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Reverse Logistics as Alleviation to Ecological Issues

Theory and Implementation

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The current rates of consumption and resource extraction render harmful impact on the environment, which could lead to the resource depletion, loss of biodiversity, economic and public health issues. Some actions should be taken to avoid environmental and economic crisis. Reverse logistics is one of the possible options, as it is essential in any attempt to achieve resource efficiency. This study examines the concept of reverse logistics and ways of implementing it in practice. To achieve better understanding of the topic as well as to clarify its connection to other concepts, reverse logistics is explained through reflection of its role in other notions such as circular economy, green supply chain, closed-loop supply chain, green logistics and waste management. Further reverse logistics activities, drivers and challenges are described. Thanks to reverse logistics activities significant results could be achieved in resource efficiency and waste minimization, which contribute to the alleviation of ecological issues. In addition, the thesis proves that reverse logistics integration is very beneficial for organisations from economic point of view, which is reflected in case studies presented in the second chapter. Thus, reverse logistics could be considered as a profitable alleviation of ecological issues. However, the integration of reverse logistics could be challenging, and for this reason the third chapter presents general guidelines as well as a framework, which could simplify this process.

Keywords	Reverse logistics, reverse supply chain, reverse logistics integration

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Introduction and importance of the topic

Since the origins of capitalism dated two centuries ago (according to Marxist definition) or even earlier than that there have been numerous critiques, casting doubt on whether capitalism is sustainable by itself and able to evolve in such way that inequalities in economic, social and ecological aspects of life would be minimized. However, only over the last few decades thanks to vast research and data collected it is possible to see an evidence of the insolvency of global capitalism (at least in its current form). Hornborg (2001) presents a detailed analysis of why modern capitalism and industrialization affect environmental and social aspects of life. He points out that"…all the major issues of global survival (environmental destruction, resource depletion, world poverty, armament) ultimately can be traced to capital accumulation" (Hornborg 2001:56).

According to Hart and Christensen (2002), the most developed countries consume more than 75 percent of the world's resources and at the same time generate most of the waste. If all countries in the world would consume at the same rates, the authors suppose that more than four Planet Earths would be needed to make available natural resources and the space for waste disposal.

In recent decades, it became economically inefficient to repair or reuse products, which together with culture of "throw-away society[1]" contribute to a generation of countless amounts of waste. According to Hoornweg, Bhada-Tata, and Kennedy (2013) in 1900, in cities alone 300 thousand tonnes of waste were produced per day, by 2000, this number increased to three million tonnes per day, and by 2025, it will be twice that - enough to fill a line of rubbish trucks five thousand kilometres long every day (almost half of the Earth's equator).

Furthermore, the waste generated by humankind does not end up only on landfills, but it is carried away into the ocean and even in space. According to The Economist (2015) the plastic waste that gets into the ocean is most visible in the huge rotating ocean currents, or gyres, such as the "Great Pacific Garbage Patch" off the coast of California

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[1] A society in which products are not used for a long time despite their condition and utility.

where tonnes of debris float in an area the size of Texas. And more than 500 thousand pieces of debris, or "space junk," orbit the Earth by estimation of NASA (2013).

People have been aware of the harmful consequences of unsustainable industrial production and inefficient waste management for more than three decades. Jimmy Carter, former US president, in his Environment Message to the Congress in May of 1977, wrote:

> Solid wastes are the discarded leftovers of our advanced consumer society. This growing mountain of garbage and trash represents not only an attitude of indifference toward valuable natural resources, but also a serious economic and public health problem (Carter 1977).

Nevertheless, the situation does not seem to change, and the current way of production and consumption continues to deplete the resources and generate excessive amount of waste.

The solution to the current situation would be radical change of humankind's way of living and to implement practices that would take into consideration social, economic and ecological factors. And while scientists and researchers are trying to define such a system, some steps towards alleviation of ecological issues within capitalism should be taken, and reverse logistics could be one of them. In recent years reverse logistics has gained more attention. There are numerous researches done in this area, but this concept still stays obscure for most people due to the lack of usage of reverse logistics in practice and inconsistency of the definition of this concept among different sources.

The aim of this thesis is to explain the concept of reverse logistics and clarify its connection, often deceptive, to other concepts; determine the role of reverse logistics in alleviation of ecological issues; and demonstrate how reverse logistics could be implemented in practice. This work could be considered as another attempt to raise the awareness of reverse logistics and demonstrate how it can reduce environmental impact and at the same time raise economic value for organisations.

In the first chapter the explanation of reverse logistics in connection to other concepts will be presented. In addition, the main activities, drivers and challenges of reverse logistics will be defined. The second chapter will demonstrate successful examples (case studies) of reverse logistics integration. And the third chapter will present some

discussion and a framework that could be considered when implementing reverse logistics.

1 Understanding Reverse Logistics

With recent development of the research in the area of green logistics and sustainable (sometimes called green) supply chain, some concepts became rather vague, in particular with connection to reverse logistics. For example, in the case of logistics it is possible to indicate the difference between traditional and eco-friendly approaches and demonstrate connection to other concepts by adding the prefix "green". Thus green logistics would involve attempts to minimize environmental impact of logistics activities when traditional logistics would not, and highlight the interconnection with other concepts such as green supply chain, green warehousing or sustainable development etc. is rather apparent, which is mainly due to the difference between execution techniques involved in the traditional and "green" approaches. In the case of reverse logistics the difference between its interpretation from conventional and environmental points of view is not so clear, mostly because reverse logistics activities do not differ that much no matter which approach is chosen. In fact, reverse logistics itself, or rather the entity's (company, national or international governments) attitude towards it, could be an indicator of traditional or "green" approach. Thus if well-established and included in the strategic planning process reverse logistics would indicate a "green" approach, whereas assigning only a trivial operational role to reverse logistics would indicate a traditional approach. This aspect will be developed more in the following sections.

Furthermore, the interconnection of reverse logistics and other concepts is not always clear due to the lack of holistic research in this area as well as inconsistency of the information representation across different sources. For example, it is quite obscure how reverse logistics is related to green logistics and how this relation differs in case of traditional logistics, what place it takes in the supply chain and how different it is from the place in the green supply chain, and what role it plays in the closed-loop supply chain, waste management and circular economy.

To achieve better understanding of the topic this chapter will present the explanation of reverse logistics in connection to other related concepts such as the circular economy, green supply chain, closed-loop supply chain, green logistics and waste management. The chapter will conclude with the presentation of the fundamentals of reverse logistics.

1.1 Circular Economy and Reverse Logistics

As was discussed in the introduction the current economic system renders strong impact on the environment and on present trends will lead to the incapacity of the planet to sustain us. According to the *Signals 2014* annual publication from European Environment Agency (EEA), the consumption of energy per capita has tripled and consumption of materials doubled compared to 1900, in addition there been major increase in the population from 1.6 billion in 1900 to 7.2 billion. This level of consumption implies an extreme rate of resource extraction resulting in land deterioration and biodiversity loss; and increase in production volumes augmenting the development of "throw-away society" due to the reduction of products' life cycles and resulting in the creation of excessive amounts of waste. In addition unequal distribution of the consumption among developed and less-developed countries contributes to the creation of unequal social conditions. In order to share the benefits more evenly and reap them with minimal environmental impact the current economic system should be reconsidered, the amount of extracted materials should be reduced, and the production and consumption should become more resource efficient.

In an attempt to do so, the concept of circular economy has been developed. The term "circular economy" foresees a production and consumption system that generates as little loss as possible. In an ideal world, almost everything would get re-used, recycled or recovered to produce other outputs (EEA 2014).

The circular economy is restorative by intention. It aims to enable effective flows of materials, energy, labour and information so that natural and social capital can be rebuilt. It seeks to reduce energy use per unit of output and accelerate the shift to renewable energy by design, treating everything in the economy as a valuable resource. (Ellen MacArthur Foundation 2013:26).

The Ellen MacArthur Foundation presents very detailed overview of a circular economy and its implementation. It also takes into consideration the thermodynamic laws[2] in the development of the circular economy model and differentiates the circulation of

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[2] The laws of thermodynamics define fundamental physical quantities (temperature, energy, and entropy) that characterize thermodynamic systems (Boundless 2014).

biological and technical materials, which distinguishes its research from many others. Similar comparison of biomass and "technomass" was presented by Hornborg (2001:17):

> Both are dissipative structures, requiring inputs higher than outputs and subsisting on the difference. A crucial difference is that biomass is a sustainable process whereas technomass is not. For biomass, energy resources are virtually unlimited, and entropy[3] – in the form of heat – is sent out into space. For technomass, resources are ultimately limited, and we are left with much of entropy in the form of pollution.

It is important to mention that even though the concept is called "circular" economy in practice it represents rather "looping" economy, as the second law[4] of thermodynamics prevents infinite unaltered cycles, i.e. everything degrades. Thus, the circular economy would not ultimately resolve environmental degradation, but it would definitely slow it down.
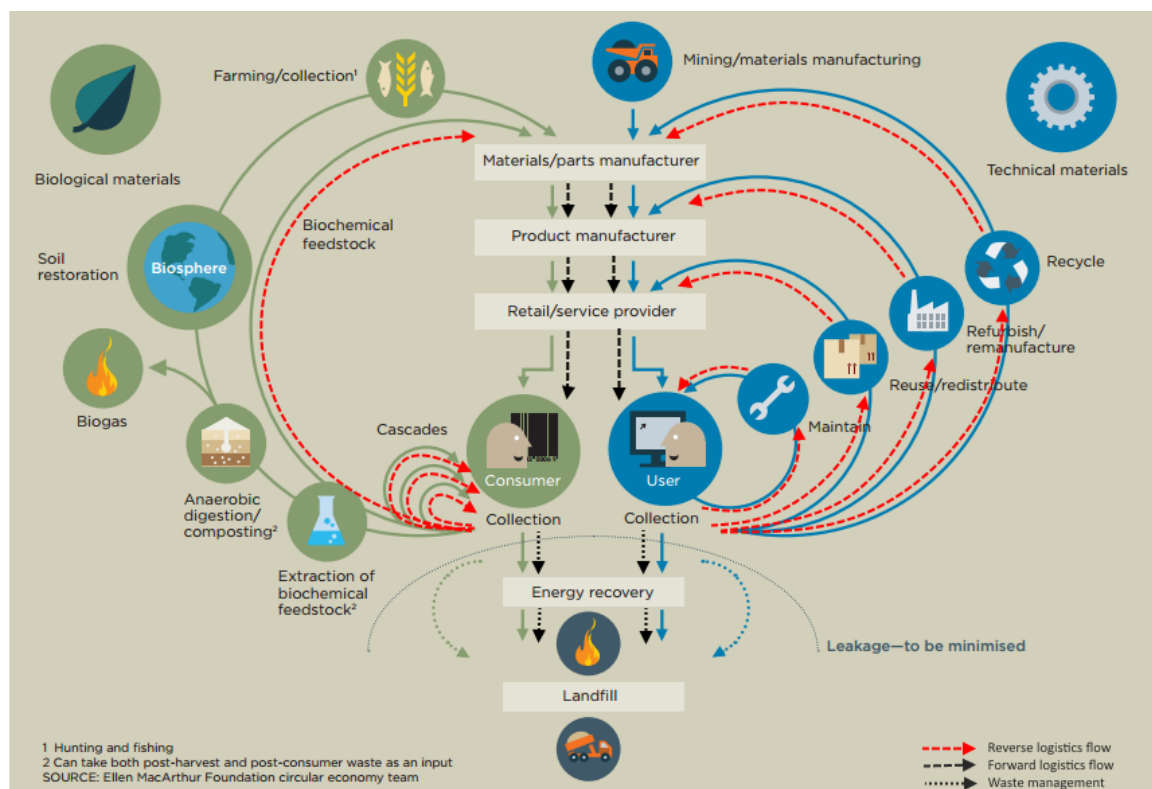
Figure 1. The model of the circular economy[5]

Figure 1 above illustrates biomass and technomass looping through the economic system. In this model of circular economy the term *cascaded use of materials and*

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[3] A measure how evenly the energy is distributed in the system. The higher the entropy, the higher the disorder
[4] The entropy of any isolated system almost always increases (Boundless 2014)
[5] Source: based on Ellen Macarthur foundation (2013:29)

components is introduced, the meaning of which is putting materials and components to different uses after the end of their lives across different value streams and extracting their stored energy and material "coherence" (Ellen MacArthur Foundation 2013:32). The wood cascade could be used as an example of a cascaded use of materials. The use of wood in furniture followed by the use of this furniture as a raw material for particle boards, which is continued by possible recycling of particle boards and the final incineration reflects a cascaded use that ensures resource efficiency by reducing the input of wood as a raw material. That is, the raw material wood is used sequentially in a series of different applications and finally turned into energy. Although cascaded use of materials could be applied to technical materials in some cases, it is mainly a property of biological materials. Nonetheless, resource efficiency in case of technomass could be maintained through reuse, remarketing, disassembly, refurbishment and remanufacture, and recycling. At this point reverse logistics enters the circular economy.

To ensure the efficient, cost effective flow of information and technical and biological materials (as well as products and components made out of them) from the point of consumption or use upstream the supply chain for the purpose of further extraction of energy and material "coherence" or proper disposal, well-developed reverse logistics processes should be established. From Figure 1 it is apparent that reverse flows (red lines) represent essential part of circular economy - that is without reverse logistics the model would reflect an economic system with no circularity or looping of materials, products or components.

There is one more concept which is related to the circular economy, namely the "green" economy. A green economy is essentially one in which socio-economic systems are organised in ways that enable society to live well within planetary boundaries (EEA 2015). This concept has several dimensions: resource efficiency, ecosystem resilience and people's wellbeing. The difference between circular economy and green economy is demonstrated in figure 2.
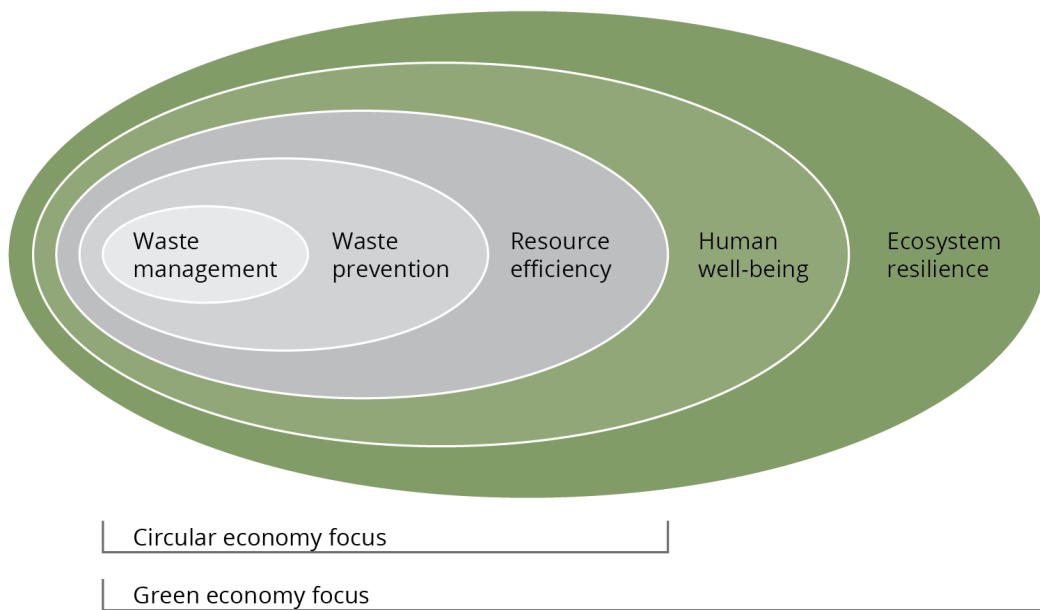
Figure 2. The difference between circular and green economy (Source: EEA 2015)

As seen from the figure above circular economy's focus lies mainly on resource efficiency and waste minimization, whereas green economy's focus is extended to the management of resources in a way that secures human well-being and ecosystem resilience. Therefore, circular economy could be considered as one of the ways to achieve green economy's goals.

1.2 Green Supply Chain and Reverse Logistics

Traditionally a supply chain has been defined as "a system whose constituent parts include material suppliers, production facilities, distribution services and customers linked together by the feedforward flow of materials and feedback flow of information" (Stevens 1989).The main elements of a traditional supply chain are demonstrated in Figure 3, where grey lines represent material flow and dotted lines – information flow.

Figure 3. Traditional supply chain (Source: based on Beamon 1999)

Usually in traditional supply chains reverse logistics has a rather trivial role, where it is associated mostly with returns management (see Blumberg 2005). Rogers et al. (2002:5) offer a good overview of the interrelations between returns management and reverse logistics. According to them, "returns management is that p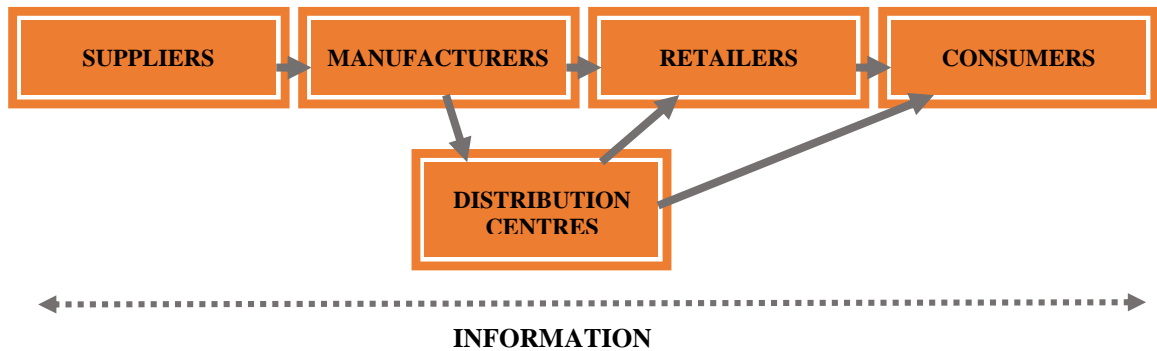art of supply chain management that includes returns, reverse logistics, gatekeeping and avoidance", where avoidance is associated with minimization of the return (e.g. ensuring proper products quality) and gatekeeping – with control and minimization of the number of units entering the reverse flow (e.g. control over items that should not be returned). Reverse logistics is considered as the process of moving goods from the point of usage or consumption for the purpose of recapturing value, or proper disposal. Rogers et al. (2002) point out that reverse logistics also can include such activities as remanufacturing and refurbishing, processing of returned damaged products, seasonal inventory, recalls (return implemented due to safety or quality reasons), recycling programs, hazardous material programs, obsolete equipment disposition, and asset recovery. It is important to notice that returns management as well as reverse logistics started to gain more attention just recently, as in many of the cases, the returns management process had been ad hoc, meaning that the strategies, operations, and guidelines were not well-defined or thought out (Mollenkopf & Closs 2005).

However, the attitude towards reverse logistics and returns management differs significantly when considering the green supply chain concept. Green supply chains consider the environmental effects of all processes of supply chain from the extraction of raw materials to the final disposal of goods (Emmett & Sood 2010). Beamon (1999) describes green supply chain as a supply chain consisting of all elements of the traditional structure (Figure 3), but extended to combine product and packaging recycling as well as reuse and remanufacturing activities. Therefore, green supply chain focuses on the

reduction of energy consumption, minimization of waste and pollution, and increase of recycling and reuse rates. The example of green supply chain is presented in Figure 4. Consequently, it incorporates the elements of a reverse flow (red lines), reflecting the entire life cycle of the goods (see Harris et al. 2010).

Thus, in case of traditional supply chain reverse logistics occupies an insignificant place, whereas in the case of green supply chain it stands at the very foundation of the concept. It demonstrates the similarity of the interrelation between reverse logistics and circular economy. The main difference is the scale of activities.

It is important to mention that the model of green supply chain presented above was included in this section to identify its connection to reverse logistics. However, it is rather simple and does not reflect all activities involved in green supply chain such as green design, green procurement, evaluation of suppliers ' environmental performance, green packaging, green production etc.(see Emmett & Sood 2010).
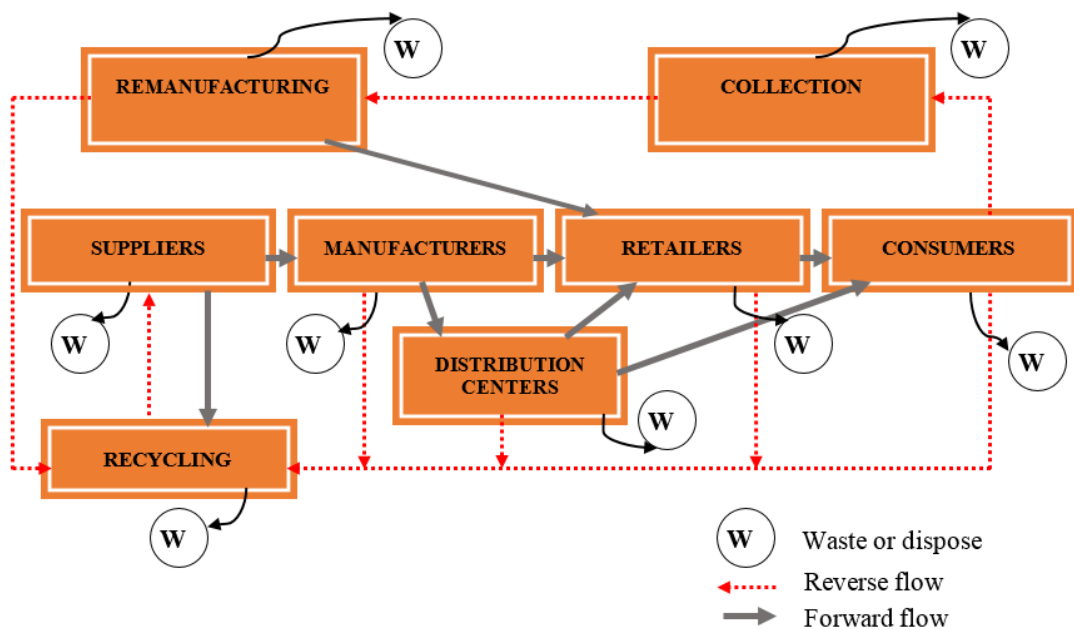

Figure 4. Green supply chain (Source: based on Beamon 1999)

1.3 Closed-Loop Supply Chain and Reverse Logistics

Closed-loop supply chain (CLSC) is very similar to green supply chain. The main difference is that CLSC is a more technical term used to describe supply chain simultaneously carrying out forward and reverse flows, whereas green supply chain incorporates ideology of sustainable development and vast number of activities which are not included in the CLSC (e.g. green warehousing, green packaging etc.).

The exact definition of CLSC differs across various sources. Some suggest that the term CLSC should be used only in the case of supply chain with integrated forward and reverse flows and in other cases the use of the term "supply chain loops" is more appropriate (e.g. see Lebreton 2007, Emmett & Sood 2010). Others refer to CLSC even when forward and reverse flows are organized independently (e.g. see Blumberg 2005, Guide et al. 2003). However, in this section the exact use of these terms is not significant as the main focus is on the examination of connection between reverse logistics and CLSC.

The connection between CLSC and reverse logistics becomes apparent when considering the components of the former. According to Emmett and Sood (2010) there are three main components of supply chain loops:

- Circular supply chain: supply chain where output from one process is utilized as a key input for a totally different process;
- Reverse logistics, in this context movement of the goods in reverse order for the purpose of recapturing the value or proper disposal;
- Disassembly lines: these have well developed processes and infrastructure to facilitate disassembly and/or redeployment of by-products or end-of-life products.

In general terms, reverse logistics is an indispensable part of CLSC, as without reverse flow there is no loop in the supply chain. Schematically, interrelations of reverse logistics and CLSC could be demonstrated as in Figure 5 below.
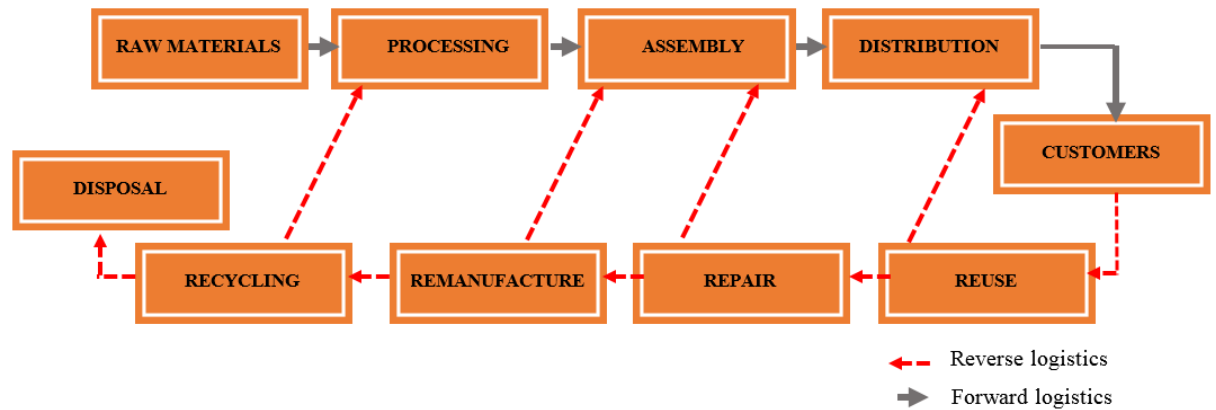
Figure 5. Reverse logistics in closed-loop supply chain

1.4 Green Logistics and Reverse Logistics

Logistics is the term now widely used to describe the transport, storage and handling of products as they move from raw material source, through the production system to their final point of sale and consumption (McKinnon 2010:3). Whereas green logistics could be defined as an environmentally-friendly and efficient transport and distribution system (see Rodrigue et al. 2001) The main purpose of green logistics is to enable resource efficiency, minimize the environmental impact of logistics activities and promote economic development harmoniously, thus creating environmentally responsible logistics system (see Changling 2011)

It is important to mention that while logistics is one of the subsets of supply chains, by itself it only links in the total and complete supply chain (Emmett & Sood 2010). The same stands for the green supply chain and green logistics. While the former incorporates various activities aimed at minimizing environmental impact across the whole supply chain, the latter usually is associated with the relations between participants in the supply chain (e.g. delivery of raw materials from supplier to manufacturer) and can include such activities as minimization of environmental impact of freight transportation, green warehousing, optimization of the routing of vehicles, improvement of the vehicle utilization, etc.

Even though reverse logistics and green logistics have many similarities they are not interchangeable. The focus of reverse logistics lies on the reverse flow of the materials,

components and products, while green logistics' aim is to measure and minimize the environmental impact of all logistics activities (see Rogers & Tibben-Lembke 2001 and Rodrigue et al. 2001). The concepts overlap when reverse flow activities lead to greater resource efficiency. For example, taking back mobile phones from the consumer for repair purposes would be included in reverse logistics (but not in green logistics) and doing it for the purposes of recycling or remanufacturing would be included in both reverse and green logistics. Figure 6 demonstrates the differences and similarities between discussed concepts.

Reverse Logistics   **Green Logistics**

- Products return;
- Marketing returns;
- Secondary markets.

- Recycling;
- Remanufacturing;
- Reusable packaging.

- Packaging reduction;
- Air and noise emission
- Environmental impact of mode selection.
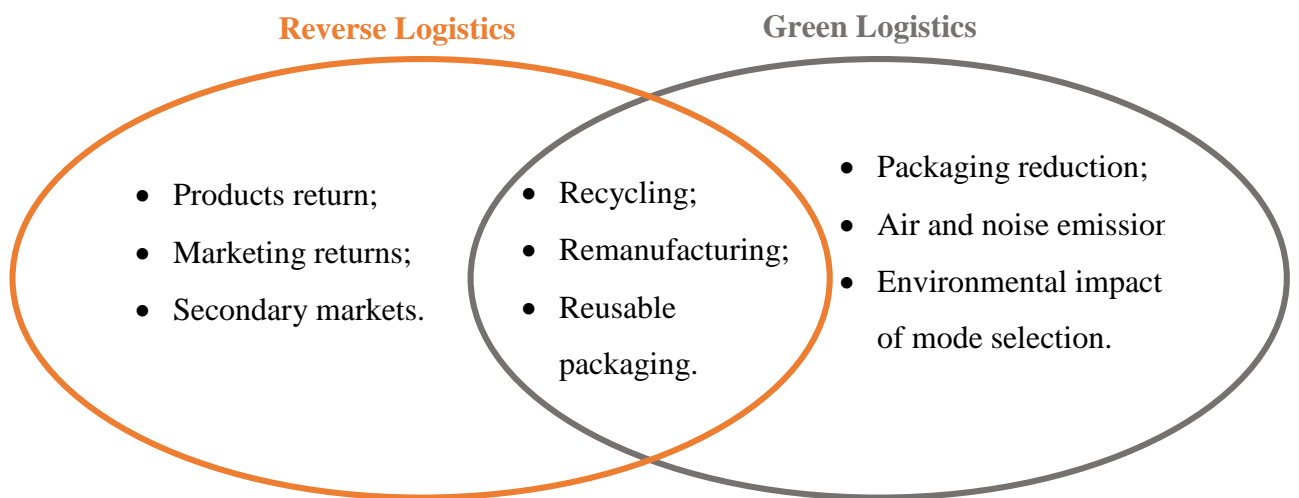
Figure 6. Relations between reverse logistics and green logistics (Source: based on Rogers & Tibben-Lembke 2001:131)

1.5 Waste Management and Reverse Logistics

In this section it is important to define the concept of product recovery management due to its direct connection to waste management and reverse logistics. Product recovery management encompasses the management of all used and discarded products, components, and materials that fall under the responsibility of a manufacturing company. The objective of product recovery management is to recover as much of the economic (and ecological) value as reasonably possible, thereby reducing the ultimate quantities of waste, according to Thierry et al. (1995). The authors defined product recovery management by investigating the recovery options, which are: direct re-use (and re-sale); product recovery management (repair; refurbishing; remanufacturing; cannibalization; recycling); and, waste management (incineration and land filling). The implementation of product recovery management as well as of direct re-use requires

arrangement of the logistics infrastructure for the flow of used and recovered products, i.e. reverse logistics (see Beullens 2004).

However, most of the researches consider product recovery (or asset recovery) management as a part of a reverse logistics (e.g. see Cherrett et al. 2010; Helms & Hervani 2006; and Emmett & Sood 2010) rather than reverse logistics as a supporting activity for the product recovery, for this reason the same was assumed in this chapter.

According to De Brito and Dekker (2003) waste management could be described as collecting and processing waste in an efficient and effective way. They emphasize that the exact definition of the waste plays significant role in identifying the difference between waste management and reverse logistics. Waste could be explained as goods, which cannot be used in any other application or with no value to extract, and reverse logistics concentrates on those streams where there is some value to be recovered. Another difference is the movement of the outcome, reverse logistics' outcome re-enters the supply chain, whereas waste management's outcome reaches its final destination at a landfill or incineration centre.
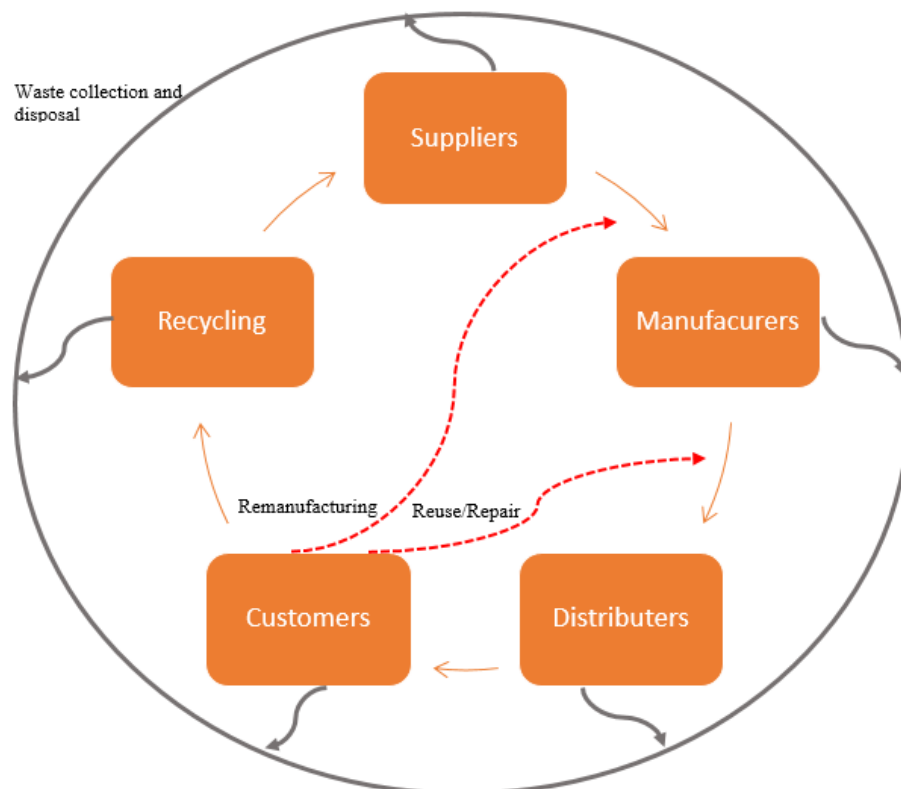

Figure 7. Waste management and reverse logistics

Thus, in frames of supply chain the reverse logistics' (together with forward logistics') and waste management's activities could be considered as parallel (see figure 7). The movement of materials, components and products goes on along supply chain, and during this process used goods with value to be extracted continue the circulation, while goods that cannot be used in any other way exit the circulation of the supply chain and enter to the waste management cycle.

1.6 Reverse Logistics: Fundamentals

In previous sections reverse logistics was considered with connection to other concepts, which was necessary to avoid further misunderstanding and misinterpretation of some terms. Furthermore, it allowed to demonstrate reverse logistics in a broader prospect. This section will discuss the definition and components of reverse logistics, its main drivers and challenges.

1.6.1 Defining Reverse Logistics and its Main Activities

Probably one of the most popular definition of the reverse logistics is the one presented by Rogers and Tibben-Lembke (1998:2).

> Reverse logistics is 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 value or proper disposal.

Even though this definition fully reflects the idea of reverse logistics, one alteration should be done. Depending on the type of reverse process employed, products may not necessarily be returned to their point of origin, but to a different point for recovery (De Brito & Dekker 2003).

Further understanding of reverse logistics could be gained through the investigation of activities involved in it. The description and structure of these activities differs among various sources depending on the positioning of the reverse logistics in the research. Based on the combination of the information from Rao (2008), Bloomberg et al. (2002),

Grant et al. (2006), Lebreton (2007), De Brito and Dekker (2003), Rogers and Tibben-Lembke (1998), and Emmett and Sood (2010), reverse logistics activities could be recognised as the following:

- Acquisition: a process that involves the collection of the product from the market (end user) and delivering it to the point of recovery or "gate keeping" centre.

- "Gate keeping": it is the point of entry of goods into the reverse flow and it requires the careful *inspection* of returned goods in order to identify the reason of return, the *sorting* – to structure inspected goods according to the reason of their return, and *selection* – to identify whether goods should be reused/ resold or sent to the recovery point (the type of recovery could be identified at this stage):
  - Inspection,
  - Sorting,
  - Selection.

- Recovery could be described as a process of recapturing the value of used goods:
  - Repair – replacement of faulty or failed parts to make a product usable again;
  - Refurbishing – most of the structure of the product is untouched, the product gets its "as new" condition via cosmetic changes such as minor repairs, new paints, cleaning, removal of stains, et.;
  - Reconditioning – total overhaul of the product but not full manufacturing process the basic structure remains the same but the worn out or failed parts are replaced with new ones,
  - Remanufacturing – a full manufacturing process is carried out to produce goods using a combination of material that is new and from used goods;,
  - Disassembly and cannibalization – removal of functioning parts from used products for the further reuse while remaining parts are recycled or disposed, cannibalization could be characterized as a very selective disassembly;
  - Reclamation or retrieval – at this stage any valuable materials that can be reclaimed will be reclaimed, and any other recyclable materials will be removed before the remainder is finally sent to a landfill;
  - Recycling – processing used goods in the way that they could be used again, either in the same form or in a different form.

1.6.2 Drivers of Reverse Logistics

Reverse logistics can contribute into the minimization of environmental impact by reducing the amount of waste generated and improving resource efficiency. However, it is important to remember that there are other reasons for installing a reverse logistics system such as warranty returns, consignment agreement returns (e.g. art work placed in a salesperson's care is not sold and later returned to the owner), units sent to the organization for a product upgrade, take-backs (e.g. unnecessary pallets taken back when not needed), product recalls (e.g. return of goods due to the safety or security reasons), return of products not meeting the manufacturer's guarantee to the customer, rental or lease returns etc. (Bloomberg et al. 2002).

De Brito and Dekker (2003) discuss reasons for products returns in more detail, differentiating manufacturing (raw materials surplus, quality control returns, production leftovers/ by-products), distribution (products recall, B2B commercial returns, stock adjustments etc.), and customer returns (warranty returns, service returns, end-of-use return etc.). Even though these could be considered as excessive reasons for the setting up the reverse logistics, they are not always sufficient to make it as important are other operations (e.g. forward logistics or marketing). As a result often decision to integrate reverse logistics and include it into the strategic planning is affected by additional factors or drivers.

According to De Brito and Dekker (2003) there are three main types of reverse logistics drivers: economic (opportunity to profit), legislation and corporate citizenship. Meanwhile Kokkinaki et al. (2000) suggest three clusters of incentives for the reverse logistics integration: positive environmental impact, competitive advantage, and regaining value. While both views reflect the reality, the former seems to be more viable from the business point of view, since no rational company will invest in reverse logistics just to achieve a positive environmental impact (see Guide et al. 2003).

Usually *economic* drivers of reverse logistics include reduction of the raw materials usage, adding value with recovery, and reducing disposal costs. Other aspects that could economically benefit companies are marketing, competition and strategic issues. For example, companies can get more involved with reverse logistics as a strategic step to

be prepared for future legislations, thus dealing with the challenges that these legislations could render in a more efficient way. In terms of competition, the take-back services are organised to prevent competitors from getting the technology, or gain competitive advantage by offering more beneficial return policies. In terms of marketing, improvement of the reverse logistics processes could be a part of an image development (e.g. H&M, Xerox or IBM). In addition, reverse logistics can help to improve customer and channel relationships by giving retailers opportunity to return obsolete products, thus maintaining fresher stock (which could be priced higher) resulting in cost reduction for the retailer and better customer satisfaction (see De Brito & Dekker 2003 and Emmett & Sood 2010).

As in many other cases *legislation* could be considered as the most powerful driver for the integration of reverse logistics. Throughout Europe and the United States, legislation is being considered that would place conditions on the legal disposition of products that have reached the end of their life. In Germany, new laws dictate that the producer of a good must bear responsibility for the final disposal of the product. In some states in the U.S., similar measures are being proposed. For example, many states require retailers of vehicle batteries to take back used batteries. In places where legislation does not force a manufacturer to take back the product, products are not being allowed into landfills. In some cases, this will likely force the establishment of a system to collect these products (Rogers & Tibben-Lembke 1998:102). As this driver is often the main one for reverse logistics integration it seems reasonable to consider several examples in more detail.

Some examples for the European legislation in area of reverse logistics are the End of life vehicles (ELV) Directive 2000/53/EC, WEEE Directive 2002/96/EC or the Battery Directive 2006/66/EC. These directives are not compulsory for the member states, but rather guidelines, which EU countries should take into consideration.

The ELV Directive (Directive 2000/53/EC), came into force in October 2000 and aims to achieve an environmentally friendly dismantling reuse and recycling of used or crashed vehicles (or parts, for example partially worn tyres). The ultimate goal is to put only 5 percent of ELV residues into landfills (Winter 2009:16).

WEEE Directive was implemented in 2003. This directive is aiming to decrease the amount of WEEE (waste electrical and electronic equipment), and it obliges manufacturers to bear the physical and financial responsibility for the implementation of efficient model of collection and disposal of WEEE, and it should be done in such a way that individual users of electrical and electronic equipment should have the possibility of returning WEEE at least free of charge.

The Battery Directive 2006/66/EC, made official since September 2006 has two main purposes, firstly to reduce the hazardous material used in batteries (lead, lead-acid, cadmium, mercury) by establishing prescriptive limits for the producer and secondly, to achieve a maximum of collecting and recycling quota for all kind of used batteries (portable, industrial and automotive batteries). All member states have to take necessary measures in order to install efficient take back schemes to ensure that battery recycling follows the best available, environmentally friendly techniques in order to minimize the negative impact on the environment (Winter 2009:18).

The EC Directive on Packaging and Packaging waste (94/62/EC) aims to reduce the environmental impact of packaging by presenting specific recovery and recycling targets, and by ensuring waste minimization and higher rates of reuse in this area. All member states have to establish systems for the return and/or collection of packaging waste (see Winter 2009 and Cherrett et al. 2010).

All presented legislation has enhanced the development of reverse logistics and thereby forced companies to put into practice some environmental measures.

The last driver of reverse logistics, *corporate citizenship*, concerns a set of values or principles that in this case impel a company or an organization to become responsibly engaged with reverse logistics (De Brito & Dekker 2003:8). Growing environmental awareness among population creates more pressures that force companies to become more and more responsible and seek for more efficient ways to reduce environmental impact.

1.6.3 Challenges of Reverse Logistics

For reverse logistics to be beneficial it should be carefully designed, planned and controlled, and possible challenges should be addressed. Some of the challenges related to the reverse flow can include (Halldorsson & Skjott-Larsen 2007):

- Large variations in timing, quality and quantity of product returns;
- Lack of formal procedures for product returns;
- Delayed product returns causes reduction in market value;
- Lack of local competence in inspection, evaluation and disposition of returns;
- Lack of performance measurement of the efficiency of reverse logistics,
- Lack of good information system.

In most cases, it is difficult to predict when, how many and in what condition products will be returned. This uncertainty makes it difficult to identify necessary procedures and allocate resources. As a result, many companies are reluctant to start a high range reverse flow program, and returns are rather dealt with on an ad hoc basis, when resources are available. According to Lebreton (2007) there are two main reasons which maintain the uncertainty at a critical level: the absence of past data documenting the return behaviour and the demand for used items; and the product selling strategy which induces products return too late to be recovered. Hall (2001) suggests that this challenge could be minimized through implementation of leasing programs, which could ease the forecasting of the timing, quality and quantity of product returns. Some companies already adopted this approach (e.g. Xerox or Dell), whereas for some industries this option is not very suitable (e.g. food industry).

Lack of standard operating procedures for handling returns could lead to other challenges. For example, it could lead to the disagreement between retailer and manufacturer when there is no formalized system on how to define the value and condition of the returned products, or how to report the return (see Emmett & Sood 2010 and Rogers & Tibben-Lembke 1998). Another aspect to consider here is that products returned by consumers are often unpacked and without any product identifications (e.g. barcode), which makes it difficult and time-consuming to give the products right identification label again (see Halldorsson & Skjott-Larsen 2007).

Traditionally, time frames play an important role in forward logistics and organisations devote lots of attention to this issue, whereas in reverse logistics returns are managed without addressing the time considerations. However, time-to-remarket is essential for time-sensitive returns, e.g. clothes, books, mobile phones, and electronic equipment (Halldorsson & Skjott-Larsen 2007). Blackburn et al. (2004) introduced the concept of marginal value of time, which explains why it is important to manage return in a timely manner. The authors demonstrated that for goods that quickly become obsolete, the reverse logistics management should concentrate on minimizing lead time rather than costs. One of the findings of the research conducted by Dawe (1995) supports this point of view and highlights that shortening returns processing time is important for handling returns well.

Furthermore, organisations could face challenges in one of the essential parts of reverse logistics, gate keeping, which requires careful examination and sorting of returned products. In order to perform this activity in a correct and beneficial way a certain level of competence should be acquired. Quite often this competence is not available at the local level or very expensive to maintain (Halldorsson & Skjott-Larsen 2007:8).

In order to manage reverse flow in an efficient way, to be able to recognize possible difficulties in time and identify progress it is necessary to employ performance measures. However, few companies have a formalized system in place for monitoring their reverse logistics activities (see Halldorsson & Skjott-Larsen 2007 and Rogers & Tibben-Lembke 1998).

Several sources (e.g. Rogers & Tibben-Lembke 1998; Emmett & Sood 2010 and Lebreton 2007) point out that the accumulation of the data concerning product returns is of high importance in reverse logistics management. Rogers and Tibben-Lembke (1998:31) argue that "being able to see defective products and to track return issues by reason codes can be more useful than simply improving return handling efficiencies". Usually, to organize the data collection the information system is needed, and at the moment there are not many good reverse logistics information systems available. Such a system would have to be very flexible and operate between different supply chain participants as well as across many internal functions of the organizations, which makes development of reverse logistics system quite challenging.

Execution of reverse logistics, as discussed earlier, can be very beneficial for companies despite the challenges that it involves, and there are many examples that support that point and some of them will be presented in following chapter.

2 Reverse Logistics in Practice: Case Studies

In the previous chapter the theoretical base of reverse logistics was presented and explained. However, it is always important to support theory with practical examples for better understanding of a theory's applications in real life. In this chapter several case studies will be presented to demonstrate the expediency of the reverse logistics implementation in practice. Case studies were selected so that the use of reverse logistics could be demonstrated in broader prospect.

2.1 Free Pack Net: Reusable Packaging

The core business of Free Pack Net is to rent the high protection packaging for companies operating in the white goods industry and manage the return of packaging from customers through its reverse logistics network.

After conducting thorough research on suitable materials and the technical, economic, and practical feasibility of such product, Free Pack Net was able to design a structural modular packaging with clamps that is able to handle up to 1.2 tonnes of horizontal or vertical loads (Figure 9). Because of its modularity, the packaging could be collapsed when returned from the customer (Figure 8) reducing the reverse logistics costs due to decreased volume of freight. Such a design allowed to optimize costs and maximize the technical characteristics of the product. It is important to mention that even though the design was elaborated by Free Pack Net the production of this packaging was outsourced to other companies.

Efficient organisation of its logistics network could be considered as another success factor of Free Pack Net. Detailed planning of the reverse logistics network is essential for the company as it allows to monitor the volume of the packaging and the time when it is available for renting out. This activity is implemented through monitoring of the journey made by each piece and careful transportation organisation, which is possible thanks to its information technology system.

Figure 9. Packaging used for vertical load[6]   Figure 8.Collapsed packaging

As soon as packaging arrives back to the sales point, Free Pack Net transports it (using services of 3PL companies) to the collection centres and then to sorting centres, where the packaging is cleaned and reconditioned, and the kit is reassembled and sent back to the domestic white goods manufacturers. In this way, the packaging circulates twenty times until the end of its useful life when it is sent by sorting centres to the factories for remanufacturing and recycling (then remanufactured packaging is sent back to the sorting centres and the process is repeated).

The main benefits of Free Pack Net's service are:
- The total rental costs of the reusable packaging are less than the purchase and disposal costs of disposable packaging,
- Significant reduction in damages of electrical appliances during transportation and handling operations,
- Environmental benefits.

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[6] Source: http://www.freepacknet.com/

After comparison of the environmental impacts of traditional disposable packaging and the one from Free Pack Net, it was discovered that the energy consumed in the life cycle of reusable packaging for a washing machine was 85 percent lower than that consumed in the life cycle of twenty (since one packaging from Free Pack Net is used twenty times) different types of similar traditional packaging. This could be represented as a saving of approximately 39 barrels of petroleum for every 1800 washing machines produced, which amounted to around one million barrels a year for the entire annual European production of domestic white goods. More details on the case study can be found at Emmett and Sood (2010).

This example reflects the possibility of reverse logistics organization, which will bring benefits to the company and the environment.

2.2 ReSolve: Outsourcing of Reverse Logistics

ReSolve offers reverse logistics management for technology-driven companies, providing service spares inventory, product returns management, and redeployment of assets. ReSolve was established in 2010 through the strategic acquisition of Converge by Arrow Electronics, Inc.[7]

One of ReSolve's clients, a leading retail chain specializing in consumer electronics, was receiving an extensive amount of product returns. The retailer found that most of the returns were due to hardware malfunctions or overheated circuitry, repairs of which were completed with a replacement of some parts of the product. Extracted parts were then delivered to the company's service depots resulting in the excessive inventory of possible damaged parts, which later were simply disposed as the retailer could not identify which parts were faulty or damaged, thus destroying millions of dollars each year in service returns.

To resolve this problem a testing and screening process (i.e. gate keeping) had to be introduced into the product returns management strategy. However, the retailer did not

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[7] http://www.resolvebyarrow.com/about-resolve-company-overview.htm

have either capacity or resources to implement gate keeping in-house and turned to ReSolve for help in developing a custom solution to overcome the challenge.

All service depot returns were redirected to a ReSolve facility where they were exposed to a sort and inspection process, undergoing product identification, screening for physical damage, and functionality testing. Through this process ReSolve found that over 65 percent of the returns had no trouble found and met manufacturer specifications on certain, high-value commodities.

Some of the materials with no trouble identified re-entered the organisation's supply inventory and were utilized for future repairs, which helped to reduce the inventory replacement cost significantly, and others were remarketed (resold), recovering even more revenue. Whereas faulty goods were recycled or returned to the original manufacturer for warranty reclamation.

As a result, the retailer saved millions as a direct result of the reintroduced service parts and the cost avoidance for new service spares. More details on the case study are presented in ReSolve (2011).

This case study demonstrates that reverse logistics could not only reduce amount of waste generated, but also bring significant increase in revenue (or rather recover revenue), and these results can be achieved through outsourcing reverse logistics, especially in case when there is lack of resources or competence in this area.

2.3 Xerox: Reverse Logistics in Large Corporation

Xerox is an American multinational corporation, a leader in document technology and services, and is among the world's leading enterprises for business process and document management. Xerox offers global services such as claims reimbursement, automated toll transaction, customer care centres and HR benefits management.[8]

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[8] http://www.xerox.com/about-xerox/company-facts/enus.html

The company has been conducting an environmental program since 1991, the main purpose of which is to produce waste-free products in waste-free facilities to reduce the amount of waste. The program focuses on the designing the products, packaging and supplies that help to achieve resource efficiency; minimization of waste; reuse of material where possible and recycling what cannot be reused. Since the beginning of the program over two billion pounds of potential waste were prevented from entering landfills through efficient recycling and remanufacturing.[9]

Since the early 1990s, Xerox has maintained an internal initiative known as the waste-free factory. This initiative drives the global implementation of an ISO 14001-compliant environmental management system, and helps achieve a 93 percent recycling rate for non-hazardous materials.[10] Prior to the development of the remanufacture facilities valuable components would be considered waste even if they had just minor defects. The new operation ensures the reuse of all of these components and even improving the performance of the products (Benn & Dunphy 2004:259). The production lines in waste-free factories are designed so that it is possible to produce new products by using some of the returned products' parts.

Reuse and recycling of parts and components are considered in detail during the product design phase. Xerox evaluates the lifecycle of products and considers extended life of parts, easy disassembly, part reusability and material recyclability to reduce costs and extend durability of some parts, which could be repaired or used for remanufacturing (see Grant et al. 2013).

Moreover Xerox developed effective product returns management offering customers several free of charge return options (Grant et al. 2013:162-163):
- *Single item return* is a programme for customers to return a single item, for example a cartridge. Customers can submit a cartridge return label request and receive a label for shipping the cartridge by post free of charge.
- *Bulk returns* on a pallet is a return programme for those who have more than thirty items to be returned. The Xerox Pallet Returns process allows customers

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[9] http://www.xerox.com/about-xerox/environment/recycling/enus.html
[10] http://www.xerox.com/about-xerox/environment/recycling/enus.html

> to download the Xerox Bulk process, which contains the instructions of how to prepare items and schedule a pickup.

- *Eco Box* is a programme where customers may order kits of three boxes each at no cost, bundle items together in the box, download a pre-paid label, and return them to a returns partner.

Furthermore, Xerox extends its recovery channels throughout the whole supply chain by involving suppliers of raw materials and spare parts. Product returns are sent back to Xerox factories, where they are inspected, sorted and reprocessed. Parts that can be reused are sent to the spare parts suppliers for repair, reuse or remanufacturing; whereas faulty parts that cannot be reused are sent to the spare parts supplier as raw materials. Other recycled materials are sent to the supplier of raw material for further production. More details on the case study could be found in Grant et al. (2013) and Benn and Dunphy (2004).

This case study demonstrates how reverse logistics could be implemented at a multinational corporation, bringing both economic gain and environmental impact minimization.

2.4 Integrated Chain Management in Germany

One of the examples of reverse logistics integration at a national level could be an integrated chain management concept developed in Germany. It is defined by the Enquete Commission of the German Bundestag on the "Protection of Humanity and the Environment":

> Integrated Chain Management (Stoffstrom management) is the management of material flows by stakeholders [to be] the goal-oriented, responsible, integrated, and efficient manipulation of material flows. Set targets derived from the ecological and economic realm, under consideration of social aspects. Goals are set on the level of the single firm, within the supply chain of actors, or on the public policy level (Morana & Seuring 2011:680).

Moreover, German packaging law has played an important role in the development of reverse logistics. Looking back over almost twenty five years it is possible to call the

German Packaging Ordinance revolutionary. This claim finds support from Rogers and Tibben-Lembke (1998:137):

> No single piece of packaging legislation has been as widely discussed, nor has had as wide an impact as the packaging laws recently implemented in Germany. The German system is worth examining at in detail because it has been so widely discussed in the popular business press, and has formed the basis for programs in other countries.

According to Ackerman (1997), the 1991 Packaging Ordinance has four main aspects that allow to increase manufacturer responsibility for packaging waste:

- Manufacturers and distributors must accept transport packaging, such as pallets, boxes, etc., and reuse or recycle them.
- Retailers and distributors must accept back secondary packaging (e.g. cardboard box from candies in wrappers) and reuse or recycle it.
- For primary packaging (e.g. candy wrapper), the same rules apply as for secondary packaging.
- A deposit/refund system is required for beverage, detergent, and paint containers.

This legislation implies that industries should organize the retrieval of reusable packaging waste, and local authorities should continue to manage the remaining waste. Under the legislation, companies must either collect the packaging themselves, or contract with someone else to perform the collection.

As a result of discussed legislation the Duales System Deutschland (DSD) was created by 400 companies across Germany. This initiative was shaped through the agreements with three groups. First of all, it created a "Green Dot" symbol and licensed it to those packaging manufacturers who put the DSD logo on their products. Secondly, it established cooperation with private waste haulers and municipal waste collectors to gather packaging with the "Green Dot" logo. And, finally, it contracted with industry organizations that guarantee the waste will be recycled.

The general scheme developed by DSD could be summarised as follows. Used packaging is collected from consumers and retailers and sent to secondary materials organisations for reprocessing. The collected packaging is reused to make new packaging, which then

re-enters the supply chain. In case some packaging cannot be reused, it is recycled or utilised for other purposes (see Ackerman 1997 and DSD 1998).

Even though the DSD's initiatives faced many challenges and critics, it has been successful. By 1997, the recycling rate of all sales packaging from households and small businesses reached 86 percent, significantly decreasing the amount of packaging waste (see Rogers & Tibben-Lembke 1998)

This case study showed how reverse logistics activity could be executed at a national level. In addition, it demonstrated that the legislation significantly affects the development of reverse logistics, and in order to broaden the reverse logistics integration among companies presumably governments should consider the adoption of German legislation practices.

2.5 Summary

It is possible to see from the presented case studies that there are examples of successful reverse logistics integration, which have generated economic benefits as well as alleviation of ecological issues. These case studies also demonstrate that reverse logistics could be implemented in various ways and at different levels. Whether it is a multinational corporation with capacity to organise well-established product returns management and in-house remanufacturing, or a medium-sized company that handles reverse logistics well but lacks capacity to perform production and transportation operations, or a retailer without in-depth knowledge of neither production nor transportation operations, or even a nation that recognizes the importance of environment preservation. However, most companies are still reluctant to adopt reverse logistics management mainly due to the challenges of its implementation. In the next chapter this aspect will be considered in more detail.

3 Integration of Reverse Logistics

Previous chapters provide a general overview for a better understanding of the reverse logistics concept and demonstrate the feasibility of reverse logistics implementation in practice. This chapter's focus lies in presenting general guidelines or procedures that should be considered when executing the reverse logistics. In other words, this chapter could be considered as a guide for organisations willing to develop an efficient reverse flow.

3.1 Considerations Prior to Reverse Logistics Integration

Before moving to the actual strategies of reverse logistics implementation, it is important to consider several aspects.

3.1.1 Levels of Reverse Logistics Implementation

It is important to identify the levels at which reverse logistics could be implemented since activities associated with reverse logistics integration may differ according to these levels. This issue is considered in detail in the research conducted by Morana and Seuring (2011). They differentiate the societal or governance level, the chain level and the actor level.

The *societal level* (sometimes called political level) involves such players as governments and governmental organisations as well as voluntary initiatives of companies. One example of this level was considered in the case study of Germany in the previous chapter. Usually at this level legal requirements and economic conditions for product take-backs are analysed.

The *chain level* considers a supply chain as a whole and at this level all reverse logistics activities are analysed (acquisition, gatekeeping, recovery and then further redistribution) as well as the role of each party involved in it.

The *single actor level* considers each supply chain player separately and internal activities involved in reverse logistics integration. For example, if at chain level the retailer would be considered as the one responsible for conducting, let's say, gatekeeping activities, at the actor level these activities and costs associated with them would be considered in more detail.

The levels of reverse logistics implementation could be also explained in terms of goals that are to be achieved, at societal level usually the goal is improved environmental conditions; at chain level the goal is to make movement of the goods as efficient as possible through development of collaboration between supply chain actors so that all of them benefit; and at the single actor level the goal is to implement reverse logistics activities in such a way that brings economic advantages to an individual organisation.

Thus, before implementing reverse logistics it is necessary to decide at which level it should be implemented, which would define the scale of efforts and actions required. In the case of the single actor level, the interests of single organisations are considered; the chain level requires close collaboration between supply chain players and the interests of all of them should be taken into consideration while more careful planning should be executed; the societal level is the most complex and requires collaboration between various stakeholders.

However, the level could change over time: for example, the organisation can implement reverse logistics internally and when a certain level of expertise is achieved, it can encourage other supply chain actors to do the same, and over time form an initiative (e.g. Duales System Deutschland) linking various companies in an attempt to establish an efficient reverse flow.

Most of the research conducted in the area of reverse logistics targets the individual organisations or the supply chains as a whole, but there is little information about reverse logistics implementation at a societal level. Nevertheless, it is always possible to elaborate the solution based on successful practices and for the societal level the case study of Germany could be taken as a basis.

3.1.2 Outsourced or In-house Reverse Logistics

Reverse logistics could be implemented in-house or outsourced to other organisations (fully or partly). An organisation should analyse its capacities and resources to understand which activities should or could be implemented in-house and which could be outsourced. Implementation of all reverse logistics activities in-house is reasonable when the frequency and volume of returned goods deliveries is high and the organisation has the needed capacity and resources (e.g. vehicles, facilities for gatekeeping and recovery operations, enough competent staff etc.) to execute these activities (see Cherrett et al. 2010).

Furthermore, in case the organisation is unable to perform some activities then those activities could be outsourced to other companies (e.g. transportation of return goods from retailer to manufacturer, gatekeeping, remanufacturing etc.). Often organisations with little or no expertise in reverse logistics prefer to fully outsource it in order to focus on their core activities as in the ReSolve study case.

DATAMONITOR (2003) describes the role of companies offering reverse logistics services as following:
- Recognizing and anticipating the critical issues,
- Identifying opportunities for new services and capabilities,
- Tailoring products better to the needs of their clients.

According to Trebilcock (2000) when considering the outsourcing of reverse logistics three issues should be addressed:
- Whether or not handling returns internally will enhance or hinder a company's core competency,
- Whether the company is handling soft goods or hard goods (hard goods are typically candidates for outsourcing),
- Determine the company's ability to dispose inventory through non-traditional sales channels.

3.1.3. Centralised or Decentralised Reverse Logistics

It is important to decide whether reverse logistics should be centralised or decentralised. Centralised reverse logistics is a system, where one organisation is responsible for collection, sorting and redistribution of returned items, and in the case of a decentralised system, multiple organisations are involved (Halldorsson & Skjott-Larsen 2007).

In the case of a centralised system, gatekeeping activities are performed by one organisation, and all returned goods (usually returned to retailer) are delivered to a certain facility for the inspection and sorting, from where they are transported for further reuse or reprocessing. Whereas in a decentralised system, often retailers perform gatekeeping activities and then goods are sent to different (depending on results of inspection) facilities for reuse/resale, for value recovery (thereto different organisations can handle different types of recovery), for recycling or for disposal. This requires the presence of specific and formal guidelines for the identification of the product condition, local skills to perform the initial inspection, and a logistics infrastructure to process the items further (Halldorsson & Skjott-Larsen 2007:16).

The decentralised system usually is more beneficial for time-based strategies (Blackburn et al. 2004), as the individual item can be delivered faster and in more direct way. However, a centralised system offers economy of scale in logistics, and lower costs of managing reverse flows and of developing and maintaining the necessary amount of resources and competencies.

3.1.4. Level of Maturity of Reverse Logistics

Finally, the range of challenges that organisations can face depends on their level of expertise in this area, hence it is necessary to identify the level of maturity of reverse logistics operations. Cope (2007) distinguishes five levels of maturity:

- The innocence. Organisations do not have any understanding of reverse logistics and are not involved in any reverse logistics activities and processes;
- The understanding. Organisations have growing understanding of the need of reverse logistics, but it is not implemented in the organisation or poorly developed;

- The competence. Organisations have solid capability in organising and managing reverse logistics applying traditional approach;
- The development. Organisations have broader scope of reverse logistics with growing focus on environmental aspects;
- The excellence. Organisations are world-class leaders and experts in reverse logistics

3.2 Framework for Reverse Logistics Integration

During the research it was identified that even though there are various frameworks developed for reverse logistics implementation, often they are too specific, i.e. they target one of the supply chain stakeholders (often manufacturers) or focus on one of the specific activities (e.g. remanufacturing, disassembly or used goods acquisition). However, there is a framework that is general enough, holistic and could be used by various organisations, specifically the framework presented by Badenhorst (2013).

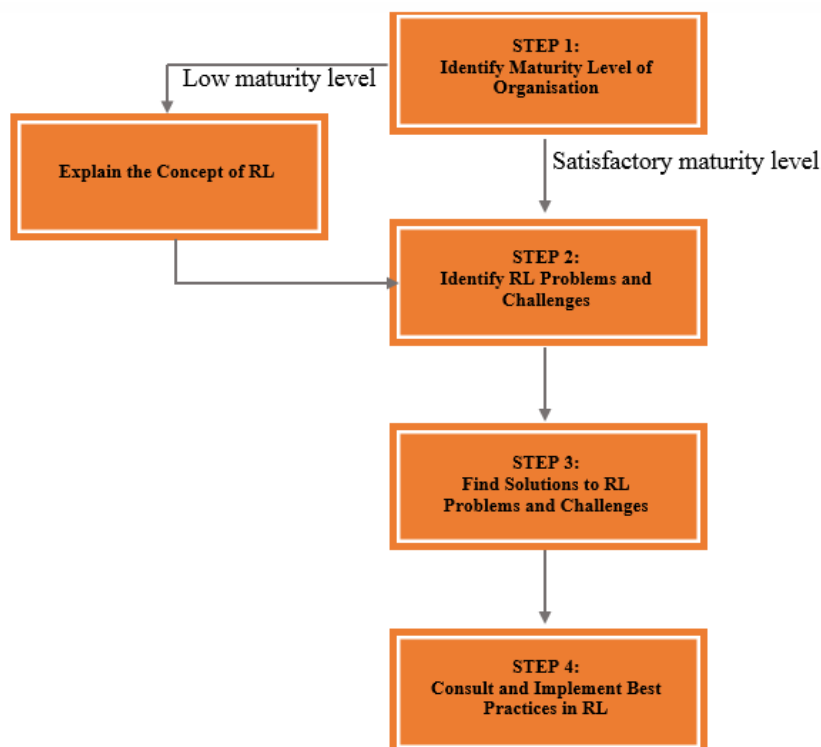Further each step of the framework depicted below (figure 10) will be explained.

Figure 10. The framework for reverse logistics integration

STEP 1: Identify maturity level of organisation

In previous section the maturity levels of organisation in reverse logistics were explained. For those organisations who have no or little understanding it is necessary to improve the understanding of reverse logistics, its activities, drivers and challenges.

STEP 2: Identify reverse logistics problems and challenges

In this step, the challenges in reverse logistics specific to certain organisation should be identified. Some of them are:

- Cost associated with reverse logistics.
- Lack of appropriate information system for reverse logistics.
- Problems with product returns and reverse logistics processes, or uncertainty of time quality and quantity of product returns.
- Organisational and management-related problems. For example, lack of formal procedures for product returns, lack of competence etc.
- Problems between reverse supply chain partners. The problems in this category include a lack of collaboration, a lack of communication and a lack of support from channels members.

STEP 3: Find solutions to reverse logistics problems and challenges

The main challenges and their possible solutions are presented in Table 1 below.

STEP 4: Consult and implement best practices in reverse logistics

This step includes the application of the best practices in reverse logistics. Some of following practice could be implemented to ensure more efficient reverse logistics:

- Information related best practices include investment in wireless technology, investment in new technology, utilisation of reverse logistics management system, implementation of information system compatible with other supply chain members etc.;

Table 1. The challenges in reverse logistics and possible solutions (Source: based on Badenhorst 2013)

Challenges	Solutions
Costs associated with reverse logistics	Information-related solutions: • Invest in information technology • Use data collection • Implement appropriate information system Solutions related to activities and flows of reverse logistics: • Establish efficient gatekeeping • Implement centralised reverse logistics system • Introduce careful planning of reverse logistics activities Personnel and management related solutions: • Implement formal policies, guidelines and programmes for reverse logistics Outsourcing as a solution: • Outsource reverse logistics Partnerships as a solution: • Collaborate with other organisations for more efficient reverse logistics
Lack of appropriate information system for reverse logistics	Information-related solutions: • Invest in information technology • Use data collection • Implement appropriate information system Solutions related to activities and flows of reverse logistics: • Implement centralised reverse logistics system to ease the data collection Outsourcing as a solution: • Outsource reverse logistics
Uncertainty of product returns	Information-related solutions: • Use data collection • Implement appropriate information system Solutions related to activities and flows of reverse logistics: • Establish efficient gatekeeping • Implement centralised reverse logistics system • Introduce careful planning of reverse logistics activities Personnel and management related solutions: • Implement formal policies, guidelines and programmes for reverse logistics

	• Increase competence of personnel Outsourcing as a solution: • Outsource reverse logistics
Organisational and Management related challenges	Information-related solutions: • Use data collection • Implement appropriate information system Personnel and management related solutions: • Introduce strategic planning for reverse logistics • Enlist support of top management • Ensure collaboration between functional departments Outsourcing as a solution: • Outsource reverse logistics
Problems between reverse supply chain partners	Information-related solutions: • Invest in information technology • Use data collection • Implement appropriate information system Personnel and management related solutions: • Implement formal policies, guidelines and programmes for reverse logistics Outsourcing as a solution: • Outsource reverse logistics Partnerships as a solution: • Collaborate with other organisations for more efficient reverse logistics

- Practices related to activities and flows of reverse logistics include introduction of careful planning of reverse logistics activities, establishment of well-developed gatekeeping, centralisation of product returns etc.

- Personnel and management related practices include implementation of detailed strategy for reverse logistics, creation of formal uniform return policies, employment of personnel dedicated to successful reverse logistics integration, providing appropriate training to existing personnel, ensuring the support of top management etc.

- The best practices related to reverse supply chain partnership include creation of alliances, sharing an integrated information system among supply chain partners, building and development long-term partnerships etc.

More detailed information on best practices in reverse logistics could be found in the work of Badenhorst (2013).

3.3 Summary

The framework presented in this chapter reflects the general guidelines for reverse logistics integration. However, it lacks some specification of such reverse logistics activities as collection strategy and recovery processes, which are probably too vast to reflect in a single framework since there are several researches fully devoted to each of these activities.

For example, Langella (2007) conducted research specifically on disassembly with deterministic[11] and stochastic[12] yields. Reimann and Lechner (2012) present a production and remanufacturing strategy and study the production decisions of a firm for a single product with uncertain demand that can be supplied through manufacturing brand new products or remanufacturing returned cores from sales in previous periods. Hanafi et al. (2008) conducted research on the collection of end-of-life products, the strategy presented in their paper integrates forecasting model and product collection strategy to provide a solution to end-of-life product management at different locations. Krikke (2001) presents a recovery strategy, making use of analytical models that give decision support for the set-up of a reverse logistics system for durable consumer products. Lebreton (2007) studies the strategic closed-loop supply chain management specifically for original equipment manufacturers. These works are just a few examples, and more studies could be obtained, which demonstrates how vast and complex the field of reverse logistics is.

It is important to mention that there is some variation between the challenges described in Badenhorst's framework and those presented in the second chapter of this research. These variations could be due to the different literature used in the research, and may also indicate that more profound investigation of challenges and possible solutions in

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[11] Pre-determined outcomes
[12] The outcome is not predictable

reverse logistics could be done to improve the framework, which also could benefit from further investigation of best practices in reverse logistics.

Conclusion

This work has demonstrated that reverse logistics is essential when an organisation's environmental impact is considered. It is an integral element of such important environmental concepts as circular economy, green economy and green supply chain. Thanks to the reverse logistics activities significant results could be achieved in resource efficiency and minimization of waste, which would contribute to the alleviation of ecological issues related to resource depletion and the generation of waste. In addition, it was argued that reverse logistics, given that it is carefully planned, could bring significant economic benefits to organisations.

The concept of reverse logistics itself is not so clearly defined and its connection to other notions sometimes could be misleading despite the vast quantity of research in the area. For this reason, reverse logistics was presented in a broader perspective and explained through reflection of its interrelations with such concepts as circular economy, green supply chain, closed-loop supply chain, green logistics, and waste management. It became apparent that it is difficult to define specific limits between reverse logistics and some others notions (e.g. green logistics) and some more holistic and universal standards could be introduced.

Despite its economic and ecological benefits, reverse logistics (as a high range programme) is implemented in few companies, mainly because it is seen as a complicated and unworthy process. However, this thesis showed that there are successful examples of reverse logistics integration that helped to overcome some critical problems rather than create them.

The previous chapter presented some guidelines and framework, which could be useful when it is decided to integrate reverse logistics. Even though there is literature related to the reverse logistics integration, usually it is either not sufficiently comprehensive or too specific. The framework depicted in this research is quite inclusive and could be useful for different types of organisations, but it needs to be studied further and improved. For example, challenges, solutions and best practices in reverse logistics could be studied in more detail, and the structure of the framework could be simplified to ease its understanding and use in practice.

It is important to mention that the wide implementation of reverse logistics could help to ease the environmental impact of the current economic system, but it is not an ultimate solution. The current way of living should be subjected to radical changes to achieve sustainability from social, economic and ecological points of view. This change could not be easy, but it is possible to take some steps towards it already now, and one of these steps could be reverse logistics integration.

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