An Option for a Second Life: Multisectoral Analysis of Reverse Logistics

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Abstract

Environmental awareness increases and companies are exposed to social changes and pressures. As a consequence, they need to adapt their way of management modifying, among other things, the supply chain giving to it more environmental friendly nuances with the increasing interest about reverse logistics activities. Although this tendency is observed in larger extent in concrete industries, it is pretended to be implemented in the majority of them.

Unfortunately, some difficulties originated by additional costs, deeper collaboration with suppliers and customers, wrong mentality that reverse flow does not worth it, etc. create a lot of boundaries that hinder reverse logistics implementation.

Key words: supply chain, supply chain management, reverse logistics, waste

Desde hace tiempo se observa incremento en la concienciación medioambiental y con esto las empresas están expuestas a cambios y presiones sociales. Como consecuencia, estas necesitan adaptarse modificando, entre otras cosas, la cadena de suministro dándole un aspecto más medioambiental con el creciente interés sobre logística inversa. A pesar de que esta tendencia se observa con mayor medida en determinadas industrias, es la mayoría que pretende implantarla.

Desgraciadamente, ciertas dificultades originadas por el coste adicional, la necesidad de una colaboración más profunda con proveedores y clientes, incorrecto pensamiento de que el flujo inverso no merece la pena, etc., crean muchas barreras que entorpecen la implantación de la logística inversa.

Palabras clave: cadena de suministro, gestión de la cadena de suministro, logística inversa, residuos
Preface

In order to expose the reasons of the selection of this issue, it is necessary to say that they are basically two. Firstly, this topic caught my attention because I consider that it is very current as a consequence of the increasing environmental friendly movement. In this line, I consider that society has experimented strong mentality change which is still in development. Hereby, in my opinion the reverse logistics topic will continue to attract interest and relevance.

Additionally, I opted for this topic also because of personal reasons since I enjoy nature and I think that it is duty to all of us to protect it and damage it the less it is possible. As it is well known, the current human development and actions cause strong harm to the environment and I think that this is something we can reduce in different ways. Correct residues management is one of the actions we have to carry out in order to conserve what we have.

What I pretend to achieve with this final master project is to do my bit in this green movement and make the reader see that residues are not rubbish and that they can be useful presenting one of the management processes I consider will be widely applied in the future. In this line, what I do is to give general information about what reverse logistics and its current application in some sectors. In order accomplish this aim I consider that the easiest way to represent this information and to make it accessible for the reader is to create two main parts - a theoretical and a practical one.
I. Introduction

All human actions experiment changes and evolution among the history. We observe the same in companies and their different ways of management. Reasons are coming basically from changes in social mentality and emerging of new ideas and problems since “the corporation is, firstly, a social institution”\(^1\) and as a consequence, “antecedent to the mandate given to the managers by the shareholders is the mandate given to the entrepreneur by the society” (Breton & Pesqueux, 2006, p.12). The new ways to see what is around us, affect consequently governmental policies and decisions and, obviously, companies and their practices. Thus, modifications has experimented also the concept of Supply Chain Management which has added to its concept “greener” and more environment-friendly vision (Srivastava, 2007). This concept passed to take part of a lot of researchers’ headlines and papers but also has attracted the attention of a lot of companies since “competition is becoming less ‘firm vs. firm’ and more ‘supply chain vs. supply chain’” (Hult et al., 2007, p.1047). So, due to its relevance in both, business and academic activities, we pretend to give some introduction on it.

Nevertheless, present work object of study will be the reverse logistics activities related particularly with the waste management. There are a lot of reasons which have made this issue interesting and attractive not only for researchers and investigators but also for practitioners. Four forces basically are the source of pressures for companies to implement this kind of program: customers, suppliers, competitors and government agencies (Carter & Ellram, 1998). Moreover, the major complexity of reverse logistics programs could be for the firm a source of difficulty replicable competitive advantage (Amini et al., 2005).

Nonetheless, in spite of all advantages that it could create for the firm, there are still a lot of barriers. It is to mention the additional cost, necessity of human resources (Rogers & Tibben-Lembke, 2001), more planning complexity, uncertainty (Fleischmann et al., 2001; Srivastava, 2008) and so on but may be the most dangerous is the underestimation of its importance and the mentality that it just deals with junk (Rogers & Tibben-Lembke, 2001).

Due to increasing interest on reverse logistics programs my aim in this final master project is to analyse briefly its application in some industries and make final conclusions about it. Nevertheless, before that I considered it suitable to make some theoretical reference. In this way, I present its definition, the reasons to implement this kind of activity and the advantages it could suppose and also difficulties and barriers that it is possible to find. Moreover, an analysis of reverse logistics process is also pointed out. Afterwards, as I have already said, I present reverse logistics application in three industries and also in a particular company.

\(^1\) Seen in Breton & Pesqueux, 2006, p.12
In order to obtain information for the theoretical part I consulted basically articles and papers that in its majority date from 2000 till 2010 and I took in account both, reviews specialized in operations, environment management and logistics issues, and general reviews treating about management. In reference to the practical part, I consulted basically the net where I checked again some articles but also news items, reports, statistics, etc. Finally, in relation to the company’s analysis, I obtained the information basically through personal interview with the responsible of Quality and Environment issues in the firm.

The final master project is organized in two main parts the first one of which consists of theoretical review of different concepts. This part includes two principal points, in turn. In the first one I pretend to place reverse logistics process in the supply chain and to offer a review of supply chain management concept, while the second point is thought to give a more detailed reverse logistics analysis and it is structured as follows. Firstly, a review of reverse logistics concept and characteristics are offered. Next, reasons of the change towards more environment policies and also differences and synergies between both flows, forward and reverse one, are discussed. Afterwards, reverse logistics process is examined and a brief reference to RFID application in reverse logistics activities is provided too. Hence, some disadvantages and problems will be pointed.

The second main part is designated to present practical analysis of three industries-the pharmaceutical, the intensive agriculture and the plastics one. At the end of this part, it is presented an example of agricultural company.

Finally, some conclusions and suggestions are provided.
II. Theoretical review

1. Location: GrSCM

1.1. Supply Chain and Supply Chain Management concepts

Reverse logistics is part of the supply chain: a wide-ranging term that includes different processes and activities. This term has its origins at the mid 70’s but it is from 80’s on when it came into context (Fortes, 2009).

“The traditional supply chain is defined as an integrated manufacturing process wherein raw materials are manufactured into final products, then delivered to customers via distribution, retail, or both” (Beamon, 1999, p.9). Nevertheless, a more environment conscious definition would take in account the product after its use and processes related to causing an upstream flow not only of information but also of material goods.

It is in 1999 when Beamon redefined the traditional supply chain and considered an extended one. In her opinion, the traditional supply chain includes only activities related with manufacturing. However, a new definition and wider view were necessary “due to recent changing environmental requirements affecting manufacturing operations” and “environmental management strategies for the supply chain” were required (Beamon, 1999, p.1). She observed that “the current interest has sought to extend the traditional supply chain to include “reverse logistics”, to include product recovery for the purposes of recycling, re-manufacturing, and re-use” (Beamon, 1998, p.2).
A review of supply chain concept is provided in Table 1. The common characteristic is the consideration that the supply chain is constituted by several organizations. A large part of them point out the members of the supply chain too. Nevertheless, it is convenient to notice that it is a complex concept since it “is not a chain of businesses with one-to-one, business-to-business relationships, but a network of multiple businesses and relationships” (Lambert & Cooper, 2000, p.65). In most of the definitions it is possible to observe also the acquisition of raw material as the beginning of the process.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Stevens, 1989</td>
<td>“The supply chain is the connected series of activities that deals with planning, coordinating, and controlling material, parts, and finished goods from suppliers to customers”.</td>
</tr>
<tr>
<td>Christopher, 1992²</td>
<td>“The network of organizations that are involved through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services delivered to the ultimate consumer”.</td>
</tr>
<tr>
<td>La Londe &amp; Masters, 1994</td>
<td>“The set of firms which pass (these) materials forward”.</td>
</tr>
<tr>
<td>Supply Chain Council,</td>
<td>“The supply chain [...] encompasses every effort involved</td>
</tr>
</tbody>
</table>

² Seen in Mentzer et al., 2001.
in producing and delivering a final product, from the supplier’s supplier to the customer’s customer. Four basic processes – plan, source, make, deliver – broadly define these efforts, which include managing supply and demand, sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, and delivery to the customer”.

| Quinn, 1997 | “...all of those activities associated with moving goods from the raw-materials stage through to the end user. This includes sourcing and procurement, production scheduling, order processing, inventory management, transportation, warehousing, and customer service. Importantly, it also embodies the information systems so necessary to monitor all of those activities”.

| Lummus & Alber, Supply Chain Management: Balancing the Supply Chain with Customer Demand, 1997 | “The network of entities through which material flows. Those entities may include suppliers, carriers, manufacturing sites, distribution centers, retailers, and customers”.

| Lambert, Stock, & Ellram, Fundamentals of Logistics Management, 1998 | “The alignment of firms that brings products or services to market”.

| Beamon, Supply Chain Design and Analysis: Models and Methods, 1998 | “...an integrated process wherein a number of various business entities (i.e., suppliers, manufacturers, distributors, and retailers) work together in an effort to: (1) acquire raw materials, (2) convert these raw materials into specified final products, and (3) deliver these final products to retailers”.

| Lummus & Vokurka, Defining supply chain management: a historical perspective and practical guidelines, 1999 | “…all the activities involved in delivering a product from raw material through to the customer including sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, delivery to the customer, and the information systems necessary to monitor all of these activities”.

| Mentzer et al., 2001 | “A set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances and/or information from a source to a customer”.

Table 1. Supply Chain concept review

In Beamon’s opinion, “two basic, integrated processes” form the supply chain and “provide the basic framework for the conversion and movement of raw materials into

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3 Seen in Lummus & Vokurka, 1999.
final products”: “(1) the Production Planning and Inventory Control Process, and (2) the Distribution and Logistics Process” (Beamon, 1998). In this line, we can observe the common mistake of thinking that logistics and supply chain refer to the same concept. Lambert & Cooper (2000) analyze this error and confirm that logistics is just part of supply chain.

It is convenient to headline the relevance of supply chain members’ collaboration. Literature has widely analyzed this issue and proposes collaborative efforts between the organization, its suppliers and customers (Hong et al., 2009). Future “partnerships or even joint ventures with entrepreneurial firms” are seen as possible practices for producers of virgin items (Srivastava, 2007). Organizations’ capabilities to cooperate with the rest of supply chain participants increase its power of attraction among researchers and became to be seen as some kind of “capital” or “resource” that could origin “durable strategic advantage” (Chen et al., 2004). Alliances and partnerships are two of the top five topics identified for Supply Chain Management (Rungtusanatham et al., 2003).

Supply chain linkages definition is provided by (Rungtusanatham et al., 2003). They also pointed them out “as a resource and as a knowledge-acquisition capability that can promise either temporary or sustainable superior operational performance for a firm”.

An evolution has experimented also the concept of Supply Chain Management (see Table 2), term which was introduced by consultants in the early 1980 (Oliver & Webber, 1982).

<table>
<thead>
<tr>
<th>Reference</th>
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<tbody>
<tr>
<td>Jones &amp; Riley, 1985</td>
<td>“Supply chain management techniques deal with the planning and control of total materials flow from supplies to end users”.</td>
</tr>
<tr>
<td>Houlihan, 1988</td>
<td>“Supply chain management differs from classical materials and manufacturing control in 4 ways: 1. The supply chain is seen as a single process. 2. Supply chain management requires strategic decision making due to its impact on overall costs and market share. 3. Supply chain management requires that inventories be viewed as a balancing mechanism of last resort. 4. A new integrating approach to systems is needed.”</td>
</tr>
<tr>
<td>Stevens, 1989</td>
<td>“The objective of managing the supply chain is to synchronize the requirements of the customer with the flow</td>
</tr>
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</table>

4 The concept of Supply Chain Coordination is defined as “Collaborative efforts of supply chain participants that include supplier development, coordination with suppliers and customers” (Hong et al., 2009).

5 Supply Chain Linkages concept is defined as: “Explicit and/or implicit connections that a firm creates with critical entities of its supply chain in order to manage the flow and/or quality of inputs from suppliers into the firm and of outputs from the firm to customers” (Rungtusanatham et al., 2003).

<table>
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<tr>
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<th>Definitions</th>
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<tbody>
<tr>
<td>Cooper &amp; Ellram, 1993</td>
<td>“…an integrating philosophy to manage the total flow of a distribution channel from supplier to ultimate customer.”</td>
</tr>
<tr>
<td>La Londe &amp; Masters, 1994</td>
<td>“…the strategy of applying integrated logistics management to all the elements of a supply chain.”</td>
</tr>
<tr>
<td>Monczka &amp; Morgan, 1997</td>
<td>“integrated supply chain management is about going from the external customer and then managing all the processes that are needed to provide that customer with value in a horizontal way.”</td>
</tr>
<tr>
<td>Lambert, Cooper, &amp; Pagh, 1998</td>
<td>“Suppliers management practices directly affect four components of material ordering cycle time: (1) transmission of requirements to suppliers, (2) the suppliers’ ordering and manufacturing cycle time, (3) delivery from suppliers, and (4) incoming receiving and inspection”</td>
</tr>
<tr>
<td>Trent &amp; Monczka, 1998</td>
<td>“Supply Chain Management is the integration of key business processes from end user through original suppliers that provides products, services and information that add value for customers and other stakeholders.”</td>
</tr>
<tr>
<td>Monczka, Trent, &amp; Handfield, 1998</td>
<td>“SCM is a concept “whose primary objective is to integrate and manage the sourcing, flow, and control of materials using a total systems perspective across multiple functions and multiple tiers of suppliers”.”</td>
</tr>
<tr>
<td>Srivastava, Green supply chain management: a state-of-the-art literature review, 2007</td>
<td>“GrSCM is defined as ‘integrating environmental thinking into supply-chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life.””</td>
</tr>
<tr>
<td>Council of Supply Chain Management Professionals, 2010</td>
<td>“SCM encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities[...] it also includes coordination and collaboration with channel partners [...]. It includes all activities noted above, as well as manufacturing operations, and it drives coordination of processes and activities with and across marketing, sales, product design, finance and information technology.”</td>
</tr>
<tr>
<td>Free Logistics - The free Supply Chain portal</td>
<td>“Physical and information flows management mode aiming at optimizing the ordering, the manufacturing and the delivery processes. From the supplier to the final customer.”</td>
</tr>
</tbody>
</table>

Table 2. Supply Chain Management concept review

Furthermore, GrSCM is considered as an environmental and organizational innovation (Zhu et al., 2010).
On the other hand, in order to implement supply chain management it is necessary to define its key members, the processes that are going to be linked with each member and the level/type of integration is needed (Lambert et al., 1998).

Modern supply chain is also made more complex by the necessity to manage also reverse logistics operations since as I point out later the role of the final consumer is essential.
2. Reverse logistics: Literature Review

2.1. Reverse logistics concept and characteristics

Reverse logistics program “has gained increasing importance as a profitable and sustainable business strategy” (Dowlatshahi, 2000). According to De Brito & Dekker (2003) conception of this term exist long time ago. Nevertheless, origins of reverse logistics research could be dated to 1995 and basically are carried out by researchers from Netherlands, Germany and USA (Rubio et al., 2007).

Reverse logistics is defined as a process in which manufacturer accepts used products from consumers in order to recycle or re-manufacture them (Dowlatshahi, 2000; Carter & Ellram, 1998). Fortunately, literature has pointed out a wide range of definitions of this concept (See Table 3) which also permits us to appreciate its main characteristics.

- it involves planning, implementing and controlling

In any process, in order to achieve desired results and efficiency is necessary to take in account these three phases. Previous knowledge of steps we are going to do is essential in order to anticipate the resources we need (financial, material, human, time and information) and the difficulties we may have. This plan would become reality through the process of implementing within each member who participates in it has to identify perfectly not only his responsibilities but also how to collaborate with the others ones. Controlling is another essential phase which has experimented a large evolution passing from a final step concept (post) to a new one which argues that control during the process contributes to reduce errors, economic wastes and increase satisfaction (internal and external).

- reverse logistics treats what is left after the use of some product or service

These rests could be used products or parts of them, non-used products with some defect, expired date product or information.

- it is a reverse flow

In reverse logistics the origin is the consumer (or the last one who had the product because in some cases it is not the final consumer\(^7\)) and the addressee is the manufacturer.

- recapturing value and respect the environment are some of the aims of reverse logistics

\(^7\) For example, the reason of recovery could be expired date. In this case, the product will be retired not from the final consumer but from the vendor.
<table>
<thead>
<tr>
<th>Reference</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Lambert &amp; Stock, Strategic Physical Distribution Management, 1981</td>
<td>“Going the wrong way on a one-way street because the great majority of product shipments flow in one direction”</td>
</tr>
<tr>
<td>Murphy &amp; Poist, 1989</td>
<td>“Movement of goods from a consumer towards a producer in a channel of distribution”</td>
</tr>
<tr>
<td>Stock J., Reverse Logistics, 1992</td>
<td>“…the term often used to refer to the role of logistics in recycling, waste disposal, and management of hazardous materials; a broader perspective includes all relating to logistics activities carried out in source reduction, recycling, substitution, reuse of materials and disposal”</td>
</tr>
<tr>
<td>Kopicky, Berg, Legg, Dasappa, &amp; Maggioni, 1993</td>
<td>“Reverse Logistics is a broad term referring to the logistics management and disposing of hazardous or non-hazardous waste from packaging and products. It includes reverse distribution […] which causes goods and information to flow in the opposite direction of normal logistics activities”</td>
</tr>
<tr>
<td>Stock J., Development and Implementation of Reverse Logistics Programs, 1998</td>
<td>“the role of logistics in product returns, source reduction, recycling, materials substitution, reuse of materials, waste disposal and refurbishing, repair and remanufacturing”</td>
</tr>
<tr>
<td>Carter &amp; Ellram, 1998</td>
<td>“the process whereby companies can become more environmentally efficient through recycling, reusing and reducing the amount of materials used”</td>
</tr>
<tr>
<td>Rogers &amp; Tibben-Lembke, 1999</td>
<td>“the process of planning, implementing and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing or creating value, or for proper disposal”</td>
</tr>
<tr>
<td>Dowlatshahi, 2000</td>
<td>“Reverse logistics is a process in which a manufacturer systematically accepts previously shipped products or parts from the point for consumption for possible recycling, remanufacturing, or disposal”</td>
</tr>
<tr>
<td>Dekker, Inderfurth, Van Wassenhove, &amp; Fleischmann, 2003</td>
<td>“The process of planning, implementing and controlling flows of raw materials, in process inventory, and finished goods, from a manufacturing, distribution or use point, to a point of recovery or point of proper disposal”</td>
</tr>
<tr>
<td>Srivastava, Network design for reverse logistics, 2008</td>
<td>“the process of planning, implementing, and controlling the efficient, effective inbound flow, inspection and disposition of returned products and related information for the purpose of recovering value”</td>
</tr>
<tr>
<td>Council of Supply Chain Management Professionals, 2010</td>
<td>“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”</td>
</tr>
</tbody>
</table>

*Table 3. Reverse logistics definition review*
As it is logical, definitions are similar but through the years more details are offered since the different activities of the process are included and also the flow of information is pointed out.

Interestingly, Rogers & Tibben-Lembke (2001) distinguish “green logistics” or “environmental logistics” from pure “reverse logistics”. According to them, the first one could be defined as “efforts to measure and minimize the environmental impact of logistics activities” whereas they reserve the term of “reverse logistics” for “the flow of products and materials going the wrong way on a one-way street”\(^8\). For the object of this final master project we focus more on “reverse logistics” rather than “green” one.

Literature distinguishes between reverse logistics of products and reverse logistics of packages (Rogers & Tibben-Lembke, 2001). In this line, we can observe reverse logistics flow when “reusable packages return to the serviceable inventory in new products”; “products after remanufacturing return to the serviceable inventory in “as good as new” products”; “products after repair return to the serviceable inventory in new products” and/or “recycled products provide raw materials to the inventory in materials” (Georgiadis & Vlachos, 2004).

There are several reasons for product to go on the reverse way: remanufacturing, refurbishing or because the costumer returned it whereas packaging reverse logistics is consequence basically from the possibility to reuse it. A classification of reasons to return is provided by Rogers & Tibben-Lembke (2001) depending on if the one who returns the product or the packaging is the end-user or it is some partner from the supply chain. Thus, consumers usually return a product because it is defective or they do not want it anymore; because they still have the possibility to use the warranty period of the product; due to recalls or for environmental reasons. On the other side, motives for partners of the supply chain could be stock control, marketing returns or end of life/season of the product. As said before, both, end-user and a partner could return packaging and generally the cause is the possibility to reuse them or disposal one. Additionally, it is convenient to mention also the paper of Murphy (1986)\(^9\) who according to Pohlen & Farris (1992) is result of consumer initiative since he/she could want to return a defective product, industry initiative in the case when the company decides to recycle or initiative of the government.

Furthermore, Dowlatshahi (2000) identifies costs, overall quality, customer service, environmental and legislative concerns as strategic factors in reverse logistics system. In addition, he pointed out operational factors of this kind of systems, Cost-benefit analysis, transportation, warehousing, supply management, remanufacturing and recycling, and packaging are also factors that have different weight in each

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\(^{8}\) A comparison of these two concepts is also offered by them.

organization. It is to mention that vertical integration is observed in reverse logistics and recycle processes due to its high cost (Martín Peña & Díaz Garrido, 2007).

2.2. Reasons and differences between RL and forward one

Adding “green” to supply chain management and a major worry to do business harming less the environment is consequence of several factors.

Literature talks about socio-political changes (Zhu et al., 2010). Nowadays, interest for environment respect reducing negative human effects on it has a very elevated level and day by day there are more organizations and more individuals who demand positive actions from companies. These organizations and individuals are some of the stakeholders of the firms and among them are also some of their clients, actual and potential, so companies are very interested in satisfy them. Governments are also conscious about increasing levels of pollution and a lot of regulations have its origins on the attempt to conserve the environment. As a result, companies’ profits depend on their action in order to be more respectful with the environment. Positive policies about this became a tool of competition.

In this line, DiMaggio and Powell (1983) analyse the institutional theory and argue that environmental orientation can be predisposed by three pressures: normative, coercive and mimetic. The first one is referred to organization’s stakeholders. Company’s image and social responsibility have a huge importance and, for example, for Japanese manufacturers are essential (Zhu et al., 2010). Coercive pressures consist basically on regulations. Although Europe has been the first in configuring environmental legislation, nowadays it is a worldwide awareness (Fleischmann et al., 2001). The last ones, mimetic pressures, are concerned with the influence of competitors since a successful result of their policies can be a motive for other firms to follow their steps.

On the other hand, Porter and Van der Linde (1995) defend the profitability of green policies saying that they can reduce costs and provide advantages for the company in terms of proactivity: “green firms can shape future regulations and reap first-mover advantages” (Porter & Van der Linde, 1995). The possibility of cost savings as other possible result of environment friendly policies is also suggested by McCrea (2010). New opportunities for competition and new ways to add value to core business programs may be originated (Zhu et al., 2010). So, increase in competition between companies and also in the ability of successful competency is another result of implementing environment policies. Similar vision has Martín Peña & Díaz Garrido (2007) who assume that environment is at the same time an opportunity but also a threat and the company competitive position depends on it capacity to face up to environmental challenge. It is interesting the vision of “sustainable chain management as a catalyst of generating valuable inter-organizational resources and thus possible sustained inter-firm competitive advantage through collaboration on environmental and social issues” (Gold et al., 2010).
Positive relationship between environmental and business performance is confirmed in many empirical studies. A significant financial and environment performance as a consequence of environment practices is demonstrated in Japanese companies. On the other hand, Tooru (2001) argues that environmental management system in a company can also have positive results on operational performance (Zhu et al., 2010).

Forces analyzed earlier also affect implementation of reverse logistics in particular: customer, suppliers, competitors and government agencies are direct pressures.

We could also mention the conscious of the resource scarcity. According to Carter & Ellram (1998) resource reduction should be the ultimate goal for reverse logistics. A convenient reverse logistics framework would give a major opportunity for recycling and as consequence for using less virgin materials. As a consequence of resource reduction, both forward and reverse flows of materials are minimized (Carter & Ellram, 1998).

On the other hand, as well as all pros for GrSCM signed by the literature we could also focus our attention on reverse logistics, finding numerous studies which defend it implementation and positive results.

In addition reverse logistics programs can cause significant savings (Adams, 2008) taking in account environmental and cost benefits (Carter & Ellram, 1998). Other result could be the minimization of the threat of government regulation as a consequence of the company proactivity. In addition, they also argue that implementing reverse logistics programs can lead to better corporate image (Carter & Ellram, 1998).

Besides yet mentioned cost savings, Srivastava considers that “a well-managed RL network can also help in customer retention” (Srivastava, Network design for reverse logistics, 2008). An increasing in customer loyalty is observed also by Amini et al. (2005) as a consequence of activities valued positively by customers, like repair services, for example.

Due to its major complexity in comparison with forward logistics, the reverse one could present serious advantage not easily replicable by rival companies (Amini, et al., 2005).

Then again, firms can obtain from used products cheap resources to carry out their production processes (Fleischmann et al., 2001).

On the other hand, differences between two types of flow, forward and reverse one, are not few. We can mention the major complexity of reverse logistics and the supply chain they support in comparison with the traditional manufacturing supply chain (Amini et al., 2005).

“Higher system complexity” in reverse logistics processes is mentioned also by Grabara and Kot (2009). In their opinion, it is due to increased number of goods flow and a lot
of interactions between them besides the uncertainty that characterizes reverse logistics. What is more, they find a plenty of differences between reverse logistics and forward one as well. Environmentally drivers, besides cost and services ones are pointed out and thought to difficult the objective function (Grabara & Kot, 2009). A mismatch between supply and demand in reverse logistics is identified. Numerous suppliers and few customers seem to distinguish forward from reverse logistics too since in this last raw materials (used goods) could come from a lot of sources at low cost or even for free. Finally, they consider unexplored market opportunities as another aspect that differences reverse from forward logistics.

Difference in data-collection needs of reverse logistics and those of a forward distribution operation are identified too (Gooley, 2003).

On the other hand, reverse logistics is considered as “much more reactive, with much less visibility” (Tibben-Lembke & Rogers, 2002).

Furthermore, it is important to notice the studies of some researchers in order to find some synergies between forward and reverse logistics. It is a very relevant issue because it could be another motive for practitioners to implement and develop the reverse logistics process.

Literature analyses the possibility of sharing equipment, facilities and personnel between forward and reverse logistics (Stock, 2001; Shakantu et al., 2002). The results could be reduced costs and improved service levels.

2.3. What is returned, which activities are realized, who participate and what technology could be used

Literature has also analysed which products are appropriate to take part of reverse logistics. Composition, deterioration and use-pattern are some characteristics highlighted by Gungor and Gupta (1999) and developed also in studies of De Brito and Dekker (2003). Gungor and Gupta (1999) talk about design for recycling (DFR) characteristics and suggest that better choices for material selection such that the processes of material separation and material recovery become more efficient.

In reference to composition, in their opinion, it is not important only the type of material of the product but also the number of composing parts and the way of putting them together. Thereby, making the product of homogeneous material or less number of different materials and incorporating fewer parts in it facilitate the recovery and separation activities of reverse logistics process. On the other hand, hazardous materials hinder those actions since more attention and taking special measures will be required. The size of the product is another element to take in account (Goggin & Browne, 2000). Goggin and Browne analysed the volume, relating to the physical size of the products for collection, as a dimension of collection structure complexity. Geographical spread
(dispersion of the products to be collected), number of sources of used products, quantity of products to be collected and uncertainty associated with the timing and frequency of the required collection activity, are others analysed dimensions.

As said deterioration is another relevant characteristic since it has to take in account the degree of worsening of the product in order to know what we could do with it and in which way we could re-use it. In these terms, literature examines three aspects: intrinsic deterioration, economic deterioration and homogeneity of deterioration. The first one refers to the proportion of the degree of ageing of the product with its use. For example, there are products that are consumed completely with its use whereas there are other ones that are not. Economic deterioration refers to the speed of losing value since some products value decreases quickly as a consequence of innovation and creation of other new products. Finally, it is possible that parts of a product do not age with the same intensity giving us the possibility to re-use some of them better than others. This is what literature named homogeneity of deterioration.

Another issue to take into account is the use pattern. It is necessary to consider the location, intensity and duration of use. Firstly, it is important to know if the consumer is an individual person or it is an institution since there are differences in terms of collection and consumer efforts in this phase. Also, collection difficulties could be greater if there is large distance between different product consumers. It would be necessary more collection centres, more resources and may be more consumer efforts. In reference to intensity of use, as well as time we should consider degree of consumption, too.

Moreover, De Brito discriminates the following product categories (De Brito M., 2004):

- civil objects
- consumer goods
- industrial goods
- ores, oils, and chemicals
- packaging and distribution items
- spare-parts
- other materials

On the other hand, Srivastava offers a scheme of reverse logistics activities. Collection, inspection/sorting, pre-processing and logistics & distribution network design are identified by literature as key functional aspects and essential activities in recovery networks (Fleischmann et al., 2000; Srivastava, 2008) (See Fig.2).

Obviously, in order to exploit used products it is necessary to collect them or to accumulate the parts which rest after its use. So, collection consists on all activities
which aim is to reclaim used goods or parts of them and transport them to a facility where they will be examined (Payaro). This step is essential and besides it may be the most difficult, it constitutes a significant part of the cost of closed-loop supply chain (Fleischmann, 2001). How to recover used products or its parts? Is the firm responsible for RL which has to be in charge of this process or is the consumer who should to carry it out? How to motivate individuals to take part in this process? These are some questions which have to be resolved previously, in the planning phase.
Savaskan et al. (2004) analyze three decentralized models of collecting used products: manufacturer is in charge to recover used products (Model M-Manufacturer Collecting); the retailer takes part in the used product recollection (Model R-Retailer Collecting); a third party is contracted by the manufacturer just for collect used products (Model 3P) (Savaskan et al., 2004) (See Fig.3).

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10 Adapted from Fleischmann et al. (2000) and Srivastava (2008).
In model R, in order to stimulate retailer to collect used products, manufacturer offers him a price per product returned.

The research made the conclusion that the Model R is the most effective for the manufacturer since to recollect used products the one who is nearest to the consumer is the best option.

Srivastava analyses the possibility of existence of collection centre - “a facility where customers bring their products for resolution” (Srivastava, 2008). A pay-back price offered to consumer and nearby location are important factors to stimulate consumer to collaborate (Fleischmann et al., 2001).

Main role has also the consumer environmental awareness and the conscience of the importance of his/her cooperation. There are different behaviours of the end-users depending on the demographic location - a fact that causes differences in the amount of returned products (Hanafi et al., 2008). So, environmental education in early age of the individual could give positive results. Implication of families, colleges, Government and other institutions is core in order to create more conscious society.
In order to save costs Moritz Fleischmann comments the possibility to install drop-points where consumer can leave used products (Fleischmann, 2001). This way reduces costs of transportation but it is necessary to stock used products. Another possibility to reduce costs pointed out by Fleischmann is use of synergies between distribution of new goods and collection of used products processes.

Inspection of returned goods and sorting them is another essential activity in the process of reverse logistics and its importance comes from the quality uncertainty. Employees have to own the necessary knowledge on how to manipulate returns not only to sort them depending on their condition and way of re-use them but also about protect themselves, their colleagues and the setting from any negative characteristics. Disassembly, shredding, testing, sorting, and storage are steps that inspection and separation processes may include (Fleischmann et al., 2000). According to seen in Srivastava (2007), Cairncross (1992) suggests that separation made by the consumer or centralized separation of used products determine different collection schemes. Fleischmann considers that involving consumer in collection process could hinder the separation one (Fleischmann, 2001). Whereas, individual collection gives an opportunity to realise the separation at the same time and reduce costs of transportation. So, he points out too the importance of trade-off between convenient separation of reusable and non-reusable parts and costs of transportation in order to minimise these costs.

Thanks to effective sorting of used products pre-processing (re-processing) is possible. Transformation of used products in other ones is the result of reverse logistics process. Used products will be send to “rework centres: A facility where returned products are refurbished/remanufactured” (Srivastava, 2008). Thus the “second life” of used products could be achieved as a consequence of recycling, repair or remanufacturing (Fleischmann et al., 2000). The said processes, repair, refurbish and remanufacturing, and the technology and skills determine two types of rework centres: repair and refurbishing center and remanufacturing center (Srivastava, 2008).

Activities like cleaning, replacement and re-assembly may take part of re-processing (Fleischmann et al., 2000).

Also, inspection and sorting steps may have as a result products that cannot be re-used so it is necessary to proceed to its disposal. Beside technical, reasons could be also economical if employee decides that transformation of used product would be very expensive or the result would not have utility and market potential. Transportation, landfilling, and incineration are some activities which may be need in this phase (Fleischmann et al., 2000). GrSCM have focused on minimize disposal (Srivastava, 2007).

Market is the destination of the result of re-processing processes. Used products without any transformation could be placed on second market but also re-processed products resulting from repair & refurbishing center or remanufacturing center. These rework
sites also could place their products on primary market (Srivastava, 2008). Nevertheless, re-distribution activity always will be necessary in order to direct reusable products to potential market and to transport them. So sales, transportation and storage activities could take place in this process (Fleischmann et al., 2000). The network needed in this stage resembles the forward one (Fleischmann, 2001).

In reference to the actors who participate in reverse logistics process I go back again to De Brito (2004) who points out that basically we can discriminate the following groups:

- **forward supply chain actors**
  - As it is possible to suppose, these members also participate in the forward flow of the product and they can be suppliers, manufacturers, wholesalers, retailers, and sector organizations.
- **specialized reverse chain players**
  - In this group De Brito locates actors who are only part of the reverse flow such as jobbers, recycling specialists, dedicated sector organizations or foundations, pool operators, etc.
- **governmental institutions (EU, national governments, etc.)**
- **opportunistic players (such as a charity organization).**

As she has already said, each actor has its own objectives that motivate him to participate in reverse logistics process.

On the other side, in recent years, there has been a huge aware not only about environment pollution but also about how to combine its preservation and firms’ profits. So technology has developed a lot in order to find ways of improving processes along the supply chain. One of the creation and an actually trend is the Radio Frequency Identification (RFID). “Radio frequency identification is a powerful emerging technology that enables companies to achieve total business visibility. By knowing the identity, location and conditions of assets, tools, inventory, people and more, companies can optimize business processes and reduce operational costs.” (Roberti, RFID Journal). It provides an individual identification through an individual number ID (ID number) (Garfinkel & Rosenberg, 2005).

Possible benefits for supply chain could be related to speed, accuracy, efficiency and security of information. Update of supply chain data is effectively allowed (Jones et al., 2004). Reception and exchange of information in real time is possible so improvement of supply chain administration could be achieved (Fernández-Rebollos, 2005). On the other hand, RFID technology contributes to reduce or eliminate human errors, product accounting and inventory realization (Bendavid et al., 2006).

Besides, RFID contributes to reduce all boundaries and difficulties about information and companies’ collaboration and to improve their reverse logistics information system (Payaro).
Its origins are in the 40’s when it was used in The Second World War with military applications but its use in commerce began in 80’s (Jones et al., 2004). Its use in supply chain was promoted by the reduction of RFID technology costs (Visich et al., 2007).

RFID technology consists on the use of radio waves in order to identify objects automatically (Wikipedia, The Free Encyclopedia). A RFID system entails a tag which consists of a small silicon microchip attached to an antenna (RSA Laboratories). The microchip can be read-only or read-write and contains information of a product and the antenna conducts waves to the antenna of the reader so in this way it enables to transmit information to the reader (Angeles, 2005). This one transmits the information on a middleware (Bendavid et al., 2006). Finally, the information is processed in an administration system and can be used in different processes.

Tag can be active or passive depending on if it has a battery to power the microchip circuitry and broadcast signals to the reader (active tag) or it is the reader which sends out electromagnetic waves to induce a current in the tag antenna (passive tag). Semi-passive tag uses battery and waves sent out by the reader (Angeles, 2005). In comparison with barcodes, RFID tags are reusable so company can recover its costs throughout a long period of time (Jones et al., 2004). Another advantage of RFID technology consists on the ease of programming and speed of use since it is possible to read multiple tags simultaneously. Also, RFID tag can include much more information than barcode and it can be used in harsh environment where bar codes and light-emitting devices could have problems to work (Visich et al., 2007). And finally, RFID technology does not need line-of-sight scanning as bar codes do (Higgins & Cairney, 2006).

Reader power and frequency used to communicate are factors that influence to the “read range” of the tag (Angeles, 2005).

RFID was implemented in a lot of industries like pharmaceutical, automotive, cosmetics, and so on. Also, it has a huge application in packaging treatments and traceability. Nevertheless, RFID is thought to have positive results not only in industries but also in US NAVY (Robert, Navy Tests RFID for Reverse Logistics, 2005). Public agencies in the United States led by the Department of Defense have also implemented RFID solutions (Perset, 2006). Besides, an improvement in the payment system was achieved thanks to the use of RFID technology and a future development is possible (Tapia et al., 2007).

Nevertheless, besides all advantages of RFID technology it is necessary to notice also some problems and disadvantages it has.

Higgins and Cairney (2006) identify a lack of coding standard which hinds its international use from one country to another. But in opinion of Alexander Gauby (Managing Director of RF-IT Solutions) not enough RFID standards is just a public perception although he recognizes it is necessary to adopt some further activities in order to obtain national and international synergies and to achieve better collaboration.
Furthermore, in their study of firms from different sectors Rogers & Tibben-Lembke (2001) identified some boundaries for executing reverse logistics. The barriers they pointed out and the percentage of interviewed companies that suffer them are presented in the next table.

<table>
<thead>
<tr>
<th>Barrier</th>
<th>Percentage of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Importance of reverse logistics relative to other issues</td>
<td>39,9%</td>
</tr>
<tr>
<td>Company policies</td>
<td>35,4%</td>
</tr>
<tr>
<td>Lack of systems</td>
<td>35,1%</td>
</tr>
<tr>
<td>Competitive issues</td>
<td>32,1%</td>
</tr>
<tr>
<td>Management inattention</td>
<td>27,3%</td>
</tr>
<tr>
<td>Personnel resources</td>
<td>19,3%</td>
</tr>
<tr>
<td>Financial resources</td>
<td>18,9%</td>
</tr>
<tr>
<td>Legal issues</td>
<td>14,1%</td>
</tr>
</tbody>
</table>

*Table 4. Barriers to reverse logistics*

Source: Rogers & Tibben-Lembke, 2001
Another issue is the value of information. It is necessary to say that this type of logistics suffers an important lack of information which makes more difficult the successful realization of the process. Srivastava comments benefits which could be obtained if one could know how much products would be returned and this information could be used successful in the management of returns. Lack of information is observed in “timing, quality, quantity and variety of returns; estimation of operation and cost related parameters for RL networks” which constitutes some of the risks related to product recover (Srivastava, 2008).

Supply uncertainty in recovery networks in terms of quality and availability origins the importance of separation and inspection processes (Fleischmann et al., 2001).

In spite of limited effect of uncertainty on network design (Fleischmann et al., 2001), reducing its influence is an important issue. So, modern technology, for example, is determined as a support of quality uncertainty of recovered goods.

On the other hand, Grabara & Kot (2009) pointed out some of the most frequent mistakes of firms. So, reverse logistics design is one of them since it should be done in concordance with forward logistics. The authors consider that product design has to be taken in account from the beginning. This idea is also defended by Srivastava who includes green design in the concept of GrSCM and consider it should take in account the whole life-cycle cost of the product (Srivastava, 2007). Focus on “out-of pocket costs only” and “negligence of sustainability as an optimization issue” are other frequent mistakes (Grabara & Kot, 2009).

According to Schwartz (2000), Dr. Richard Dawe with the Fritz Institute of International Logistics pointed out some symptoms that show that returns have become a problem. Thus, when returns arrive faster than processing or disposal it seems that there is some kind of difficulty. Existence of large amount of returns inventory in the warehouse, as well unidentified or unauthorized returns are other indicators that something is going wrong. Moreover, lengthy cycle processing times, unknown total cost of the returns process and lose of customers’ confidence in the repair activity are pointed too.

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11 RL: reverse logistics
III. Practical reference

The practical reference of this project consists on the study of three industries and also the analysis of an agricultural company, Vicasol – Sociedad Cooperativa Andaluza.

The industries that this part refers to are the pharmaceutical, the intensive agricultural and the plastic one. The reason of this selection is their relationship with the company that was analysed since it is an agricultural company. Besides it could seem that the pharmaceutical industry is not related with this case, in my opinion it is so, since it is thought that this industry seems to the alimentary one.

The methodology used in this part consists basically on research on the net. Companies’ Webs and researchers’ articles were consulted in order to find relevant information about the selected industries.

In the analysis of these three industries there are several common points that are studied. In this line, I firstly expose the reasons for recycling and the necessity of correct residues management. Secondly, I make reference to the different types of residues in each one of the industries. The third common point of analysis is, in my opinion, key step of the reverse logistics process and it is about the passage of the residue from the final user of the product that originated it to the entity that can manage it. The third commonly studied aspect is the “second life” of these residues and the different use they can have. Also some problems of reverse logistics process are presented. This analysis will contribute to make some conclusions about the similarities and the differences in these three industries and also about common difficulties since in order to improve it is essential to know the boundaries and lacks they present.

In order to obtain information about the company already mentioned, I realized personal interview with the Responsible of the Quality and Environment Department of the organization and I also talked with other employees who could provide me useful facts. In this part, as in the referred to the three industries, the diverse kind of waste is analysed and the way to incorporate it in the reverse flow too. Finally, this analysis is of use to make some comparison with the three industries I studied.

1. Pharmaceutical industry

Environment awareness is present also in pharmaceutical business. An implication of authority, professionals and professionals’ colleges, laboratories, distributors, and so on, is required (Doménech, 2002). Pharmacies attempts to be more “green” are reflected, for example, in the use of re-usable and recyclable bags. Use of re-usable shippers is another trend since besides being an environment-friendly behaviour, it contributes to
save costs (Schlenker & Chapman, 2010). So, an improvement of reverse logistics programs is required in this area, too, in order to achieve better results.

But what about threat of non-used drugs?

There are several reasons for their return (Arnal, 2001, May):

- Because they are expired
- We could mention “the unspoken principle that too much stock is better than too little” for hospitals and pharmacies so there is a huge probability to have an over-stock of drugs (Ritchie et al., 2000).
- Recall from the market of certain batch
- Withdrawal of certain drug
- Temporary cancellation of marketing of certain drug
- Deterioration as a responsibility of the laboratory
- Closing-down of a laboratory
- Health authority resolution

Nevertheless, expired drugs and recalls are the two most common causes of returns in the pharmaceutical industry (Kumar et al., 2009).

It is necessary to say that reverse logistics in pharmaceutical industry has a particular importance since “the health of patients may be put at risk if drugs are not withdrawn expeditiously” (Ritchie et al., 2000).

According to Arnal pharmaceutical reverse logistics aim is to protect health and environment (Arnal, 2001, May). A prove of negative effect on environment is given by a Geological Survey from United States realised in 2002 based on study of 139 streams across 30 states. The results were that “80 percent had measurable concentrations of prescription and nonprescription drugs, steroids, and reproductive hormones” (Richman, 2007). Serious problems are analysed as a consequence of pharmaceutical waste presence in the environment. Besides increased occurrence of cancer, we could mention unusual physiological processes and reproductive impairment, antibiotic-resistant bacteria and augmented toxicity of chemical mixtures (Hunter et al., 2005).

“Exposure even to low levels of pharmaceuticals, has been shown to harm fish and other aquatic species” (Richman, 2007).

Characteristic for reverse logistics in pharmaceutical industry is the existence of a lot of regulations referred to it. “Perhaps no other business is as regulated as the pharmaceuticals industry when it comes to returns” (Gooley, 2001). “A complex regulatory environment” is observed to be a boundary for proper pharmaceutical disposal. In United States, for example, there are several organizations that have some control on this activity. “The Food & Drug Administration, state boards of pharmacy,
the Drug Enforcement Administration, and EPA\textsuperscript{12} all have the power to regulate at least parts of the lifecycle of pharmaceuticals. And each agency has differing priorities that can be difficult to reconcile” (Paul, 2007).

Also security has a huge priority in companies dedicated to pharmaceutical returns. Monitors and screens take part in employees monitoring (Gooley, 2001).

Another characteristic is that medicaments are not recycled ( Arnal, 2001, May). On the other hand, recall or withdrawing from use of pharmaceutical products is thought to be irregular event (Ritchie et al., 2000)

In general terms and talking about pharmaceutical waste, these could arise from (Hunter et al., 2005):

- Pharmaceuticals returned by patients or discarded by the public
- Discontinued drugs that have not reached their expiration date
- Pharmaceuticals that have passed their recommended shelf life or are no longer required
- IV-preparation and general-compounding materials
- Spills and breakage
- Partially used vials/syringes (biohazardous if contaminated) and discontinued, unused preparations
- Pharmaceuticals discarded due to off-specification batches or contaminated packaging
- Waste generated during the manufacture and administration of pharmaceuticals

I am going to analyze the reverse logistics process in SAFA Group in order to see some example. The group consists of 10 firms and 25 warehouses and the recovery management is centralized in its warehouse in Zaragoza (Spain). Drugs are returned from pharmacies and from warehouses, too. Once received returned drugs, the Return Department of the group realizes selection and classification tasks. In these activities drugs are distinguished depending on what treatment they will receive since it is possible to return them to the laboratory they come from, or to destroy them. So, in the first case, a classification depending on the laboratory origin is required. Others activities consist on the valuation of received drugs and on sending non-received from laboratories drugs to waste manager for destruction. Before, non-expired drugs were sent to ONGs in order to supply some developing countries. Nevertheless, nowadays this is not recommended since it is difficult to guarantee the correct drugs conservation.

In reference to medication’s reverse logistics in Spain we could remark the role of SIGRE – a non-profit-making organization created in 2001 in order to guarantee the

\textsuperscript{12} Environmental Protection Agency
correct environment management of packet and drugs rests coming from families. The organization classifies its aims as environmental and healthy ones.

Its activity begins with the recovery of drugs waste through specific bins in pharmacies (SIGRE’s points) where consumers drop drugs that they do not need any more or expired ones, as well as their empty packets. Once drugs waste is recovered it is stocked in containers that lately are retired by authorized persons for its transport to Drugs Waste Classification Plant in Cerceda (A Coruña) (SIGRE Medicamento y Medio Ambiente). Once classification is realized, drugs waste is sent to authorized entities that are in charge of its final treatment. It is necessary to remark that it will be recycled only the part of the packet that has not been in direct contact with the drug, whereas the rest will be incinerated. A lot of controls, as well as operating instructions, audits, security protocols and so on, are applied in order to achieve a correct realization of the process. Regulations like UNE-EN ISO 9001:2008 about Quality Management Systems, UNE-EN ISO 14001:2004 about Environment Management Systems and the 18.001:2007 referred to Labor Security and Health Management Systems are being obeyed.

Figure 4. Drugs’ cycle

Adapted from SIGRE Medicamento y Medio Ambiente
In the United States, reverse distributors are essential in drugs recover. They help pharmacies and healthcare facilities to take the opportunity presented by drugs manufacturers programs that enable to recoup costs for unused drugs (Paul, 2007). Receiving shipments of medications and incinerating drugs destined for destruction are some of the services offered by reverse distributors to pharmacies. What is more, in some cases, when medications are in good condition they route them overseas (Paul, 2007). Nevertheless, according to Smith (2002) “any outdated items that do not meet the manufacturers’ return policy become waste at the reverse distributor”.

Also, “return processors” are contracted by drugs manufacturers but it is necessary to remark that they offer different level of services (Hunter et al., 2005).

Another case we could mention is the one of Schering AG, a pharmaceutical company founded in 1871 in Berlin with sales regions in the European Union, North America, Asia and Latin America. There are several types of reverse logistics in this firm but the most important seem to be the related with by-products and the related with reuse and recycling of impure solvents (Teunter et al., 2005). By-products are obtained in many production processes of the company and also contain important value materials. So, it is important to reuse them in order to reduce need of virgin materials and to save costs as well. As we can suppose, the main motive to realize this activity is economical. But also is done in order to protect the environment and to attain better image. Another factor is the legislative since in Germany industries are imposed by several legislative acts to be more environmentally responsible and to reduce their waste stream. Unfortunately, reusing causes some difficulties like production process complication, for example.

On the other hand, in reference to impure solvents, these are “cleaned in a distillation facility and then reused, if this reuse option is economically attractive”. Otherwise, if cleaning is too expensive, then, if it is possible, they are thermally recycled. This could be interesting since it “might be attractive to recover the energy that is contained in such a solvent”.

Other less important recycling program in Schering is the one related of drums reuse in the activities of transporting and storing solvents.

Returning to drugs’ recover and according to said in previous section, consumers’ implication is essential in reverse logistics process. Fortunately, it seems that some people are concerned with giving use of unused medication. An interesting case had took place in San Mateo County (California, United States) when in February 2006 was approved a program according to which pharmacies are allowed “to dispense previously sold, unexpired and unopened medicine to low-income or severely disabled patients” (Stanford Magazine, 2006). The resolution was consequence of the suggestion of few students and the Californian senator at that time recognized that “drugs usually are
either flushed down the toilet or thrown in the garbage where they threaten the environment and contaminate waterways” (Richman, 2007).

In order to involve consumers in medication recover, in Spanish pharmacies there is a disposal box for unused, unnecessary or expired drugs where the consumer can drop them. In other countries, like the United States for example, a similar system is developed. A medicine drop-off box is developed in Washington thanks to the collaboration between the pharmacy board and the Group Health Cooperative (GHC), a nonprofit, clinic-based healthcare system. “Consumers drop unused drugs, though not controlled substances, into the box, which is emptied and sorted at a secure location. Once the drugs are sorted, they are repackaged and sent to a reverse distributor for destruction” (Paul, 2007).

An interesting program is developed in Maine in order to facilitate the recover process and the consumer participation. It suggests that “patients would receive a return mailer with their medications that they could use to send the drugs back to the appropriate reverse distributor without any intervening steps” (Paul, 2007).

Unfortunately, there are some boundaries and problems for medication recover. Existence of “a large number of locations where drugs are kept - wards, operating theatres, day clinics, etc., as well as the pharmacy stores” - is thought to hind drugs’ recall (Ritchie et al., 2000).

Another problem to solve is the cost related to returns. Though the difficulty of its calculation, it is estimated to be 3%-6% of annual pharmaceutical sales (Hunter et al., 2005).

In the Conference that took place in Zaragoza in 2001 Arnal suggested some practices in order to save costs in the return process. Speed in reverse logistics is considered essential for saving costs from stock activity. Checking received drugs condition is another suggestion as well as analyzing causes of breakdowns in the supply chain and also the use of returns as a commercial tool (Arnal, 2001, May).

In their analysis of Manchester Royal Infirmary Pharmacy, Ritchie et al. (2000) suggest ensuring that only drugs above a certain value were recycled as a step in order to improve the returns process and develop its cost effectiveness.

Additional cost comes from treatment of drugs that have to be destroyed. In Spanish laboratories, once they have received drugs that have to be eliminated, as said before, these are sent to waste manager. Nevertheless, this activity generates some manipulation, transport and stock costs. This is the reason why SAFA Group has agreements with certain laboratories according to which it becomes the responsible to manage drugs elimination through the waste manager (Arnal, 2001, May).

13 This is, for example, a SIGRE point.
On the other hand, it is convenient to remark that a typical problem in pharmaceutical industry is counterfeiting drugs. This fact causes a lot of problems some of which are loss of consumer confidence and a lot of money, too (Kumar et al., 2009).

As a possible solution literature points out the use of RFID, since besides its application in order to prevent out of stock situations, this technology could be useful to prevent introduction of counterfeit drugs into the supply chain. An advantage for reverse logistics could be an improvement and increase in control (Kumar et al., 2009).
2. Intensive Agriculture

Agriculture is defined as “the science, art, or practice of cultivating the soil, producing crops, and raising livestock and in varying degrees the preparation and marketing of the resulting products” (Merriam Webster). It is the primer sector and it has suffered a lot of changes. Besides increase of industry importance and reducing benefits and interest of agriculture, this sector is source of food and “feeds 6,000 million people” (Tilman et al., 2002).

On the other hand, it is convenient to point out what is meant by the concept cleaner production which is referred a strategy that pretends to minimize waste through prevention of residues, integration and continuous improvement (United Nations Environment Programme, 2006).

In this line, we could consider also the concept of sustainable agriculture which is defined as “practices that meet current and future societal needs for food and fibre, for ecosystem services, and for healthy lives, and that do so by maximizing the net benefit to society when all costs and benefits of the practices are considered” (Tilman et al., 2002). It is known that there already exist governments that motivate farmers to produce adopting policies which are more environmental friendly like for example, Australia, Canada, European Union (EU) countries, Japan, Norway, Switzerland and the United States (Tilman et al., 2002).

Besides this attempt to damage less the environment there is still negative impact coming from agriculture activities.

There are a lot of studies that refer to the necessity to carry out better waste management in the agriculture. Moreover, besides reducing environmental damage, there are also other positive results like for example, the obtaining of useful material which could be used lately in agricultural activity. This is the case of biowaste since it can be used as “fertilizer or soil conditioner” (European Environment Agency, 2011, p.7) saving in this way natural resources. Other possibility to take advantage of biowaste is to obtain energy and biofuel through the process of its burns (Yevich & Logan, 2003; Elias, X., 2007). Actually, this is very interesting issue which attracted the attention of a lot of researches since it represents clearer and more environmental friendly source. Other source of fertilizers and conditioners for agriculture could be also provided by municipal solid waste (MSW) (Hargreaves et al., 2008). Nevertheless, it is observed the necessity to improve its quality since it is essential to contain less metal and salt. This could be achieved through “early source separation” (Hargreaves et al., 2008, p.11).

In order to present more detailed information for our study we will concentrate the project in Almeria, Spain. Moreover, it is convenient to say that Almeria is the
Andalusian province with the mayor number of people occupied in private agricultural companies, a fact which we could appreciate in the next table.

<table>
<thead>
<tr>
<th>Province</th>
<th>Employees</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almeria</td>
<td>3,516</td>
<td>19.4%</td>
</tr>
<tr>
<td>Cadiz</td>
<td>1,301</td>
<td>7.2%</td>
</tr>
<tr>
<td>Cordoba</td>
<td>3,106</td>
<td>17.2%</td>
</tr>
<tr>
<td>Granada</td>
<td>2,526</td>
<td>14.0%</td>
</tr>
<tr>
<td>Huelva</td>
<td>2,397</td>
<td>13.3%</td>
</tr>
<tr>
<td>Jaen</td>
<td>981</td>
<td>5.4%</td>
</tr>
<tr>
<td>Malaga</td>
<td>1,746</td>
<td>9.6%</td>
</tr>
<tr>
<td>Seville</td>
<td>2,517</td>
<td>13.9%</td>
</tr>
<tr>
<td><strong>Andalusia</strong></td>
<td><strong>18,090</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>

*Table 5. Employees in private agricultural companies in Andalusia in 2008*

Source: Junta de Andalucia-Consejería de Medio Ambiente, 2008

Particularly, greenhouses of Almeria lead to very interesting issues in the area of agriculture and environment. Remarkably, intensive agriculture of Almeria has become one of the most important exporters of Europe (Wikipedia, The Free Encyclopedia).

The area of greenhouses is doing a considerable increase in order not only to improve built greenhouses infrastructure but also to make new ones (Ruiz, 2009). As a consequence, in Almeria we can find the largest concentration of greenhouses of the world, covering approximately 30,000 hectares and it is actually called “the sea of plastic” (De los Ángeles Blázquez, 2003; Callejón et al., 2010; Barcelona Field Studies Centre, 2011).

*Figure 5. Surface of greenhouses in Almeria*

Source: Barcelona Field Studies Centre, 2011
Thanks to these infrastructures a major control of climate conditions is achieved since the temperature, humidity and soil fertility are regulated (De los Ángeles Blázquez, 2003).

Unfortunately, like many other human activities, this one has also negative effects. In this line, climate of Almería province seems to be affected since researchers have observed temperature cooling (Barcelona Field Studies Centre, 2011).

On the other hand, the impact on nature is not only produced by chemicals used in the production but also by the wastes that are left. According to “Environmentalists in Action” the intensive agriculture generates 30 millions of kilos of wastes in the Oriental Coast of Andalucía, Spain. The majority of these wastes are plastics and organic material and also toxics (Gómez, Contaminación e invernaderos).

It the following table, we could appreciate the principal sources of hazardous waste in agricultural industry in Andalucía.

<table>
<thead>
<tr>
<th>Type of waste</th>
<th>Quantity</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contaminated containers</td>
<td>441,794</td>
<td>36.82</td>
</tr>
<tr>
<td>Oils</td>
<td>346,107</td>
<td>28.85</td>
</tr>
<tr>
<td>Batteries</td>
<td>64,405</td>
<td>5.37</td>
</tr>
<tr>
<td>Inorganic substances without metal</td>
<td>44,389</td>
<td>3.70</td>
</tr>
<tr>
<td>Residues from tank and/or equipment cleaning</td>
<td>38,954</td>
<td>3.25</td>
</tr>
<tr>
<td>Residues from products used as solvents</td>
<td>38,810</td>
<td>3.23</td>
</tr>
<tr>
<td>Non halogenic organic substances which are not used as solvents</td>
<td>34,261</td>
<td>2.86</td>
</tr>
<tr>
<td>Mixture of oil/water or hydrocarbon/water, emulsions</td>
<td>30,950</td>
<td>2.58</td>
</tr>
<tr>
<td>Other type of residues with special characteristics</td>
<td>30,318</td>
<td>2.53</td>
</tr>
<tr>
<td>Non identified chemical substances and/or new ones that come from researchers activities</td>
<td>29,689</td>
<td>2.47</td>
</tr>
<tr>
<td>Inks, colourings, pigments, paintings and lacquers</td>
<td>23,457</td>
<td>1.96</td>
</tr>
<tr>
<td>Products which contain PCB and/or PCT</td>
<td>20,056</td>
<td>1.67</td>
</tr>
<tr>
<td>Soaps and fats</td>
<td>18,422</td>
<td>1.54</td>
</tr>
<tr>
<td>Others</td>
<td>38,226</td>
<td>3.19</td>
</tr>
</tbody>
</table>

*Table 6. Principal sources of hazardous waste originated by the agriculture activity in Andalucía in 2006*

Source: Junta de Andalucía-Conserjería de Medioambiente, 2006

Almería is not an exception and its waste is basically constituted by plastics, packages and organic residues. According to Callejón et al., (2010), the intensive agriculture in Almería generates 3,078,000 m³ per year of vegetable residues, 2,513,700 packages per year and 18,000 tons per year of plastic waste.

More details about the plastic residues and the packages are offered in the section of plastic industry.
On the other hand, as mentioned before, organic waste could be very useful in order to fertilize the soil or to produce energy. In this line, “agriculture in Almeria generates 769,500 tons of plant remains per year from greenhouse-grown horticultural crops” (Callejón-Ferre & López-Martínez, 2009, p.1). Obviously, for that purpose a relevant issue is the work of the transformation centers which are created to manage the waste that comes from the agricultural activity. We could mention basically the center in Nijar which is constituted by the plant of Albaida and where the farmers can leave their waste. The center is working with organic residues, mixed waste and fruits. In the next table, we can observe the prices for each one of these types of waste since 23 of June of 2010.

<table>
<thead>
<tr>
<th>Waste</th>
<th>Price (€/t)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic</td>
<td></td>
</tr>
<tr>
<td>All types</td>
<td>23,38</td>
</tr>
<tr>
<td>Mixed</td>
<td></td>
</tr>
<tr>
<td>Rubbish, packages, tubes, covers, plastic for the ground, vegetable residues and thermal blanket</td>
<td>229,17</td>
</tr>
<tr>
<td>Wood, wire, paper and cardboard</td>
<td>211,99</td>
</tr>
<tr>
<td>Substrata</td>
<td>37,81</td>
</tr>
<tr>
<td>Fruits</td>
<td></td>
</tr>
<tr>
<td>All types</td>
<td>7,70</td>
</tr>
<tr>
<td>For hectare and campaign</td>
<td>272,12</td>
</tr>
</tbody>
</table>

*Note: the prices do not include the Value Added Tax.

Table 7. Prices in the center of Albaida-Nijar
Source: Adapted from a information document in Vicasol

On the other hand, there is another center for that purpose, the one which is in La Mojonera, but it is not functioning for the moment. The prices there were lower than the ones offered by the other center in Nijar. For the period from 1st of November 2010 to 30 of September of 2011, the price for vegetable waste from the greenhouses and fruits was 12,50 €/t, while the price for plastics, substrata and inorganic waste was 150,00 €/t.

In spite of the existence of this centre, it seems that agriculture in Almeria has a lot of problems with the recycling of residues it generates. First of all, farmers are complaining about the high prices they have to pay in order to comply with the legislation and leave their waste at the transformation centre (El Ejido Actualidad, 2011). Another problem for the farmers is that the created landfills are not operational entirely. In this line, it is necessary to remark that the landfill of Ejido Medioambiente is closed. Property in our days of the company Morgan Aqua since 2010, this landfill has suffered serious problems in August 2010 due to huge fire that lasted 45 days. This fact affected not only the farmers since they could not leave there anymore their waste, but also the resident and the tourism activity of the zone (Ideal.es, 2010). One year later, in August 2011, La Junta de Andalucia resolved the disciplinary action against Ejido
Medio Ambiente imposing a fine of 30.051 euros for the fire in 2010 (El Ejido Actualidad, 2011).

As a consequence of these problems and also of the already not sufficiently developed awareness of the farmers about the problems they could originate, sometimes they create illegal landfills burying there the waste resulting of their activity. Nonetheless, this action is penalized by the responsible organizations (Ideal.es, 2011).
3. Plastics

Firstly, it is convenient to say that there wide range of types of plastic materials but the main are following ones:

<table>
<thead>
<tr>
<th>Polymer types</th>
<th>Abbreviation</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene terephthalate</td>
<td>PET</td>
<td><img src="image" alt="PET" /></td>
</tr>
<tr>
<td>High-density polyethylene</td>
<td>HDPE</td>
<td><img src="image" alt="HDPE" /></td>
</tr>
<tr>
<td>Polyvinyl chloride</td>
<td>PVC</td>
<td><img src="image" alt="PVC" /></td>
</tr>
<tr>
<td>Low density polyethylene</td>
<td>LDPE</td>
<td><img src="image" alt="LDPE" /></td>
</tr>
<tr>
<td>Polypropylene</td>
<td>PP</td>
<td><img src="image" alt="PP" /></td>
</tr>
<tr>
<td>Polystyrene</td>
<td>PS</td>
<td><img src="image" alt="PS" /></td>
</tr>
<tr>
<td>Any other plastics</td>
<td>OTHER</td>
<td><img src="image" alt="OTHER" /></td>
</tr>
</tbody>
</table>

*Table 8. Main types of plastics*

Source: Waste & Resources Action Programme

Since plastic material is used basically for packaging it is to observe that it is widely used material and plastics waste come from practically all industries (Hopewell et al., 2009; Plastics Europe, 2010). Moreover, according to statistics, world’s annual plastic consumption increased 5 million tons in comparison with 1950 to nearly 100 million tons today (Green Living Tips, 2009). There is information that in 2001 in the UK were used 4.7 million tons of plastics while in western European countries plastics consumption increases 4% per year (Waste Online).

Furthermore, the relevance of correct management of this kind of residues increases especially if you bear in mind the toxicity of this material.

As a result, reverse logistics is an essential part of plastic life cycle. In the next figure, it is possible to observe the different processes in the life cycle of plastic.
It is necessary to observe that between the final consumer and the activities of recycling, incineration or landfilling, it is carried out the collecting and sorting of the residues.

In reference to the first stage of the process of reverse logistics of this kind of material, the collection is facilitated in some way by the existence of containers destined specially for plastics. Each country has its own system to distinguish between the different recycling containers but it is widely used the colour difference. Some countries agree in their election (for example, Spain, Singapore, Poland the yellow container is used for plastics, the blue one for paper while the green one for glass) while others use different colours for the diverse kind of residues (in Rumania, for example, it is used the blue one for plastics (Wikipedia, The Free Encyclopedia).

As said, in general, in Spain consumers should leave their plastic residues in the yellow container where also it is necessary to throw metal packages. The plastic household residues are basically boxes of different kind of products as mil, wine, juice, etc., tubes, plastic bags and wrappers.

So, it is important to headline the role of the consumer since the collection of the residues depends on his aware of the necessity to separate. In this way, citizen participation is one of the circumstances that limits the quantity of plastics recycled (Barnes et al., 2009).

In reference to the sorting stage, although it is still very important the manual separation (Inspiraction) there exist also technologies that facilitate the process. In this stage the residues are separated according to the type of plastic and the colour too (Frers).
The re-processing could be achieved through mechanical recycling or chemical one. In the first type, the process does not involve breaking down the original polymer chains and molecules since it is just a physical process (Plastics Europe, 2010) in which the plastics are cut into pieces and washed in order to remove contaminants (American Chemistry Council). Sometimes they are mixed with sand in order to obtain firm structure (Inspiraction). Lately, they are sold to manufacturers in order to produce other products such as bottles, containers, carpets, plastic lumber, etc. and here is when it came to place the molding process of the pieces and their conversion into another object. It is necessary to observe that it is possible to recycle in this way only the PEAD, PS, PP, PET (Amigos de la Tierra).

The second type is not so widely implemented but it seems that it could give very good results. In this line, the chemical process consists on divide the molecules in order to obtain new materials and here we can talk about different processes (Inspiraction).

- **Pyrolysis**: this process “involves heating plastics in the absence or near absence of oxygen to break down the long polymer chains into small molecules” (American Chemistry Council). The advantage of this process is that it enables the use of mixed types of plastics (Frers).

- **Gasification**: it consists on the obtaining of gas through the application of heat and oxygen (Inspiraction). The obtained gas could be used in order to produce methanol and ammonia and also in the production of steel (Frers).

- **Methanolysis**: it is one of the most used processes for the depolymerization and it consists on the plastic degradation through the application of high temperature and pressure (Lituma & Kuniyoshi, 2009).

It is convenient to make reference also to the incineration process which enables the use of plastic material as fuel. Nevertheless, this process produces different gases which are very toxics and dangerous (Rodríguez, 2000). The fact that the most used alternative is the incineration, proves that the clean management of plastics waste is not still rationally solved (Sotelo et al.).

On the other hand, landfilling is the destination of large part of the waste but it is possible to say that it is not a permanent solution but in this way we only “store the problem for the future” (Barnes et al., 2009) and it generates some environmental problems such as they take a lot of space, damage the view and remain a lot of time (Amigos de la Tierra).

According to dates, in 2009 in the European Union 22,5% of the waste was destined to be recycled, 31,5% for energy recovering and 46% for disposal (Plastics Europe, 2010). Fortunately, it is to expect that recycling and energy recovery will increase (Plastics Europe, 2010).

Finally, it is important to say that the recycling of plastics waste is hindered from the addition of other materials in order to make the plastics more suitable for its different uses (García Díaz & Macías Matos, 2008).
On the other hand, as said in the section of Intensive Agriculture, some information about plastic waste and used packages of this activity will be given in this section.

In reference to the first ones, unfortunately, there is still huge part of plastic waste coming from greenhouses that is left in the environment in gullies. The result is sometimes the creation of real tips since this activity incites people to throw other residues there (Plan Territorial Especial de Ordenación de Residuos de Tenerife). In other cases, it is burnt by greenhouse employees, an activity which generates dangerous and toxic gases (Gómez, Waste magazine). Fortunately, the awareness of this problem is increasing and nowadays there are special centers where plastic is transported in order to be recycled. In these plants we can find a lot of processes but the majority of them are mechanics or chemicals (Inspiration). Interestingly, the plastic waste that come from the agriculture could be used in order to obtain fuel in thermal central or other industries as ceramics or cement ones (Cervantes Villamuelas et al., 2000).

Nevertheless, it is essential the collaboration of farmers and plants. Sometimes, the farmers transport the residues to the plant but in other cases, when they do not have a suitable vehicle or they just do not have enough time, it is the company which recovers the plastic (Plan Territorial Especial de Ordenación de Residuos de Tenerife). Nevertheless, it is essential to make reference to one of the problems farmers should face up to which consists on the lack of space where they could stock the used plastic for some period of time.

Furthermore, there are other systems of recovering as could be for example the determination of drop points where the farmers could leave there their waste and lately this will be recovered by the institution in charge of this activity. An example could be the County of Galicia, since the farmers should transport the plastic residues to the drop points for that purpose and when the contents of the containers exceed the half of its capacity, the council will communicate to the recovering company that it should retire the residues (Sistema de Información de Residuos de Galicia).

About the packages, their original contents are basically fertilizers or pesticides (Plan Territorial Especial de Ordenación de Residuos de Tenerife). This fact creates a lot of important questions at the moment to manage their recycling process since these kinds of substances are in some ways pollutant so it is very important to think about the destination of the water that is used in the cleaning process (Plan Territorial Especial de Ordenación de Residuos de Tenerife). Another problem in reference with these residues is the fact that there are still a lot of farmers that bury them or just leave them in the outskirts (Plan Territorial Especial de Ordenación de Residuos de Tenerife).
4. Vicasol

4.1. Introduction

“Vicasol - Sociedad Cooperativa Andaluza” is an agricultural union created in 1979 and constituted nowadays of about 1400 members. It is dedicated to “the reception, handling, classification, packing and commercialisation of fruits and vegetables, besides the sale of supplies for the agricultural farming” (Vicasol's President Report, 2011). Its production is constituted basically by tomatoes, cucumbers, aubergine, melon and peppers. It is one of the most outstanding agricultural companies not just in the province of Almeria but also in national level and the major part of its production is destined for the European market.

4.2. Company Policies and Applicable Environmental Legislation

The company is conscious about the social requirements and the necessity to be more environmental friendly so it tries to achieve its aims making efforts in the areas of consumption, cleaning and residues, atmospheric emission control and maintenance (Vicasol).

It seems that the company values not only the huge steps towards environmental friendly policy, but also the little acts that each one of its workers could carry out. In this way, in the photocopy room and also in the reception of its principal centre we can see a document destined to the employees that motivates them to save paper using the white side to write some notes or for drafts and also to make photocopies and to print on both sides of the papers. There is also a table which compares the materials we need to produce one tone of virgin paper and one tone of recycled paper. We can observe this comparison in the next table.

<table>
<thead>
<tr>
<th>To produce one tone of paper</th>
<th>Raw material Kg/m3</th>
<th>Water litres</th>
<th>Energy Kw/h tep</th>
<th>Waste generation kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virgin paper</td>
<td>Wood 3,5 m3 14 trees 2300 kg</td>
<td>15 m3</td>
<td>9600 kw/h 0,4 tep</td>
<td>1500 kg</td>
</tr>
<tr>
<td>Recycled paper</td>
<td>Used paper 1250-1400 kg</td>
<td>8 m3</td>
<td>3600 kw/h 0,15 tep</td>
<td>100 kg</td>
</tr>
</tbody>
</table>

*Table 8: Comparison between materials needed to produce virgin and recycled paper*

Source: Adapted from the information of the mentioned document

Moreover, the company fulfils with diverse rules like UNE-EN-ISO 9001, UNE-EN-ISO 14001, BRC, IFS, UNE 155000, GLOBAL GAP, TESCO NURTURE 10, INTEGRATED PRODUCTION since 2010 and ICE since February of 2011.

Nevertheless, it is convenient to comment that there exist different laws applicable to Vicasol concerning diverse areas. In the next table we can observe them.
As a hazardous waste producer, the company has some obligations which are basically the following ones (Law 10/1998, 21 of April, about Waste):

- Separating and not mixing the hazardous waste

<table>
<thead>
<tr>
<th>Area</th>
<th>Legislation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water</strong></td>
<td>Order SAS/1915/2008</td>
</tr>
<tr>
<td></td>
<td>Law 4/2010</td>
</tr>
<tr>
<td></td>
<td>Order in Council 1/2001</td>
</tr>
<tr>
<td></td>
<td>Order in Council 140/2003</td>
</tr>
<tr>
<td><strong>Atmosphere</strong></td>
<td>Decision 280/2004</td>
</tr>
<tr>
<td></td>
<td>Code 2037/2000</td>
</tr>
<tr>
<td></td>
<td>Law 1/2005</td>
</tr>
<tr>
<td></td>
<td>Law 34/2007</td>
</tr>
<tr>
<td></td>
<td>Order in Council 2085/1994</td>
</tr>
<tr>
<td></td>
<td>Order in Council 919/2006</td>
</tr>
<tr>
<td></td>
<td>Decree 74/1996</td>
</tr>
<tr>
<td><strong>Energy</strong></td>
<td>Law 54/1997</td>
</tr>
<tr>
<td></td>
<td>Law 2/2007</td>
</tr>
<tr>
<td></td>
<td>Order in Council 661/2007</td>
</tr>
<tr>
<td></td>
<td>Decree 279/2007</td>
</tr>
<tr>
<td></td>
<td>ITC MIE AEM-1</td>
</tr>
<tr>
<td><strong>Waste</strong></td>
<td>Order MAM/304/2002</td>
</tr>
<tr>
<td></td>
<td>Law 11/1997</td>
</tr>
<tr>
<td></td>
<td>Law 10/1998</td>
</tr>
<tr>
<td></td>
<td>Order in Council 952/1997</td>
</tr>
<tr>
<td></td>
<td>Order in Council 833/1998</td>
</tr>
<tr>
<td></td>
<td>Order in Council 1416/2001</td>
</tr>
<tr>
<td></td>
<td>Order in Council 208/2005</td>
</tr>
<tr>
<td></td>
<td>Order in Council 679/2006</td>
</tr>
<tr>
<td></td>
<td>Order in Council 106/2008</td>
</tr>
<tr>
<td><strong>Noise</strong></td>
<td>Law 37/2003</td>
</tr>
<tr>
<td></td>
<td>Order in Council 286/2006</td>
</tr>
<tr>
<td></td>
<td>Vicar by-law</td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td>Code 1580/2007</td>
</tr>
<tr>
<td></td>
<td>Law 31/1995</td>
</tr>
<tr>
<td></td>
<td>Law 16/2002</td>
</tr>
<tr>
<td></td>
<td>Law 7/2007</td>
</tr>
<tr>
<td></td>
<td>Law 8/2007</td>
</tr>
<tr>
<td></td>
<td>Law 26/2007</td>
</tr>
<tr>
<td></td>
<td>Order in Council 379/2001</td>
</tr>
<tr>
<td></td>
<td>Order in Council 814/2007</td>
</tr>
</tbody>
</table>

*Table 9: Environmental legislation applicable to the company*

Source: Own preparation using the information obtained in an interview
Packaging and labelling of the containers where hazardous waste is stored according to the normative
Carry out a register of the produced hazardous waste
Give to the companies responsible for the waste management the information they need
Present to the Civil Service annual report about the waste that the company produced
Inform to the Civil Service about any disappearance, loose or leak of hazardous waste
Present each 4 years a Plan for Prevention and Reduction of hazardous waste (M Ambiental-Environmental Consulting).

Furthermore, the company is placed in the group of big producers of waste since it generates more than 10 tons of hazardous waste\textsuperscript{14} and due to this fact, the company has additional obligations in comparison with the small producers of waste. In this way, Vicasol has to present the annual report each year while the small producer does not have to present it (M Ambiental-Environmental Consulting). Moreover, Vicasol pays superior tax to the Civil Administration than the small producers (Interview with the Quality Responsible, 2011).

4.3. Reverse Logistics activity

In this part, we can talk about two basic issues: the first one is related to the product of Vicasol and the second one, referred to the waste management.

On the one hand, in some cases the product delivered to the client does not fulfil his requirements since it could be too soft, ripe, too green, or the box is broken. Sometimes, the company apply a discount or reduce the price in order to compensate the client for the inferior quality. Nevertheless, in other cases the client does not want to keep the product and this is the moment when the company has to face up to what to do with these goods. According to its condition, the product could be sent to another client with fewer requirements. In this case, obviously, come to mind issues like the price, the transport time and the costs. Sometimes, the product is sent to Non-Governmental Organization making in this way a food donation. It is convenient to remark that this case is very similar to the management of non-expired drugs in the pharmaceutical industry.

\textsuperscript{14} According to the Law 10/1998, dangerous waste is those that are in the list of dangerous waste approved by the Order in Council 952/1997 and also the packaging which contained them. Additionally, are considered dangerous waste those which were qualified so by the communitarian regulation or international agreement in which Spain takes part.
Nonetheless, in other cases, there is no possibility to consume the product as it is. In these circumstances, the company sells it to organizations that are dedicated to produce different kind of sauces, for example.

On the other hand, in reference to the non-organic waste resulting of the activity of the company, this could be divided in two basic groups-dangerous and non-dangerous.

Residues are originated by different activities so in the next table we can observe them taking in account these two variables: type of the waste and source.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Waste</th>
<th>Waste code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance</td>
<td>Dangerous</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mineral oil</td>
<td>130203</td>
</tr>
<tr>
<td></td>
<td>Tyres</td>
<td>160103</td>
</tr>
<tr>
<td></td>
<td>Lead batteries</td>
<td>160601</td>
</tr>
<tr>
<td></td>
<td>Cloth absorbed with</td>
<td>150202</td>
</tr>
<tr>
<td></td>
<td>dangerous substances</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oil filters</td>
<td>160107</td>
</tr>
<tr>
<td></td>
<td>Waste of paints</td>
<td>080111</td>
</tr>
<tr>
<td></td>
<td>Non-dangerous</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wood</td>
<td>200138</td>
</tr>
<tr>
<td>Transport</td>
<td>Dangerous</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vehicles</td>
<td>160104</td>
</tr>
<tr>
<td>Administration</td>
<td>Non-dangerous</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paper and cardboard</td>
<td>200101</td>
</tr>
<tr>
<td></td>
<td>Printer cartridge</td>
<td>080318</td>
</tr>
<tr>
<td></td>
<td>Ink waste</td>
<td>080313</td>
</tr>
<tr>
<td>Warehouse</td>
<td>Non-dangerous</td>
<td></td>
</tr>
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<td></td>
<td>Vegetal waste</td>
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<td></td>
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*Table 10. Residues in Vicasol*

Source: Interview with the Quality Responsible, 2011

According to the type of the waste, it is necessary to apply different treatment. So, in some cases the waste is recovered by some institutions, whereas in other cases other organizations have to recover it.
In reference to the hazardous waste it is a specialized company that recovers them from Vicasol. The company is CESPA and from 2005 it is in charge of the collection of the waste that Vicasol generates.

The residues should be recovered at least each 6 months since Vicasol is big producer of waste. The waste is stored in external warehouse and is recovered when the company calls to CESPA, but as it was just said, the period of storage could not be superior of 6 months. The price of recovering depends on the weight of the recovered waste. It is necessary to headline the convenience of this kind of relationship since from the moment of the recovering Vicasol does not have any other responsibility besides the sending of the corresponding documents to the Environmental Office.

On the other hand, in other circumstances it is the council or other companies in charge of the waste recovering. This is the case of fluorescent tubes and also some electric devices. The advantage of this relationship between the council and the company is that the recovering of these types of waste does not have any cost for Vicasol.

Moreover, in the case of printer cartridges it is usually the supplier who recovers the waste. Nevertheless, here we find the existence of some agreement since it is observed the possibility for Vicasol to obtain some discount in future purchases.

In addition, as it was already said previously in this project, it is not necessary only the correct management of produced waste but also the minimization and prevention of residues. In this line, Vicasol widely uses reusable pallet of different sizes and materials and usually they are made of wood or plastics. The disadvantage of this policy is that it complicates the administrative processes.
IV. Conclusions

Management is not static way of doing things since it adapts to social changes, governmental legislation and rival companies actions. As a consequence, the increasing environmental awareness, the preferences of the society and the legal framework as well, have created the necessity of introducing of more environmental business practices. In this line, Green Supply Chain Management in general and reverse logistics in particular have experimented obvious increase of importance and attention.

The theoretical review and the different researches that I have consulted stage that reverse logistics process gives the possibility to improve companies’ environmental policies in different ways since it is not only a kind of publicity and way to gain the social approval but it also entails economic advantages as cost savings, for example, and positive effect on operational performance too. Moreover, it is not applicable only on products but on packaging too. Furthermore, it is a practice that could be used for a wide range of products beginning from short-life goods, as the alimentary ones for example, and finishing with long-life products of automotive industry, electrical industry, etc. As we saw in the practical reference, the three industries that were analyzed need the application of reverse logistics. We could deduce this activity is necessary in each industry since all of them generate some kind of waste. But this is not the only reason for an industry to use the reverse flow because it is also applicable to the stock control management. In this line, as a consequence of the study of the three industries, I consider that the power of these two factors – waste management at one side, and stock management on the other one, is not the same in all kind of industries. I believe that in industries like the pharmaceutical one and also in the agricultural or alimentary, it is very important for the company the stock management due to the perishable nature of the product. On the other hand, I consider that in plastics higher power for the company has the waste management.

Other difference I find is the fact that in order to collaborate in the reverse flow of pharmaceutical products and waste, and especially in the collecting stage, the final consumer has to go to the suppliers of this kind of products (pharmacies) who are actually the drop points. In this aspect, the cases of plastics and agricultural waste are different since the final consumer usually does not have to go the supplier establishment in order to leave the residue since there are external drop points.

On the other side, in reference to the actors that participate in the reverse activities of these industries, I consider that it is possible to say that the opportunistic players (charity organizations) have higher participation in industries such as the pharmaceutical and the alimentary/agriculture (for example, as we saw in Vicasol) than in plastic industry. As we saw in the practical reference, in the first ones sometimes the returned product is destined to developing countries while in the last one this option is not so frequent. The reason could be the fact that food and drugs are essential products and the NGO are more interested to provide this kind of goods.
It is important also to remind the fact that the products of pharmaceutical industry (medicaments) are not recyclable while the ones resulting from the agriculture and the plastic industry have the possibility to be useful again one way or another.

The literature considers as in important issue the difference between forward and reverse flow too. The major complexity of the second one creates the necessity of strong collaboration and relationships between the participants in this process and this need is becoming more and more obvious. In this part of the extended supply chain it is not only important the collaboration between the company and its suppliers but it is also involved the Civil Service and its different institutions as the councils, for example, as we saw in the practical reference. The analysis of the three industries helped me to see that the reverse flow is not so developed like the forward one so it needs the presence of the government and its support too. I also think that it is necessary to accept that residues are in many cases cheap raw material since only then, in my opinion, waste would really attract the attention of private companies and free market economy could be developed in this area. Unfortunately, although it is recognized that “waste often has value as a resource” (Directive 2008/98/EC of The European Parliament and of The Council of 19 November 2008), this mentality is not sufficiently widely accepted so for the moment, as I have already noticed, it is strongly necessary to feel the continuous presence and support of the government.

Additionally, it is necessary to admit the role of the final individual consumer since he became a key part of the supply chain and essential member in the reverse logistics process. This fact was already headlined by the literature but it is confirmed by the practical reference too since in each one of the three industries I analyzed the final consumer is the connecting step between forward and reverse flow. Unfortunately, it is more difficult to control his actions and to make him conscious about the relevance of his participation. While companies have to respect different laws and it is easier to find out if they comply with them, and although councils tries to implement fines for not recycling, it is almost impossible to know which household does not carry out correct separation of its residues. Hereby, the practice proves that the only way, by the moment, to involve the individual person is through awareness programs.

On the other hand, and as a consequence of Vicasol analysis, in order to develop successful reverse logistics channel, it is essential to analyze the characteristics of the waste and also the different possibilities to manage it. The company should investigate wide range of industries and the residues they generate in order to find similarities that it could use in the implementation of its own reverse logistics channels. In this line, besides pharmaceutical industry is not directly connected with the agricultural company, it was already proved that there are some similarities in the management of the product reverse logistics. This fact demonstrates the relationship between reverse logistics of alimentary products and drugs and also that companies should have wide point of view and consult practices of diverse sectors and only of their own industry. The study of other institutions, private companies and public bodies could be very useful in order to
find ideas. In this line, I consider that benchmarking in the planning and implementation of reverse logistics activities could be very enriching.

In addition, as the literature has already pointed out, it should not be forgotten the need of development of relations between forward and reverse flows in order to achieve more synergies and facilitate processes. By now sharing equipment, facilities and personnel are one of the most frequent synergies but companies are for sure willing to find other ones too. So it is an issue on which both, researchers and practitioners, will work hard.

Besides, it is convenient to mention the relevance of technology since, as in many other fields it does, technology development offer the opportunity of improve processes achieving better results in short time. The possibility of stronger control for example offered by RFID technology is very well appreciated by researchers and practitioners. The development of software of enterprise waste management is necessary too in order to facilitate the operations, to provide better members’ communication and to carry out deeper control of the activities.

In reference to the weaknesses of the present paper I could say that the most important is the lack of deeper empirical study of several companies. On the other hand, a deeper review of practitioners’ practices and opinion would be useful in order to complement the analysis of the research papers.

In spite of the important evolution that reverse logistics has achieved, deeper consideration is needed from both areas, researchers’ and practitioners’ one. In reference to the first one and in order to offer some issues of future researches more wide range empirical studies which could embrace considerable number of companies and from different countries as well are required. This could enable to make useful conclusions about the reality of business practices. Furthermore, detailed analysis of reverse logistics process in all business sectors is required in order to discover particular characteristics and necessities of each one of them and to have the opportunity to improve activities and efficiency.

Finally, besides reverse logistics evolution, a lot of firms still do not appreciate its relevance and as the practice analysis has showed, mentality change process is not finished. Perhaps deeper contact between companies and researchers could be useful to assume this kind of management transformations.
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