclusion

The above detailed analysis of one aspect of the overpackaging issue, quality, focused on corrugated packaging, and clearly shows that the careful analysis of the packaging is very important for an industrial customer. The main conclusions of the analysis are summarised below:

- A thorough analysis of the packaging needs of a company may provide the company with lower overall cost:
 - Overall packaging cost.
 - Overall transportation cost.
 - Overall storage cost.
- A better redesign of the packaging itself, may result in a better environmental performance since the overpackaging issue aggravates the environment both from a raw materials and transportation perspective (fuel emissions).
- Due to the competition, less cost for the industrial customer results in less cost for the final consumer.
- Lighter packaging results in cheaper packaging, which is a fact that could favourably affect domestic products because:
 - As already mentioned above, a wide range of factors such as the means of transport used, fatigue time etc. strongly influence the required stacking strength. Therefore, products imported from other countries, far from the country of destination, require stronger packaging in order to protect more effectively every single product included throughout the supply chain.
 - Heavier packaging means higher transportation cost that is added to the final selling price.
- A better redesign of the corrugated packaging may drive the industrial customer to use lighter packaging for some of his customers with no special needs or small time of warehousing. On the other hand, heavier and stronger packaging should be used for products under particular circumstances, such as long time storage, high humidity rates, or during long distance transportation and storage, as may be the case, for products exported, thus economising a great deal of money.
- At higher resistance needs, sometimes, the use of better quality paper may provide with even better results avoiding the need of moving to double sided containers. If for example a single sided wall container weighing 480gr/m² should be replaced for strength reasons and the packaging manufacturer provides a single sided wall container with 520gr/m² (assuming that the

strength needs are fulfilled), it would be far cheaper than to substitute with a double sided wall container of 680gr/m².

- The same detailed packaging analysis performed above, could be extended to other types of packaging (e.g. primary packaging) as well as packaging manufactured from other materials (plastic, glass, metal etc). In addition, the full packaging analysis of a product (if the product includes more than one packaging), may give a better understanding of the overpackaging issue and provide the industrial user with cost effective solutions.

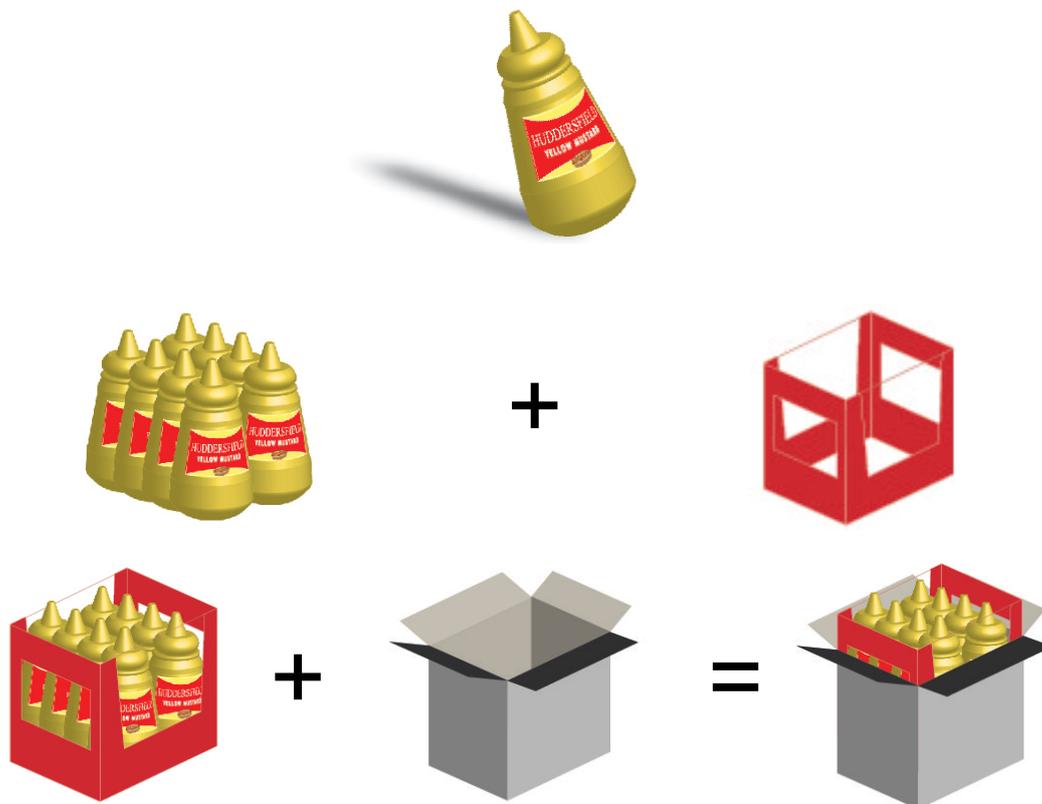


Figure 6.52. Packaging presentation of an imaginary product

The full packaging analysis of a product (if the product includes more than one packaging types), may give a better understanding of the overpackaging issue and provide the industrial user with cost effective solutions.

It should be noted that the analysis of packaging needs should be thorough and detailed, in order to avoid any problematic situations for the industrial customer such as unsuitable packaging, bad performance and complete or partial damages throughout the supply chain. These problems, could result in higher costs both from direct economic losses or from indirect losses such as lost sales or replenishment delays.

6.5. Summary

This chapter focuses on the discussion of the results of the data collected and presented to Chapter 5. It includes and discusses seven packaging issues that need special attention, as derived by the previous conducted analyses. Issues such as the environmental legislation, the affordability of measures, the push of cost to the succeeding links of the supply chain, the effectiveness of reverse channels and take-back programmes, as well as the use of environmentally friendly packaging are all discussed in the present chapter. It further includes alternative suggestions concerning potential packaging improvements, while the overpackaging issue is further investigated in an effort to provide a better understanding of the problem.

All the above issues provide the academic literature with evidence on specific packaging issues. This investigation aims to have an important contribution not only to academic literature but on policy as well, by providing useful information concerning the implications that may derive by the implementation of specific packaging regulations. In addition the investigation aims to provide significant information to packaging industry by developing relevant methodology that could be used by individual companies in their efforts to measure and ameliorate their packaging operations.

CHAPTER 7 – CONCLUSIONS AND FURTHER WORK

7.1. Introduction

This chapter starts with the presentation of the conclusions derived from the research. The contribution of the research to empirical and academic knowledge is then discussed. The chapter concludes with the limitations of the research and evaluates the contributions that could be possibly examined and developed in the future.

7.2. Research Summary. Aims and objectives completion.

All aims and objectives presented in **Chapter 1 – Introduction**, have been adequately addressed in the present research. By exploring the broader sense of the packaging operations and the several problematic issues that occur or may occur in the packaging supply chain in the Greek market, this research has evaluated the problems arising from the implementation of the Packaging and Packaging Waste Directive (94/62/EC). In addition, it also considered the investigation of key issues such as the overpackaging issue and the redesigning effects and has sought to provide alternative suggestions for a more sustainable packaging supply chain.

What is relevant to the second part of the investigation -where the overpackaging issue and the secondary packaging redesigning process are presented and analysed- is designed to provide a practical and useful tool for all companies that use or may use any form of packaging. Despite the fact that the investigation is focusing on the secondary, corrugated paper packaging market in Greece, the method can be adjusted to be used in any country for any kind of packaging or any packaging material. In this way, a company will be able to examine all kinds of packaging used in its operations and implement to changes or corrections that could help it to achieve serious packaging improvements.

The conclusions derived from the investigation will be presented and discussed below.

7.2.1. Success – Acceptance of the Legislation

The majority of the participants of the supply chain, consumers excepted, were negative towards the implementation of the directive. Most of them had their

doubts concerning the directive since they believed that its implementation was going to generate serious problems to the normality of the market. Since most of the tax systems are weight based, in the case of environmental enactment, the companies are going to be left with extra costs. Their thoughts are that such measures will inevitably increase their operational costs.

This fact clearly underlines the opposition of the Greek market to the position of environmental legislation that could potentially increase the various operational business costs.

The above mentioned prevalent view is very close to reality. That means, anything increasing the operational cost of a business, which in most cases is mainly taxation, generates irregularities that inevitably aggravates competition in the market. That is the main reason that most companies object to the application of relevant legislation. However, in general such costs are finally pushed down to the succeeding links of the supply chain. The specific issue is being described in the following chapter 7.2.2.

7.2.2. The push of cost to the next links of the supply chain

An important finding of the research was the push of cost generated for each link, to the next links of the supply chain. The majority of the Suppliers and the Packaging Manufacturers answered that they were not intending to increase the prices of their products. On the other hand, the majority of the participants of all the other links were positive into pushing the cost generated by the directive to the next link. The participants admitted that the push of cost will be achieved by incorporating the added cost in the prices of their products.

The views of Suppliers were particularly important. As already described, the Suppliers were mainly the Recycling Centres who collect the waste paper from the supply chain. In order to complete this operation, the Suppliers pay some money to acquire this waste. Since however, there is not a specific framework, they can set the value of the waste packaging they collect through lower prices and take advantage, balancing in this way, the increased cost that may be generated by the directive.

On the other hand, Paper Packaging Manufacturers are most likely to absorb that cost since they have no other way to cover this cost. This finding however, can be explained by the fact that the competition in the paper packaging sector is so high

that the companies are forced to absorb a number of increased costs without having the ability to increase the prices of their products.

7.2.3. The Effectiveness of Reverse Channels and Take Back Programmes

Based on the primary data collected, the findings showed that the recycling centres (Supplier) use their own vehicles to collect the waste paper packaging materials from the supply chain absorbing the cost for the collection of these materials while paying a prearranged amount of money to acquire these materials. The literature indicated that most of the total packaging waste generated in Greece (80%) is recycled. At the same time, the other packaging materials have lower recycling rates confirming the principle that paper is one of the most environmental friendly materials. Based on the data collected concerning the structure, the general function and the individual elements of the reverse channel concerning paper packaging, there are no doubts concerning the harmony and normality of the current system and its effective operation.

7.2.4. Lighter Packaging and its Implications

The use of lighter packaging, for the protection of the environment or the maintenance of the retention cost, is not always easy to be applied. Although the industry seems positive to such a possibility, the case study showed that there are individual elements that should be further analysed and discussed, such as the nature of the product and other factors, including fatigue time, means of transport used, the length of the channel of distribution and so on.

Seen from a technical point of view, despite the fact that the production of lighter paper packaging is achievable, the resulting packaging is not always the best solution for the protection of the products. For example, packaging for sensitive or perishable products requires special attention. This is because the cost from damages caused by inadequate packaging may outweigh the benefit coming out of the use of lighter and cheaper packaging.

Some people argue that packaging materials have been developed so as to provide adequate protection to the contained product not regarding whether the final packaging might be lighter or heavier. However, based on the present investigation, the lab tests and the information provided by Multi Pack, lighter paper packaging offers, in general, less overall protection compared to heavier paper packaging. If

this is further combined with the fact that most of the packaging users in the present investigation (~75%) admitted that they have at some time incurred damage to a product due to improper handling of its packaging, then the importance of packaging quality is fully recognised.

7.2.5. Environmental friendly packaging and cost

The primary data showed that for the majority of the final consumers the most important factor affecting their buying decision was the Price of the Product. The changing economic conditions have reduced the purchasing power of consumers. This fact explains to some extent why and how consumers make their buying decisions based on the Price (~54%) and not the Environmental Friendliness of the product or its packaging (just 2.2%). Thus, the probability that the consumers put pressure on the market to use more environmental friendly packaging is very low.

On the other hand, one of the basic targets of the Directive, which is “not to generate any barriers”, is violated. Since the consumers give no attention to Place of Origin, products imported from countries with no active environmental legislation, may be cheaper because of the lower cost and thus more attractive to the consumers who make their buying decisions based on lower prices.

7.2.6. Push of Cost

The above results make clear that protection of the environment is not enough to force the market to use more environmental friendly packaging. The most important factor is cost-based:

- cost for the industry-market, and
- price for the consumers.

It could be concluded that the only way to force markets into a more environmental friendly way of doing business is to give information for example that the change of packaging materials into recyclable would decrease the costs or charges to the participants.

As for Industrial Customers and Wholesalers-Retailers, it would be expected that the only way to talk them into using exclusively recyclable packaging materials (where possible) is for them to be enticed by governmental economic incentives (e.g.

tax exemption) to do so. In such a case, there could be an expected shift of the market towards the use of environmental friendly packaging materials.

Consumers on the other hand, need a high price motive in order to ask for “green” packaging from the supply chain. A consumer commented that: *“The present economic conditions leave no space for environmentalism or such acts since citizens are primarily seeking ways to reduce their family burdens”*, leaving the factor of “green products” last, for what is relevant to their buying decisions. This issue if further combined with the *“Push of Cost Issue”* discussed above, strengthens the following view derived from the data collected and the relevant analysis:

“Products imported from countries with no environmental legislations enacted, are having more advantages if we compare them with the domestic European products, where European Environmental Regulations are forced by the European Union to be implemented by the Member States”.

7.2.7. Packaging Redesign and Cost Effects

The concept of redesigning secondary paper packaging was investigated through the detailed analysis of two case studies. This investigation was performed with the main target to achieve a better utilization of vehicle space during transportation, to achieve a better distribution of the total packaging weight per piece and to improve the quality of the secondary packaging in order to decrease damages during various logistics operations, such as handling and transportation. The outcomes in both case studies were that the redesigning process could become really useful and cost effective. In both case studies, the product is packaged using at least two types of packaging: primary and secondary. The investigation focused on the secondary packaging (paper corrugated boxes).

The alternative suggestions showed that the redesigning process could provide multiple logistics and cost advantages such as an increase in the volume of the total products carried or a further reduction to the total packaging weight per load. Further improvements are related to the equivalence between the volume of total products that can be carried and the total volume of secondary packaging needed. The analysis indicated that a larger amount of products could be carried using less overall packaging.

However, the redesigning process is a really important issue and needs serious treatment in order to avoid any problematic situations. Failures may cause

serious malfunctions ranging from the normality in the operation of the supply chain, to damage to products and money or sale losses. These problematic situations may further cause marketing problems or a loss in the competitive advantages for a company.

7.2.8. Overpackaging

The investigation of the overpackaging issue, was based on a case study and was focused on the secondary – paper corrugated packaging. It is clear that the analysis could be further extended, including other forms of packaging or different packaging materials. It is important to underline that the complete analysis may show issues that are even more important and provide tools for serious improvements in actions such as the environmental protection, cost reduction and supply chain sustainability.

The overpackaging analysis indicated that a number of improvements could be achieved in the overall packaging, transportation and storage cost for a company. The use of lighter packaging of lower cost, could become advantageous for a company. In addition, a better redesign or revision of the packaging used, may result in a better environmental performance since the overpackaging issue aggravates the environment both with the resources used in the packaging and the fuel emissions during transportation.

It should be mentioned that a better packaging redesign may reduce the cost for the industrial user (preventing the aggravation of the products with extra cost), and eventually for the final consumer. In addition, the use of lighter packaging (addressing the overpackaging issue) at lower cost may be advantageous for the goods produced locally since the imported products need stronger and expensive packaging compared with the domestic products (that need less packaging). It can also provide additional economic benefits coming from the lower transportation costs (due to the lighter packaging).

A possible advantageous solution for a company would be the use of lighter packaging for some of its customers with no special needs or short warehousing time. Alternatively, stronger packaging may be used for special circumstances such as long storage time, high grade of humidity during transportation or storage. In this way, the company could achieve cost savings by using the most suitable packaging, in each case.

The use of excessive packaging refers to all packaged products as well as the areas of marketing and logistics. The balance between these two sections needs attention and special consideration since the redesigning process should include marketing elements and logistics components.

7.3. Limitations of the Research

Although this study has provided valuable information, there are some limitations that should be acknowledged:

- The case study where the individual links of the supply chain have participated is only focused on the secondary, paper corrugated packaging. Thus, the outcomes of the research are only relevant to this kind of packaging.
- In addition, the Suppliers and the Packaging Manufacturers belong to the paper packaging sector. Their practices may be different from those of other packaging manufacturers of different packaging kinds or materials.
- Still, although the investigation is focused on the Greek market, it is limited geographically in Northern Greece. The outcomes however are identical of the Greek market and represent the situation, the difficulties and the special circumstances that occur in Greece compared to other European Member States.
- In some instances (Suppliers, Packaging Manufacturers, Wholesalers-Retailers), the response rate to the questionnaire was relatively low. Involving more companies, who could have probably provided the opportunity to examine different options, opinions or results. However, the number of companies in each field was very limited, hence the companies that finally accepted to participate in the investigation, gave valuable information for the analysis.

Concerning the investigation of the Overpackaging issue, there are some limitations that should be mentioned:

- The strength requirements for the examined containers were calculated based on specific conditions; the results may vary if any of these factors are changed.
- The Case Study investigates an extreme scenario where the industrial customer was using an inappropriate packaging for a number of years. Still

the outcomes are indicative and describe the severity of the overpackaging issue for a company.

7.4. Scope for further research

The redesigning process that was previously analysed in detail is an issue that needs special attention and deep investigation. Further analysis could be carried out in order to extend the field of analysis to other types of packaging (e.g. primary) or to packaging produced by other than paper packaging materials that have been investigated here. The redesigning process is such a demanding operation that needs thorough examination since it needs to embody and combine marketing elements such as shape, size, colour and logistical elements e.g. way of transportation, handling and storage factors . In addition, it should be ensured that the new packaging is going to provide suitable protection to the contained product. At a second stage, it could be further examined if the newly designed packaging is going to be advantageous from an environmental perspective, analysing for example the fuel emissions during the transportation process from one case to another. It could also be examined what other benefits could offer to the company (economic or other).

For what is relevant to overpackaging, further investigation could be conducted separately to other types of packaging (e.g. primary packaging) as well as packaging manufactured from other materials (plastic, glass, metal etc). In addition, the analysis could be conducted to include the whole packaging of a product (e.g. both primary and secondary etc) that may give a better understanding of the overpackaging issue and provide the industrial user with cost effective solutions.

The Push-of-Cost issue is another field for further research. The issue could be extended to describe the situation in other countries by examining possible problems generated by the implementation of similar environmental legislations, the level of success and the way that the industry in these countries handled the cost issue. It could also provide a basis to compare cultures, methods of action and level of acceptance of such environmental measures between companies and citizens of different countries with different economical and cultural background.

7.5. Contribution of the research

Contribution to academic literature

The main aim of this research has been to provide an evaluation of paper packaging issues in relation to the barriers generated by the implementation of the Packaging and Packaging Waste Directive (94/62/EC). This problem was the core of the investigation and the basis of the research. The case study was structured on this idea and its analysis identified the weaknesses of the directive for Greece. It also provided an in-depth analysis of the role and performance of paper packaging.

At a second stage the case study provided information concerning the need for the establishment of a reverse channel for a paper packaging manufacturer by using primary data obtained from the participants. The same method was used to investigate the extent to which the packaging regulations affect the prices of the packaged products for the Greek market. The case study also provided evidence concerning the intentions of final consumers to ask for environmental friendly packaging. This very last issue focused on the main reasons affecting their buying decisions, generating a framework to provide an understanding of the main factors affecting consumption. The results have been communicated to respondents.

A separate case study was used to evaluate the use of lighter packaging and furthermore to provide evidence concerning the possible implications of such an operation. The main aim was to provide a theoretical method of estimating the strength of the packaging used and to compare and evaluate different kinds of paper packaging. This was intended in order to establish ways to generate and use lighter packaging, thus offering to the companies interested, the chance to acquire the tools that would enable them to judge the suitability of lighter packaging, in their various packaging operations. These results will clearly benefit packaging users as well as provide environmental benefits.

The second aim of this research was to provide alternative suggestions for a more sustainable packaging supply chain. Two different case studies concerning the full packaging of two different products were analysed in detail. The process was an attempt to create the theoretical framework for the development of a simple method for the investigation of different packaging options that could also help to make an optimum comparison between two or more packaging alternatives. This approach helps in the investigation and evaluation of a packaging redesigning process in a more practical way. It offers evidence, concerning the potential advantages, from an economic and logistics perspective. Although the process is focused on the

redesigning of the secondary packaging of these two products, it could be extended in order to include the analysis of other kinds of packaging. Alternatively, it could help focus on different packaging types (primary or transportation packaging).

The next step was the investigation of the overpackaging issue. Here again, a method of analysing the secondary packaging used in a company's operations from an overpackaging perspective was developed. This method provides a tool that could be used to indicate weaknesses, problems or failures that if addressed effectively could offer multiple advantages to the packaging user.

All the previous methodological development was to provide evidence that the redesign of corrugated – secondary packaging could provide important cost, weight and transportation benefits. Environmental advantages come from the combination of weight and transportation benefits. Finally, the method could be used as a tool for the improvement of the overall protection provided by the packaging used in a company's operations.

Based on the above analysis, this research offers insight into a range of theoretical issues. The issues analysed and discussed and the methods developed throughout this research can be used to improve the existing theory on packaging. The paper packaging supply chain, whose investigation offers a better understanding of its structure, may be favoured in this way, while the analysis of the overpackaging issue offers further details and ground for further research. All these elements, by being investigated concurrently, favour (or are able to favour) the sustainability notion, since the current critical environmental problems dictate the need to take steps in making various improvements (in any sector), that may help resolve serious environmental issues. In addition, the academic literature on the issues presented and analysed in this research is limited stressing in this way the contribution of the present research to the packaging literature.

Contribution to Policy

In addition, the research provides useful information concerning the implications that may derive by the implementation of environmental legislation on packaging issues. The detailed analysis concerning the way that the paper packaging supply chain is currently structured in Greece, with special attention to the reverse channel of distribution for what is relevant to the used packaging from the point of consumption back to the recycling centres, helps in this way. Furthermore, the collected data on issues such as the main factors affecting the buying decisions

of the final consumers, further enhances the knowledge basis and could help all interested parties in policy making.

Contribution to Packaging Industry

The research advances industrial knowledge by putting the outcomes to use. The methodological tools used to investigate the various issues, could be adjusted to the packaging operations of any individual company. This research is also likely to help companies to further analyse, investigate and ameliorate their packaging processes.

By using the methodology suggested in this research, a company would be able to measure and analyse its packaging needs, since the methodology developed and presented here provides a useful tool, and a practical guide to the whole process. Moreover, issues such as the estimation of a packaging's strength and the methods that could be used in order to evaluate the different kinds of paper packaging are also included in this research and of value to the industry.

Finally, the research could also inspire a company to proceed with packaging redesigning. The outcome provided by the analysis of the two case studies (i.e. for the products: a) 2TMIX and b) Wine Bottles) gives valid evidence that the redesigning process could potentially offer considerable advantage to a company keen to proceed with changes of this kind.

However, it should be mentioned that the methodologies suggested, can and should be adjusted to the special needs of any individual company. Furthermore, the implementation of packaging changes needs special knowledge and requires tight cooperation between different departments (sourcing, marketing, warehousing, logistics etc), in order to ensure stability and success.

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APPENDICES

Appendix 1: Questionnaires

Electronic

Georgakoudis Elias,
20th km National Road Thessaloniki Serres,
P.C. 57200, P.O.Box. 141, Lagkadas, Greece,
Fax. No. +30 23940 61740, Tel. No. +30 6976 869692,
e-mail: georg_mp@otenet.gr

Category: Suppliers

<p>The present Questionnaire is an important part of our investigation concerning the impact of the Packaging and Packaging Waste Directive (94/62/EU) to a specific supply chain. Your participation to the questionnaire is an important resource of information and it is crucial for our research.</p>	
<p>1. What kind of raw materials do you produce? <i>(Tick as appropriate)</i></p> <p>Paper <input type="checkbox"/> Glass <input type="checkbox"/></p> <p>Plastic <input type="checkbox"/> Metal <input type="checkbox"/></p>	
<p>2. What amount of raw materials destined for the packaging sector, do you produce per month (in tones)?</p>	<p>Click here to select</p>
<p>3. What is the amount of waste (concerning packaging materials) produced during the manufacturing process, per month (in tones)?</p>	<p>Click here to select</p>
<p>4. What amount of waste (concerning packaging materials) do you receive from the reverse flow, per month (in tones)?</p>	<p>Click here to select</p>
<p>5. What amount of this waste (concerning packaging materials) is recycled and what percentage goes for disposing because it can't be recycled anymore?</p>	<p><u>Recycling</u></p> <p>Click here to select</p> <p><u>Disposing</u></p> <p>Click here to select</p>
<p>6. What is the method of collecting the materials (concerning packaging materials) that are destined for recycling, from the supply chain?</p>	<p>Click here to select</p> <p>If "Other", please comment:</p>
<p>7. Who pays for the reverse flow of these materials?</p>	<p>Click here to select</p> <p>If "Other", please comment:</p>
<p>8. Do you pay anything for the waste (concerning packaging materials) that you receive - collect? <i>(Tick were appropriate. You can tick more than one)</i></p> <p>Transportation Cost <input type="checkbox"/></p> <p>Material Cost <input type="checkbox"/></p> <p>We pay nothing <input type="checkbox"/></p>	

<p>9. Is it more environmental friendly to recycle the waste or to produce new raw materials, in terms of energy and natural resources?</p>	<table border="0"> <thead> <tr> <th></th> <th style="text-align: center;">Recycle</th> <th style="text-align: center;">Produce</th> </tr> </thead> <tbody> <tr> <td>Energy</td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> <tr> <td>Natural Resources</td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> </tbody> </table>		Recycle	Produce	Energy	<input type="checkbox"/>	<input type="checkbox"/>	Natural Resources	<input type="checkbox"/>	<input type="checkbox"/>
	Recycle	Produce								
Energy	<input type="checkbox"/>	<input type="checkbox"/>								
Natural Resources	<input type="checkbox"/>	<input type="checkbox"/>								
<p>Your comments/suggestions:</p>										
<p>10. Due to environmental implications, the European Union, has adopted hundreds of directives, concerning environmental areas. One of them is the Packaging and Packaging Directive (94/62/EU), aiming to harmonize national management measures concerning packaging and packaging waste, in order to reduce its impact on the environment. The directive, sets specific targets, concerning the weight of packaging that should be recovered and in addition puts, specific minimum requirements of recycling, for each specific packaging material. Have you ever heard about the Packaging and Packaging Waste Directive (94/62/EU)?</p>	<p style="text-align: center;">Click here for a list of options</p>									
<p>11. Do you think that if the Directive, obligates the companies to set up take-back programmes, in order to collect their packaging from the supply chain or instead, to pay a tax to the government, is going to be affordable by the individual companies? Your Comment:</p>	<p style="text-align: center;">Click here for a list of options</p>									
<p>12. Comment the way, in which you think this directive, affects or is going to affect your business in the future.</p>										
<p>13. In your opinion, do you consider that the European Packaging Directive, is going to contribute in a better environmental performance? Your comments/suggestions:</p>	<p style="text-align: center;">Click here for a list of options</p>									
<p>14. After the implementation of the Packaging and Packaging Waste Directive (94/62/EU) and the taxes that are going to be generated, that your company is going to be forced to pay, do you think that the prices of your products are going to be</p>	<p style="text-align: center;">Click here for a list of options</p>									

increased, reflecting the increase of cost?	
Your Comment/Suggestions:	

Click in the box, if you wish to receive a summary of the results for this research:

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Category: Packaging Manufacturers

<p>The present Questionnaire is an important part of our investigation concerning the impact of the Packaging and Packaging Waste Directive (94/62/EU) to a specific supply chain. Your participation to the questionnaire is an important resource of information and it is crucial for our research.</p>	
<p>1. In which sector does the company belong ? <i>(Tick as appropriate)</i></p> <p>Paper Packaging <input type="checkbox"/> Glass Packaging <input type="checkbox"/></p> <p>Plastics Packaging <input type="checkbox"/> Metal Packaging <input type="checkbox"/></p>	
2. What amount of packaging do you produce per month (in tonnes)?	Click here to select
3. What is the amount of waste (concerning packaging materials) produced during the manufacturing process, every month (in tonnes)?	Click here to select
4. What amount of this waste is sent for recycling and what amount goes for disposing (in tonnes)?	<p><u>Recycling</u></p> <p>Click here to select</p> <p><u>Disposing</u></p> <p>Click here to select</p>
5. Who pays for the reverse flow of these materials to the recycling centers?	<p>Click here to select</p> <p>If "Other", please comment:</p>
6. Do you sell your manufacturing waste to the recycling companies?	Click here for a list of options
7. Due to environmental implications, the European Union, has adopted hundreds of directives, concerning environmental areas. One of them is the Packaging and Packaging Directive (94/62/EU), aiming to harmonize national management measures concerning packaging and packaging waste, in order to reduce its impact on the environment. The directive, sets specific targets, concerning the weight of packaging that should be recovered and in addition puts, specific minimum requirements of recycling, for each specific packaging material.	Click here for a list of options

Have you ever heard about the Packaging and Packaging Waste Directive (94/62/EU)?	
8. Do you think that if the Directive, obligates the companies to set up take-back programmes, in order to collect their packaging from the supply chain or instead, to pay a tax to the government, is going to be affordable by the individual companies?	Click here for a list of options
Your Comment:	
9. Comment the way, in which you think this directive, is going to affect your business.	
10. Most of the tax systems are weight based. Would you lighten your products (without causing any changes to their quality), in order to reduce the amount of money that you will be called to pay?	Click here for a list of options
11. In your opinion, do you consider that the European Packaging Directive, is going to contribute in a better environmental performance? Your comments/suggestions:	Click here for a list of options
12. After the implementation of the Packaging and Packaging Waste Directive (94/62/EU) and the taxes that are going to be generated, that your company is going to be forced to pay, do you think that the prices of your products are going to be increased, reflecting the increase of cost? Your Comment:	Click here for a list of options

<p>Click in the box, if you wish to receive a summary of the results for this research: <input type="checkbox"/></p> <p>Company Name:</p> <p>Name:</p> <p>e-mail:</p>

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Category: Industrial Customers

The present Questionnaire is an important part of our investigation concerning the impact of the Packaging and Packaging Waste Directive (94/62/EU) to a specific supply chain. Your participation to the questionnaire is an important resource of information and it is crucial for our research.

1. In which sector does the company belong ? *(Tick as appropriate)*

Food and Beverage	<input type="checkbox"/>	Electronic Equipment	<input type="checkbox"/>
Packaging	<input type="checkbox"/>	Chemicals and Pharmaceutics	<input type="checkbox"/>
Oil and Lubricants	<input type="checkbox"/>	Industrial Automation	<input type="checkbox"/>
Structural Materials	<input type="checkbox"/>	Services	<input type="checkbox"/>
Extractive Industry	<input type="checkbox"/>	Commerce	<input type="checkbox"/>
Plastics	<input type="checkbox"/>	Other.....	<input type="checkbox"/>

2. What amount of packaging do you use every year (in tones or quantities)?

Paper	Tones	Glass	Tones
	Quantities in pieces		Quantities in pieces
Plastic	Tones	Metal	Tones
	Quantities in pieces		Quantities in pieces

3. Can you fill in the following cells, the proportion that your company uses, per packaging material?

Paper:	%	Plastic:	%	Glass:	%	Metal:	%
--------	---	----------	---	--------	---	--------	---

4. What amount of the packaging that you use every year, is recyclable (in total or per material)?

[Click here to select](#)

Paper: %	Plastic: %	Glass: %	Metal: %
5. Do you produce any waste due to improper handling?			Click here for a list of options
6. What is the proportion of this waste, with respect to the total packaging you use?			%
7. Have you ever thought of using only recycled packaging materials?			Click here for a list of options
<p>8. Due to environmental implications, the European Union, has adopted hundreds of directives, concerning environmental areas. One of them is the Packaging and Packaging Directive (94/62/EU), aiming to harmonize national management measures concerning packaging and packaging waste, in order to reduce its impact on the environment. The directive, sets specific targets, concerning the weight of packaging that should be recovered and in addition puts, specific minimum requirements of recycling, for each specific packaging material.</p> <p>Have you ever heard about the Packaging and Packaging Waste Directive (94/62/EU)?</p>			Click here for a list of options
<p>9. Do you think that if the Directive, obligates the companies to set up take-back programmes, in order to collect their packaging from the supply chain or instead, to pay a tax to the government, is going to be affordable by the individual companies?</p> <p>Your Comment:</p>			Click here for a list of options
<p>10. Do you think that the use of the above take back programs, can result in source reduction and a more environmental friendly way of doing business?</p> <p>Your Comment:</p>			Click here for a list of options
11. Comment the way, in which you think this directive, is going to affect your business.			
<p>12. Most of the tax systems are weight-based. Would you ask your packaging suppliers to provide you with lighter packaging, in order to reduce the amount of money that you will be called to pay?</p>			Click here for a list of options
<p>13. After the implementation of the Packaging and Packaging Waste Directive (94/62/EU) and the taxes that are going to be generated, that your company is going to be forced to pay, do you think that the</p>			Click here for a list of options

prices of your products are going to be increased, reflecting the increase of cost?	
14. What process do you think is better concerning the following materials, in order to protect the environment?	Paper Click here for a list of options
	Plastic Click here for a list of options
	Metal Click here for a list of options
	Glass Click here for a list of options

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<p>the environment. The directive, sets specific targets, concerning the weight of packaging that should be recovered and in addition puts, specific minimum requirements of recycling, for each specific packaging material.</p> <p>Have you ever heard about the Packaging and Packaging Waste Directive (94/62/EU)?</p>	
<p>9. Do you think that if the Directive, obligates the companies to set up take-back programmes, in order to collect their packaging from the supply chain or instead, to pay a tax to the government, is going to be affordable by the individual companies?</p> <p>Your Comment:</p>	<p>Click here for a list of options</p>
<p>10. Comment the way, in which you think this directive, is going to affect your business.</p>	
<p>11. In your opinion, do you consider that the European Packaging Directive, is going to contribute in a better environmental performance?</p> <p>Your Comment:</p>	<p>Click here for a list of options</p>
<p>12. Have you ever thought of asking your suppliers to change the packaging of their products in order to be more environmental friendly?</p>	<p>Click here for a list of options</p>
<p>13. After the implementation of the Packaging and Packaging Waste Directive (94/62/EU) and the taxes that are going to be generated, that your company is going to be forced to pay, do you think that the prices of your products are going to be increased, reflecting the increase of cost?</p>	<p>Click here for a list of options</p>
<p>14. What process do you think is better concerning the following materials, in order to protect the environment?</p>	<p>Paper Click here for a list of options</p>
	<p>Plastic Click here for a list of options</p>
	<p>Metal Click here for a list of options</p>
	<p>Glass Click here for a list of options</p>

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Category: Consumers

<p>The present Questionnaire is an important part of our investigation concerning the impact of the Packaging and Packaging Waste Directive (94/62/EU) to a specific supply chain. Your participation to the questionnaire is an important resource of information and it is crucial for our research.</p>	
1. Name:	
2. Do you participate in any environmental organization?	Click here for a list of options
3. How do you rate your knowledge concerning the environment and the various environmental problems?	Click here for a list of options
4. Do you recycle the packaging you use?	Click here for a list of options
<p>5. What kind of packaging do you most recycle? (Place ratings from 1 to 4, beginning from the most common material that you recycle).</p>	
Paper	Click here to select
Glass	Click here to select
Plastic	Click here to select
Metal	Click here to select
6. Have you ever destroyed a product due to improper handling of its packaging?	Click here for a list of options
7. Have you ever received – bought a damaged product due to an improper or destroyed packaging?	Click here for a list of options
8. Due to environmental implications, the European Union, has adopted hundreds of directives, concerning environmental areas. One of them is the Packaging and Packaging Directive (94/62/EU), aiming to harmonize national management measures concerning packaging and packaging waste, in order to reduce its impact on the environment. The directive, sets specific targets, concerning the weight of packaging that should be recovered and in addition puts, specific minimum requirements of recycling, for	Click here for a list of options

each specific packaging material. Have you ever heard about the Packaging and Packaging Waste Directive (94/62/EU)?		
9. What do you think about it?		
10. Do you think that if the Directive, obligates the companies to set up take-back programmes, in order to collect their packaging from the supply chain or instead, to pay a tax to the government, is going to be affordable by the individual companies? Your Comment:		Click here for a list of options
11. Do you think that the use of take back programs can result in source reduction and a more environmental friendly way of doing business? Your Comment:		Click here for a list of options
12. After the implementation of the Packaging and Packaging Waste Directive (94/62/EU) and the taxes that are going to be generated, do you think that the prices of the products that you buy, are going to be affected?		Click here for a list of options
13. What process do you think is better concerning the following materials, in order to protect the environment?	Paper	Click here for a list of options
	Plastic	Click here for a list of options
	Metal	Click here for a list of options
	Glass	Click here for a list of options
14. When you buy a product, you mostly base your choice on: <i>(Tick the <u>one</u> most appropriate)</i> Your comment:		Click here for a list of options

Age:

Education: Elementary school High School Lyceum University MSC
PhD

Salary: Unemployed 0-500€ 501-800€ 801-1200€ 1201-1600€ 1601-2500€
2500 and over

e-mail:

Printed

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Category: Suppliers

<p>The present Questionnaire is an important part of our investigation concerning the impact of the Packaging and Packaging Waste Directive (94/62/EU) to a specific supply chain. Your participation to the questionnaire is an important resource of information and it is crucial for our research.</p>				
<p>1. What kind of raw materials do you produce? <i>(Tick as appropriate)</i></p> <p>Paper <input type="checkbox"/> Glass <input type="checkbox"/></p> <p>Plastic <input type="checkbox"/> Metal <input type="checkbox"/></p>				
<p>2. What amount of raw materials destined for the packaging sector, do you produce per month (in tonnes)?</p>	0-50	<input type="checkbox"/>	400-500	<input type="checkbox"/>
	51-100	<input type="checkbox"/>	500-600	<input type="checkbox"/>
	101-150	<input type="checkbox"/>	600-700	<input type="checkbox"/>
	151-200	<input type="checkbox"/>	700-800	<input type="checkbox"/>
	200-300	<input type="checkbox"/>	800-900	<input type="checkbox"/>
	300-400	<input type="checkbox"/>	900-1000	<input type="checkbox"/>
			1000 and more	<input type="checkbox"/>
<p>3. What is the amount of waste (concerning packaging materials) produced during the manufacturing process, per month (in tonnes)?</p>	0-50	<input type="checkbox"/>	400-500	<input type="checkbox"/>
	51-100	<input type="checkbox"/>	500-600	<input type="checkbox"/>
	101-150	<input type="checkbox"/>	600-700	<input type="checkbox"/>
	151-200	<input type="checkbox"/>	700-800	<input type="checkbox"/>
	200-300	<input type="checkbox"/>	800-900	<input type="checkbox"/>
	300-400	<input type="checkbox"/>	900-1000	<input type="checkbox"/>
			1000 and more	<input type="checkbox"/>
<p>4. What amount of waste (concerning packaging materials) do you receive from the reverse flow, per month (in tonnes)?</p>	0-50	<input type="checkbox"/>	400-500	<input type="checkbox"/>
	51-100	<input type="checkbox"/>	500-600	<input type="checkbox"/>
	101-150	<input type="checkbox"/>	600-700	<input type="checkbox"/>

	151-200 <input type="checkbox"/> 700-800 <input type="checkbox"/> 200-300 <input type="checkbox"/> 800-900 <input type="checkbox"/> 300-400 <input type="checkbox"/> 900-1000 <input type="checkbox"/> 1000 and more <input type="checkbox"/>
5. What amount of this waste (concerning packaging materials) is recycled and what percentage goes for disposing because it can't be recycled anymore?	<u>Recycling</u>
	5% <input type="checkbox"/> 45% <input type="checkbox"/> 10% <input type="checkbox"/> 50% <input type="checkbox"/> 15% <input type="checkbox"/> 55% <input type="checkbox"/> 20% <input type="checkbox"/> 60% <input type="checkbox"/> 25% <input type="checkbox"/> 65% <input type="checkbox"/> 30% <input type="checkbox"/> 70% <input type="checkbox"/> 35% <input type="checkbox"/> 75% <input type="checkbox"/> 40% <input type="checkbox"/> 75% and more <input type="checkbox"/>
	<u>Disposing</u>
	5% <input type="checkbox"/> 45% <input type="checkbox"/> 10% <input type="checkbox"/> 50% <input type="checkbox"/> 15% <input type="checkbox"/> 55% <input type="checkbox"/> 20% <input type="checkbox"/> 60% <input type="checkbox"/> 25% <input type="checkbox"/> 65% <input type="checkbox"/> 30% <input type="checkbox"/> 70% <input type="checkbox"/> 35% <input type="checkbox"/> 75% <input type="checkbox"/> 40% <input type="checkbox"/> 75% and more <input type="checkbox"/>
6. What is the method of collecting the materials (concerning packaging materials) that are destined for recycling, from the supply chain?	We collect them using our trucks <input type="checkbox"/> We collect them using 3PLs <input type="checkbox"/> They are being sent to us <input type="checkbox"/>
If "Other", please comment:	
7. Who pays for the reverse flow of these materials?	We pay <input type="checkbox"/> Our provider pays <input type="checkbox"/> Other <input type="checkbox"/>
If "Other", please comment:	

<p>8. Do you pay anything for the waste (concerning packaging materials) that you receive - collect?</p> <p><i>(Tick were appropriate. You can tick more than one)</i></p> <p>Transportation Cost <input type="checkbox"/></p> <p>Material Cost <input type="checkbox"/></p> <p>We pay nothing <input type="checkbox"/></p>		
<p>9. Is it more environmental friendly to recycle the waste or to produce new raw materials, in terms of energy and natural resources?</p>	Recycle	Produce
	<p>Energy <input type="checkbox"/></p> <p>Natural Resources <input type="checkbox"/></p>	<p><input type="checkbox"/></p> <p><input type="checkbox"/></p>
<p>Your comments/suggestions:</p>		
<p>10. Due to environmental implications, the European Union, has adopted hundreds of directives, concerning environmental areas. One of them is the Packaging and Packaging Directive (94/62/EU), aiming to harmonize national management measures concerning packaging and packaging waste, in order to reduce its impact on the environment. The directive, sets specific targets, concerning the weight of packaging that should be recovered and in addition puts, specific minimum requirements of recycling, for each specific packaging material. Have you ever heard about the Packaging and Packaging Waste Directive (94/62/EU)?</p>	Yes	<input type="checkbox"/>
	No	<input type="checkbox"/>
<p>11. Do you think that if the Directive, obligates the companies to set up take-back programmes, in order to collect their packaging from the supply chain or instead, to pay a tax to the goverment, is going to be affordable by the individual companies?</p>	Yes	<input type="checkbox"/>
	No	<input type="checkbox"/>
<p>Your comment:</p>		

12. Comment the way, in which you think this directive, affects or is going to affect your business in the future.

13. In your opinion, do you consider that the European Packaging Directive, is going to contribute in a better environmental performance?

Yes
No

Your comments/suggestions:

14. After the implementation of the Packaging and Packaging Waste Directive (94/62/EU) and the taxes that are going to be generated, that your company is going to be forced to pay, do you think that the prices of your products are going to be increased, reflecting the increase of cost?

Yes
No

Your Comment/Suggestions:

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Category: Packaging Manufacturers

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<p>1. In which sector does the company belong ? <i>(Tick as appropriate)</i></p> <p>Paper Packaging <input type="checkbox"/> Glass Packaging <input type="checkbox"/></p> <p>Plastics Packaging <input type="checkbox"/> Metal Packaging <input type="checkbox"/></p>				
<p>2. What amount of packaging do you produce per month (in tonnes)?</p>	0-50	<input type="checkbox"/>	400-500	<input type="checkbox"/>
	51-100	<input type="checkbox"/>	500-600	<input type="checkbox"/>
	101-150	<input type="checkbox"/>	600-700	<input type="checkbox"/>
	151-200	<input type="checkbox"/>	700-800	<input type="checkbox"/>
	200-300	<input type="checkbox"/>	800-900	<input type="checkbox"/>
	300-400	<input type="checkbox"/>	900-1000	<input type="checkbox"/>
			1000 and more	<input type="checkbox"/>
<p>3. What is the amount of waste (concerning packaging materials) produced during the manufacturing process, every month (in tonnes)?</p>	0-50	<input type="checkbox"/>	400-500	<input type="checkbox"/>
	51-100	<input type="checkbox"/>	500-600	<input type="checkbox"/>
	101-150	<input type="checkbox"/>	600-700	<input type="checkbox"/>
	151-200	<input type="checkbox"/>	700-800	<input type="checkbox"/>
	200-300	<input type="checkbox"/>	800-900	<input type="checkbox"/>
	300-400	<input type="checkbox"/>	900-1000	<input type="checkbox"/>
			1000 and more	<input type="checkbox"/>
<p>4. What amount of this waste is sent for recycling and what amount goes for disposing (in tonnes)?</p>	<i>Recycling</i>			
	0-50	<input type="checkbox"/>	400-500	<input type="checkbox"/>
	51-100	<input type="checkbox"/>	500-600	<input type="checkbox"/>

	101-150	<input type="checkbox"/>	600-700	<input type="checkbox"/>
	151-200	<input type="checkbox"/>	700-800	<input type="checkbox"/>
	200-300	<input type="checkbox"/>	800-900	<input type="checkbox"/>
	300-400	<input type="checkbox"/>	900-1000	<input type="checkbox"/>
			1000 and more	<input type="checkbox"/>
	<i>Disposing</i>			
	0-50	<input type="checkbox"/>	400-500	<input type="checkbox"/>
	51-100	<input type="checkbox"/>	500-600	<input type="checkbox"/>
	101-150	<input type="checkbox"/>	600-700	<input type="checkbox"/>
	151-200	<input type="checkbox"/>	700-800	<input type="checkbox"/>
	200-300	<input type="checkbox"/>	800-900	<input type="checkbox"/>
	300-400	<input type="checkbox"/>	900-1000	<input type="checkbox"/>
			1000 and more	<input type="checkbox"/>
5. Who pays for the reverse flow of these materials to the recycling centers?	We pay <input type="checkbox"/> The recycling company pays <input type="checkbox"/> Other <input type="checkbox"/>			
If "Other", please comment:				
6. Do you sell your manufacturing waste to the recycling companies?	Yes <input type="checkbox"/> No <input type="checkbox"/>			
7. Due to environmental implications, the European Union, has adopted hundreds of directives, concerning environmental areas. One of them is the Packaging and Packaging Directive (94/62/EU), aiming to harmonize national management measures concerning packaging and packaging waste, in order to reduce its impact on the environment. The directive, sets specific targets, concerning the weight of packaging that should be recovered and in addition puts, specific minimum requirements of recycling, for each specific packaging material. Have you ever heard about the Packaging and Packaging Waste Directive (94/62/EU)?	Yes <input type="checkbox"/> No <input type="checkbox"/>			
8. Do you think that if the Directive, obligates the companies to set up take-back programmes, in order to collect their packaging from the supply chain or instead, to pay a tax to the government, is going to be affordable by the individual companies?	Yes <input type="checkbox"/> No <input type="checkbox"/>			
Your Comment:				

9. Comment the way, in which you think this directive, is going to affect your business.	
10. Most of the tax systems are weight based. Would you lighten your products (without causing any changes to their quality), in order to reduce the amount of money that you will be called to pay?	Yes <input type="checkbox"/> No <input type="checkbox"/>
11. In your opinion, do you consider that the European Packaging Directive, is going to contribute in a better environmental performance?	Yes <input type="checkbox"/> No <input type="checkbox"/>
Your comments/suggestions:	
12. After the implementation of the Packaging and Packaging Waste Directive (94/62/EU) and the taxes that are going to be generated, that your company is going to be forced to pay, do you think that the prices of your products are going to be increased, reflecting the increase of cost?	Yes <input type="checkbox"/> No <input type="checkbox"/>
Your Comment:	

Click in the box, if you wish to receive a summary of the results for this research: <input type="checkbox"/> Company Name: Name: e-mail:
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Category: Industrial Customers

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1. In which sector does the company belong ? *(Tick as appropriate)*

Food and Beverage	<input type="checkbox"/>	Electronic Equipment	<input type="checkbox"/>
Packaging	<input type="checkbox"/>	Chemicals and Pharmaceuticals	<input type="checkbox"/>
Oil and Lubricants	<input type="checkbox"/>	Industrial Automation	<input type="checkbox"/>
Structural Materials	<input type="checkbox"/>	Services	<input type="checkbox"/>
Extractive Industry	<input type="checkbox"/>	Commerce	<input type="checkbox"/>
Plastics	<input type="checkbox"/>	Other.....	<input type="checkbox"/>

2. What amount of packaging do you use every year (in tones or quantities)?

Paper	Tones _____ Quantities in pieces _____	Glass	Tones _____ Quantities in pieces _____
Plastic	Tones _____ Quantities in pieces _____	Metal	Tones _____ Quantities in pieces _____

3. Can you fill in the following cells, the proportion that your company uses, per packaging material?

Paper:	Plastic:	Glass: %	Metal: %
--------	----------	---------------	---------------

%	%		
4. What amount of the packaging that you use every year, is recyclable in total or (see below) per material?			_____%
Paper: %	Plastic: %	Glass: %	Metal: %
5. Do you produce any packaging waste due to improper handling?			Yes <input type="checkbox"/> No <input type="checkbox"/>
6. What is the proportion of this waste, with respect to the total packaging you use?			_____%
7. Have you ever thought of using only recycled packaging materials?			Yes <input type="checkbox"/> No <input type="checkbox"/>
8. Due to environmental implications, the European Union, has adopted hundreds of directives, concerning environmental areas. One of them is the Packaging and Packaging Directive (94/62/EU), aiming to harmonize national management measures concerning packaging and packaging waste, in order to reduce its impact on the environment. The directive, sets specific targets, concerning the weight of packaging that should be recovered and in addition puts, specific minimum requirements of recycling, for each specific packaging material. Have you ever heard about the Packaging and Packaging Waste Directive (94/62/EU)?			Yes <input type="checkbox"/> No <input type="checkbox"/>
9. Do you think that if the Directive, obligates the companies to set up take-back programmes, in order to collect their packaging from the supply chain or instead, to pay a tax to the government, is going to be affordable by the individual companies?			Yes <input type="checkbox"/> No <input type="checkbox"/>
Your Comment:			
10. Do you think that the use of the above take back programs, can result in source reduction and a more environmental friendly way of doing business?			Yes <input type="checkbox"/> No <input type="checkbox"/>

Your Comment:					
11. Comment the way, in which you think this directive, is going to affect your business.					
12. Most of the tax systems are weight-based. Would you ask your packaging suppliers to provide you with lighter packaging, in order to reduce the amount of money that you will be called to pay?			Yes	<input type="checkbox"/>	
			No	<input type="checkbox"/>	
13. After the implementation of the Packaging and Packaging Waste Directive (94/62/EU) and the taxes that are going to be generated, that your company is going to be forced to pay, do you think that the prices of your products are going to be increased, reflecting the increase of cost?			Yes	<input type="checkbox"/>	
			No	<input type="checkbox"/>	
14. What process do you think is better concerning the following materials, in order to protect the environment?		Recycle	Reuse	Incineration	Disposing
	Paper	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Plastic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Metal	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Glass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Click in the box, if you wish to receive a summary of the results for this research: <input type="checkbox"/>
Company Name:
Name:
e-mail:

Georgakoudis Elias,
20th km National Road Road Thessaloniki Serres,
P.C. 57200, P.O.Box. 141, Lagkadas, Greece,
Fax. No. +30 23940 61740, Tel. No. +30 6976 869692,
e-mail: georg_mp@otenet.gr

Category: Wholesalers - Retailers

<p>The present Questionnaire is an important part of our investigation concerning the impact of the Packaging and Packaging Waste Directive (94/62/EU) to a specific supply chain. Your participation to the questionnaire is an important resource of information and it is crucial for our research.</p>			
<p>1. What is your annual turnover?</p>		0-500.000€	<input type="checkbox"/>
		500.000€-1.000.000€	<input type="checkbox"/>
		1.000.000€-2.000.000€	<input type="checkbox"/>
		2.000.000€-3.000.000€	<input type="checkbox"/>
		3.000.000€-4.000.000€	<input type="checkbox"/>
		4.000.000€-5.000.000€	<input type="checkbox"/>
		5.000.000€-7.000.000€	<input type="checkbox"/>
		7.000.000€ and over	<input type="checkbox"/>
<p>2. Have you ever noticed damages in the products, due to improper handling, that happened either in your facilities or during transportation?</p>		Many times	<input type="checkbox"/>
		Some times	<input type="checkbox"/>
		Rarely	<input type="checkbox"/>
		Never	<input type="checkbox"/>
<p>3. What amount of packaging that you originally unpack is sent for recycling every month (in tones)?</p>			
Paper:	Plastic:	Glass:	Metal:
<p>4. What amount of packaging that you originally unpack is sent for disposing every month (in tones)?</p>			
Paper:	Plastic:	Glass:	Metal:

5. What is the method of sending back for recycling the packaging materials?	
We send them <input type="checkbox"/>	The recycling centers come and take them <input type="checkbox"/> Both <input type="checkbox"/>
6. Who pays for the reverse flow of these packaging materials to the recycling centers?	We pay <input type="checkbox"/> The recycling centers pay <input type="checkbox"/> We both pay <input type="checkbox"/> Other <input type="checkbox"/>
Your comment:	
7. Are you getting paid for these materials that you send back for recycling?	We pay <input type="checkbox"/> We are getting paid <input type="checkbox"/> None of the above <input type="checkbox"/>
8. Due to environmental implications, the European Union, has adopted hundreds of directives, concerning environmental areas. One of them is the Packaging and Packaging Directive (94/62/EU), aiming to harmonize national management measures concerning packaging and packaging waste, in order to reduce its impact on the environment. The directive, sets specific targets, concerning the weight of packaging that should be recovered and in addition puts, specific minimum requirements of recycling, for each specific packaging material. Have you ever heard about the Packaging and Packaging Waste Directive (94/62/EU)?	Yes <input type="checkbox"/> No <input type="checkbox"/>
9. Do you think that if the Directive, obligates the companies to set up take-back programmes, in order to collect their packaging from the supply chain or instead, to pay a tax to the government, is going to be affordable by the individual companies?	Yes <input type="checkbox"/> No <input type="checkbox"/>
Your Comment:	
10. Comment the way, in which you think this directive, is going to affect your business.	

11. In your opinion, do you consider that the European Packaging Directive, is going to contribute in a better environmental performance?			Yes	<input type="checkbox"/>	
			No	<input type="checkbox"/>	
Your Comment:					
12. Have you ever thought of asking your suppliers to change the packaging of their products in order to be more environmental friendly?			Yes	<input type="checkbox"/>	
			No	<input type="checkbox"/>	
13. After the implementation of the Packaging and Packaging Waste Directive (94/62/EU) and the taxes that are going to be generated, that your company is going to be forced to pay, do you think that the prices of your products are going to be increased, reflecting the increase of cost?			Yes. They are going to be increased.	<input type="checkbox"/>	
			No. Nothing is going to happen.	<input type="checkbox"/>	
14. What process do you think is better concerning the following materials, in order to protect the environment?		Recycle	Reuse	Incineration	Disposing
	Paper	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Plastic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Metal	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Glass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Click in the box, if you wish to receive a summary of the results for this research: <input type="checkbox"/>
Company Name:
Name:
e-mail:

Georgakoudis Elias,
20th km National Road Road Thessaloniki Serres,
P.C. 57200, P.O.Box. 141, Lagkadas, Greece,
Fax. No. +30 23940 61740, Tel. No. +30 6976 869692,
e-mail: georg_mp@otenet.gr

Category: Consumers

<p>The present Questionnaire is an important part of our investigation concerning the impact of the Packaging and Packaging Waste Directive (94/62/EU) to a specific supply chain. Your participation to the questionnaire is an important resource of information and it is crucial for our research.</p>	
1. Name:	
2. Do you participate in any environmental organization?	Yes <input type="checkbox"/> No <input type="checkbox"/>
3. How do you rate your knowledge concerning the environment and the various environmental problems?	Excellent <input type="checkbox"/> Good <input type="checkbox"/> Average <input type="checkbox"/> Insufficient-Zero <input type="checkbox"/>
4. Do you recycle the packaging you use?	Yes. I recycle all the packaging I use. <input type="checkbox"/> Yes. I recycle some of the packaging I use. <input type="checkbox"/> No. I don't recycle anything. <input type="checkbox"/>
5. What kind of packaging do you most recycle? (Place ratings from 1 to 4, beginning from the most common material that you recycle).	
Paper <input type="checkbox"/>	Glass <input type="checkbox"/>
Plastic <input type="checkbox"/>	Metal <input type="checkbox"/>
6. Have you ever destroyed a product due to improper handling of its packaging?	Yes <input type="checkbox"/> No <input type="checkbox"/>
7. Have you ever received – bought a damaged product due to an improper or destroyed packaging?	Yes <input type="checkbox"/> No <input type="checkbox"/>

<p>8. Due to environmental implications, the European Union, has adopted hundreds of directives, concerning environmental areas. One of them is the Packaging and Packaging Directive (94/62/EU), aiming to harmonize national management measures concerning packaging and packaging waste, in order to reduce its impact on the environment. The directive, sets specific targets, concerning the weight of packaging that should be recovered and in addition puts, specific minimum requirements of recycling, for each specific packaging material.</p> <p>Have you ever heard about the Packaging and Packaging Waste Directive (94/62/EU)?</p>	Yes	<input type="checkbox"/>
	No	<input type="checkbox"/>
<p>9. What do you think about it?</p>		
<p>10. Do you think that if the Directive, obligates the companies to set up take-back programmes, in order to collect their packaging from the supply chain or instead, to pay a tax to the government, is going to be affordable by the individual companies?</p>	Yes	<input type="checkbox"/>
	No	<input type="checkbox"/>
	I don't know/ I don't care	<input type="checkbox"/>
<p>Your Comment:</p>		
<p>11. Do you think that the use of take back programs can result in source reduction and a more environmental friendly way of doing business?</p>	Yes	<input type="checkbox"/>
	No	<input type="checkbox"/>
	Neutral	<input type="checkbox"/>
	I don't know	<input type="checkbox"/>
<p>Your Comment:</p>		
<p>12. After the implementation of the Packaging and Packaging Waste Directive (94/62/EU) and the taxes that are going to be generated, do you think that the</p>	Yes. The prices are going to be increased.	<input type="checkbox"/>
	No. Nothing is going to happen.	<input type="checkbox"/>

prices of the products that you buy, are going to be affected?		I don't know. <input type="checkbox"/>			
13. What process do you think is better concerning the following materials, in order to protect the environment?		Recycle	Reuse	Incineration	Disposing
	Paper	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Plastic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Metal	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Glass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. When you buy a product, you mostly base your choice on: <i>(Tick the <u>one</u> most appropriate)</i>		Price	<input type="checkbox"/>		
		Quality	<input type="checkbox"/>		
		Price and Quality	<input type="checkbox"/>		
		The Origin of the product	<input type="checkbox"/>		
		The environmental friendliness of the product	<input type="checkbox"/>		
		Other	<input type="checkbox"/>		
Your comment:					

Age:

Education: Elementary school High School Lyceum University MSC PhD

Salary: Unemployed 0-500€ 501-800€ 801-1200€ 1201-1600€ 1601-2500€ 2500 and over

e-mail:

Appendix 2

Introductory Letter : Greek Version



Georgakoudis Elias,
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e-mail: georg_mp@otenet.gr

Αγαπητέ/ή κύριε/κυρία

Το Βρετανικό Πανεπιστήμιο του Huddersfield, διεξάγει μια μεγάλη έρευνα με αντικείμενο την εφαρμογή της Ευρωπαϊκής Οδηγίας για την Συσκευασία (94/62 EC), από τις ελληνικές επιχειρήσεις και τα προβλήματα που ενδέχεται να δημιουργηθούν από αυτήν.

Σας στέλνουμε, λοιπόν, το παρόν ερωτηματολόγιο, με την παράκληση να μας βοηθήσετε να αποτυπώσουμε την τρέχουσα εικόνα της Ελληνικής Αγοράς σε σχέση με την συσκευασία και να προβλέψουμε (βάσει μοντέλου) την επερχόμενη κατάσταση, μετά την εφαρμογή της Ευρωπαϊκής Οδηγίας.

Οι απαντήσεις των ερωτηματολογίων, θα υποβληθούν στην αναγκαία στατιστική επεξεργασία, από την οποία αναμένεται να προκύψουν τα αποτελέσματα της έρευνας.

Το ερωτηματολόγιο έχει σχεδιαστεί, ώστε να είναι απλό, εύχρηστο και να μην απαιτούνται περισσότερο από 7 λεπτά για την πλήρη συμπλήρωσή του. Σας παρακαλούμε να απαντήσετε (ο αρμοδιότερος στην επιχείρησή σας), με τη μέγιστη δυνατή ακρίβεια.

Η συμπλήρωση της επωνυμίας σας δεν κρίνεται αναγκαία (καθώς θα θέλαμε να διατηρήσουμε την εμπιστευτικότητα στην έρευνά μας, μέσω της ανωνυμίας).

Παρακαλούμε συμπληρώστε το σχετικό πεδίο στο ερωτηματολόγιο, αν θα επιθυμούσατε να λάβετε τα αποτελέσματα, μετά το τέλος της έρευνας.

Για οποιαδήποτε διευκρίνιση, μπορείτε να επικοινωνήσετε:

Γεωργακούδης Ηλίας, s0572950@hud.ac.uk, tel. 0030 6976869692

Dr. Nicoleta S. Tipi, N.Tipi@hud.ac.uk, tel. 0044 (0) 1484 47 2615

Prof. Colin G. Bamford, c.g.bamford@hud.ac.uk, tel. 0044 (0) 1484 47 2348



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e-mail: [georg mp@otenet.gr](mailto:georg_mp@otenet.gr)

Dear sir / madam.

The British University of Huddersfield, is carrying on a big research, investigating the implementation of the European Packaging Directive (94/62 EC), by the Greek companies and the problems that might occur in the Greek Market.

For this reason, we send you the present questionnaire, requesting you to help us describe the current situation of the Greek Market, in relevance with the packaging and to investigate (based on a model) the coming conditions, after the implementation of the specific directive.

The questionnaires, are going to be subject of a very detailed statistical analysis, that is expected to provide us with all the necessary outcomes and conclusions.

The questionnaire has been designed, in order to be easy and handy, and you won't need more than 7 minutes for its completion.

You are not obliged to fill in your name (because we need to keep the confidentiality of our research through anonymity).

Please, fill in the specific field in the questionnaire, if you wish to receive the results, after the completion of the research.

For further details, you may contact:

Georgakoudis Elias, s0572950@hud.ac.uk , tel. 0030 6976869692

Dr. Nicoleta S. Tipi, N.Tipi@hud.ac.uk, tel. 0044 (0) 1484 47 2615

Prof. Colin G. Bamford, c.g.bamford@hud.ac.uk, tel. 0044 (0) 1484 47 2348

Appendix 3

Timeline - Precursors

- 1839 - [Natural Rubber](#) - method of processing invented by Charles Goodyear
- 1843 - [Vulcanite](#) - Thomas Hancock
- 1843 - Gutta-Percha - William Montgomerie
- 1856 - Shellac - Alfred Critchlow, Samuel Peck
- 1856 - Bois Durci - Francois Charles Lepag

Timeline - Beginning of the Plastic Era with Semi Synthetics

- 1839 - [Polystyrene](#) or PS discovered - Eduard Simon
- 1862 - Parkesine - Alexander Parkes
- 1863 - Cellulose Nitrate or Celluloid - John Wesley Hyatt
- 1872 - [Polyvinyl Chloride](#) or PVC - first created by Eugen Baumann
- 1894 - [Viscose Rayon](#) - Charles Frederick Cross, Edward John Bevan

Timeline - Thermosetting Plastics and Thermoplastics

- 1908 - Cellophane - Jacques E. Brandenberger
- 1909 - First true plastic Phenol-Formaldehyde tradenamed [Bakelite](#) - Leo Hendrik Baekeland
- 1926 - [Vinyl or PVC](#) - Walter Semon invented a plasticized PVC.
- 1927 - Cellulose Acetate
- 1933 - [Polyvinylidene chloride](#) or Saran also called PVDC - accidentally discovered by Ralph Wiley, a Dow Chemical lab worker.
- 1935 - Low-density polyethylene or LDPE - Reginald Gibson and Eric Fawcett
- 1936 - Acrylic or Polymethyl Methacrylate
- 1937 - [Polyurethanes](#) tradenamed Igamid for plastics materials and Perlon for fibers. - Otto Bayer and co-workers discovered and patented the chemistry of polyurethanes
- 1938 - [Polystyrene](#) made practical
- 1938 - Polytetrafluoroethylene or PTFE [tradenamed Teflon](#) - Roy Plunkett
- 1939 - [Nylon and Neoprene](#) considered a replacement for silk and a synthetic rubber respectively Wallace Hume Carothers
- 1941 - [Polyethylene Terephthalate](#) or Pet - Whinfield and Dickson
- 1942 - Low Density Polyethylene

- 1942 - [Unsaturated Polyester](#) also called PET patented by John Rex Whinfield and James Tennant Dickson
- 1951 - [High-density polyethylene or HDPE tradenamed Marlex](#) - Paul Hogan and Robert Banks
- 1951 - [Polypropylene or PP](#) - Paul Hogan and Robert Banks
- 1953 - [Saran Wrap](#) introduced by Dow Chemicals.
- 1954 - [Styrofoam](#) the trademarked form of polystyrene foam insulation, invented by Ray McIntire for Dow Chemicals
- 1964 - Polyimide
- 1970 - [Thermoplastic Polyester](#) this includes trademarked Dacron, Mylar, Melinex, Teijin, and Teton
- 1978 - Linear Low Density Polyethylene
- 1985 - Liquid Crystal Polymers

Source: Bellis, M. (2005) 'The History of Plastics' About, Inc., A part of the New York Times Company, [online] Available at: <<http://inventors.about.com/od/pstartinventions/a/plastics.htm>> [Accessed 18th December 2005]

Appendix 4

Packaging Priorities:

The following points and issues are just some of the considerations that could be taken into account in the decision – making process:

- ♻️ Cargo transported by air can usually be packed in thinner cartons than if the same cargo is transported by sea, because transit time is shorter and usually there are fewer stages of handling involved. The strength of a carton must be stronger when shipped loose than when it is unitised (pallet or full container or truckload) because it is subject to greater strain during transit.
- ♻️ Care must be taken to use correctly sized cartons, crates, drums, sacks, etc., in order to properly utilize the mode of transport's loading dimensions. Size is also important in respect to market requirements and commercial practices. Many items are sold by the count of so many units per carton, such as alcoholic drinks, cigarettes and fruit when sold wholesale.
- ♻️ Transit time is another important issue. The same product will require different packaging if transported over a longer distance than for a shorter distance, even if the same mode of transport is used. For example, washing machines transported by truck from Germany to the Netherlands are wrapped in plastic with wooden supports of the side. The same washing machines transported from Germany to Turkey are packaged in reinforced carton box pallets.
- ♻️ Strength is another important issue. The more cartons stowed on top of one another, the stronger the cartons must be. The strength factor must also be considered in conjunction with the number of handling stages the cargo will be subject to.
- ♻️ Presentation can also be a big issue. Will the product be sold in the same packaging used for transport? If so, can the packaging be used as a marketing tool as well? Anything that looks nice sells easier.
- ♻️ At the same time that conventional methods of packaging are being studied, it is often interesting to investigate alternative methods that may offer additional advantages for the same or similar cost.

Source: Lambert L. 'A SOLE Workshop: International Transportation Logistics', SOLE VP International Pacific

Appendix 5

Recycle over reuse arguments

Just moved to Brussels? Did your Chinese vase arrive in one piece?

Moving to a new home means that your small and large treasures are exposed to risk. You therefore ask for the help of an experienced moving company: these guys know how to pack!

They pack your valuables in **corrugated board boxes**: a versatile and economical product.



But there is much more behind corrugated...

Corrugated boxes are mainly made from recovered fibre -recycled paper and board are their principal raw material source (up to 80%)- and after use a box becomes the raw material for another new box: **It is 100% recyclable!**



For many applications **corrugated boxes** reduce environmental impact **more effectively** than reusable packaging, notably when packaged goods are transported over long distances.

Unlike reusables, corrugated packaging does not need to be sent back empty over long distances for refilling, thus reducing transport and greenhouse gas emissions.

The sustainability of paper based packaging is therefore undisputed!

Corrugated is **lightweight** yet offers the best protection one could desire. It also provides exceptional stacking and space utilisation, which guarantees optimum loading of trucks meaning far less vehicles on the road.

Moreover, Corrugated packaging offers a **clean and hygienic new container** each time, thus limiting the contamination problems sometimes associated with re-use of packaging for short shelf-life foods.

Interested? Want to know more?
Don't hesitate to contact us!



European Federation of Corrugated Board Manufacturers
information@fefco.org - <http://www.fefco.org>
Avenue Louise 250 - B-1050 BRUSSELS



Why? Because corrugated is so good for me and our Environment!

I don't get bruised and arrive in perfect condition in your shop

Corrugated is respectful of the Environment because it contributes to forestry preservation by encouraging forest maintenance and replanting

It provides maximum space utilisation and minimises transport costs, traffic and therefore CO₂ emissions and oil consumption: vehicle movements can be cut by up to 44% compared with re-usable crates transport!

Corrugated Board has one of the best recovery and recycling records of any packaging material on earth and

Last but not least...Used Corrugated is 're-used' as raw material for the paper and board industry!

To know more about the benefits of
Recyclable=One-Way packaging
Please visit our new website!!

www.fefco.org

FEFCO
European Federation of
Corrugated Board Manufacturers

CORRUGATED BOARD = RECYCLABLE PACKAGING

Environmentally sound!

WHAT OTHER PACKAGING MATERIAL OFFERS THIS?

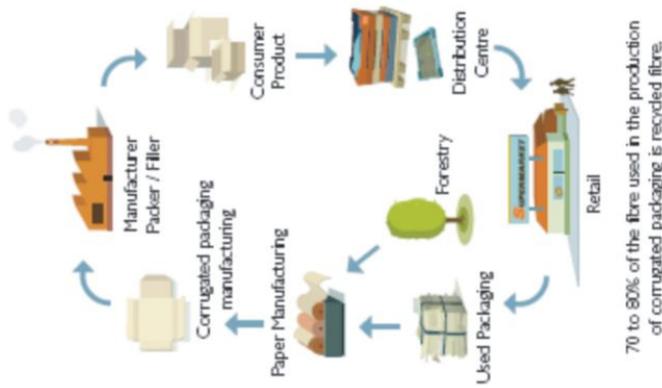
Corrugated Board has one of the best recovery and recycling records of any packaging material on earth and fully complies with the targets set by the European Directive on Packaging and Packaging Waste.



> It is made from **natural and renewable resources**. Not only does this render its manufacture more independent from fossil resources, but moreover the trees will also absorb CO₂ that would otherwise damage the climate by increasing the rate of global warming.

> It is **100% recyclable**, becoming new paper again for the benefit of the environment. Efficient recycling systems for packaging guarantee the reduction of used packaging sent to landfill: "closed loop" system in which used packaging is collected, recycled and used again for manufacturing new packaging.

Recycling is essential for the corrugated packaging industry, as recycled paper and board is the principal raw material source (up to 80%) of a corrugated board box.



> For many applications corrugated packaging reduces environmental impact more effectively than re-use, notably when packaged goods are transported over long distances. The packaging does not need to be sent back empty to the filler for re-use, so it requires less transport, reducing greenhouse CO₂ emissions. It also offers exceptional stacking and space utilisation, which guarantees optimum loading of trucks meaning far less vehicles on the road:

Less trucks on the roads, less atmospheric pollution and less fuel consumption!

> Corrugated packaging offers a **clean and hygienic** new container each time, therefore limiting the contamination problems sometimes associated with re-use of packaging for short shelf-life foods. It requires no washing, cleaning or drying, thus **saving water and detergent use and reducing effluents**.



European Federation of Corrugated Board Manufacturers
 information@fefco.org - <http://www.fefco.org>
 Avenue Louise 250 - B-1050 BRUSSELS

For a Sustainable Future, Think Paper-Based Packaging.



Renewable, Recyclable, Responsible.