

## REVERSE SUPPLY CHAIN

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### Abstract:

The paper focuses on the presentation of the reverse supply chain, of which the role in the modern business grows along with the increasing number of environmental regulations and possibilities of reducing an operating cost. The paper also describes main problems in developing the profitable chain and possibilities to take an action in order to overcome them.

*Key words: reverse supply chain, reverse logistics, remanufacturing*

### INTRODUCTION

Seeking new operation models to maintain and expand companies' market share has its roots in the increasing competition in the market, changing customer requirements, a concern for the natural environment and the new provisions of law concerning the products' end-of-life management. Fundamentally, companies pay attention to development of forward and reverse flow of goods and components in order to maintain and increase their market share [2].

The management of waste is more and more often a task for logisticians – it is reflected in the developing reverse logistics. According to the Council of Logistics Management, reverse logistics is a term often used to refer to the role of logistics in recycling, waste disposal, and management of hazardous materials. It contains the reverse distribution which causes the flow of goods and information in the opposite direction to a normal action [8].

Several years ago, reverse logistics, associated by managers only with an additional cost, was not a subject of interest for many companies. Despite representing a relatively young field of research, wide array of establishing reverse supply chains has already been proposed for numerous different applications in practice [5]. However, it is necessary to mention that unlike forward supply chains, designed strategies for reverse supply chains are relatively unexplored and underdeveloped [3].

### REASONS TO FOCUS ON REVERSE SUPPLY CHAIN

V. Daniel R. Guide Jr. and Luk N. Van Wassenhove point out a few reasons for focusing on the reverse logistics, especially on the reverse supply chain [9]. In many cases the main factor is a concern for the natural environment and the environmental regulations. In Poland, the example is "the principle of extended producer responsibility" which was implemented by the Act of April 27, 2001 [1]. This principle included for example new and used tires. Companies

which put these products on the market, producers and importers were made obliged to organize a collection of used tires and ensure appointed levels of the recovery and recycling.

What is more, companies take the initiative, seeing opportunities to reduce their operating costs by reusing products or components. The example is Kodak, which remanufactures its single-use cameras after the film has been developed. It is proved, that over the past decade, this company has recycled more than 310 million cameras in more than 20 countries.

Finally, some companies, for instance Bosch, use reverse supply chain as indispensable part of new businesses. The company has built advantageous business selling power hand tools which have been remanufactured. Moreover, Bosch is a leading supplier of industrially remanufactured products such as starters, alternators, air-conditioning compressors, brake calipers, ignition distributors, diesel injection pumps, and many other components. This process of remanufacturing vehicle parts is not just a cheaper alternative for final customers – it also protects the environment by reusing much of the original product. Consequently, this system cuts down on the use of raw materials and produces fewer CO<sub>2</sub> emissions than would be generated by the production of new parts.

### PROCESSES IN THE REVERSE SUPPLY CHAIN

In the area of the reverse supply chain there is a set of steps which are necessary to collect the used product and to implement the most appropriate product's end of life strategy. The reverse supply chain begins with the collection of products from customers and some companies in different parts of supply chain. It is necessary to claim that these sources are very often dispersed geographically. Then, there is the phase of control which will decide about possible opportunities for processing or recovery.

Considering the phases that occur in the chain, there is a wide range of products, which in the current – one-way

**Table 1**  
**Features of postponement and preponement concepts of products' returns**

Postponement concept	Preponement concept
Usually it is used in forward supply chains	Usually it is used in reverse supply chains
Delaying individuation of products - the final shape is picking up only in the last stages in the manufacturing process and distribution	Making a disposition as early as it is possible
It allows a company to minimize unnecessary inventories of finished goods	It allows a company to recover the maximum value of returned products
It requires close cooperation between the chain participants	It requires close cooperation between the chain participants

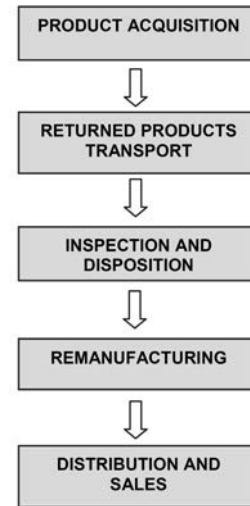
presentation constituted the end of the supply chain, seen as only forward flow of goods. These products are:

- products which broke down but can be repaired or reused,
- products which are obsolete but have still value,
- unsold products which are at the retailer,
- products which are withdrawn from sale,
- repaired parts which have value,
- elements that can be used in a different way, e.g. items that after exhausting the possibility of their use in the way they have other uses;
- waste which must be inventoried and neutralized or used for the energy production
- packages which must be returned to their place of origin or the entity dealing with the consolidation of packages.

In the subject literature an attention is being returned on the concept of product postponement and have shown that it has substantial financial benefits [3]. This concept assumes delaying individuation of products – the final shape is picking up only in the last stages in the manufacturing process and distribution. There is a big chance that a modification of this concept will be very useful in the reverse supply chain management: managers should make a disposition as early as it is possible in order to be able to avoid processing returns with no recoverable value. This concept is called “preponement” and posit that it can have a big benefit for profitability of a firm by avoiding unnecessary processing expenses, while providing faster recovery of products with meaningful value at the same time. Product returns and their reverse supply chains represent a chance to make a value stream, not an automatic financial loss. Undeniably, reverse supply chains deserve as much attention at the corporate level as forward supply chains and should be managed as business processes which are able to create value for the company.

Table 1 presents fundamental differences between postponement and preponement concepts of products' returns.

It should be noted that not all of the reversed supply chains are identical. There are certain elements that are present in each reverse supply chain, regardless of its kind, and those that are specific for certain supply chain (Fig. 1). It should pay particular attention to those elements that are common to all reverse supply chains. Their analysis and thorough examination is necessary in order to make rational decisions regarding the subjective and flow structure of the reverse supply chain. The subjective structure contains a system of links in enterprise networks in which material and information flows are realized [6]. Undeniably, not all reverse supply chains are identical. However, most return supply chains are organized to carry out five key processes:



**Fig. 1 Key stages of the reverse supply chain [based on 9]**

#### *Product acquisition*

Experts say that a collection of used product is key to creating a profitable chain. It is necessary to know that the quality, quantity, and timing of product returns need to be cautiously managed. In another way, companies may find themselves flooded with returned products of such unstable quality that efficient remanufacturing is impossible. Companies often will need to have a good relationship with retailers and other distributors to coordinate collection.

#### *Returned products' transport*

After being collected, products are transported to facilities for inspection, sorting, and disposition. Unfortunately, there is not one best design for a transport infrastructure. Each has to be adapted to the products and the economics of their reuse. Products which are difficult to handle, for instance tires, will require very different handling than small but fragile products like cameras. Therefore, companies should take into consideration not only the costs for shipping and storing but also how quickly the value of the returned products will decay and the need for control over the products. In many instances, it will make sense to out-source logistics processes to a specialist.

#### *Inspection and disposition*

The testing, sorting and classifying of returned products are laborious and time consuming tasks. These processes can be improved if companies uses sensors, bar codes, and other technologies to automate tracking and testing.

#### *Remanufacturing*

Companies can obtain the value of the returned product by extraction and regeneration of parts intended for reuse or by completely remanufacturing the products for resale. Reconditioning and remanufacturing processes seems to be less predictable than traditional manufacturing processes because of the possibility of a large degree of uncertainty in

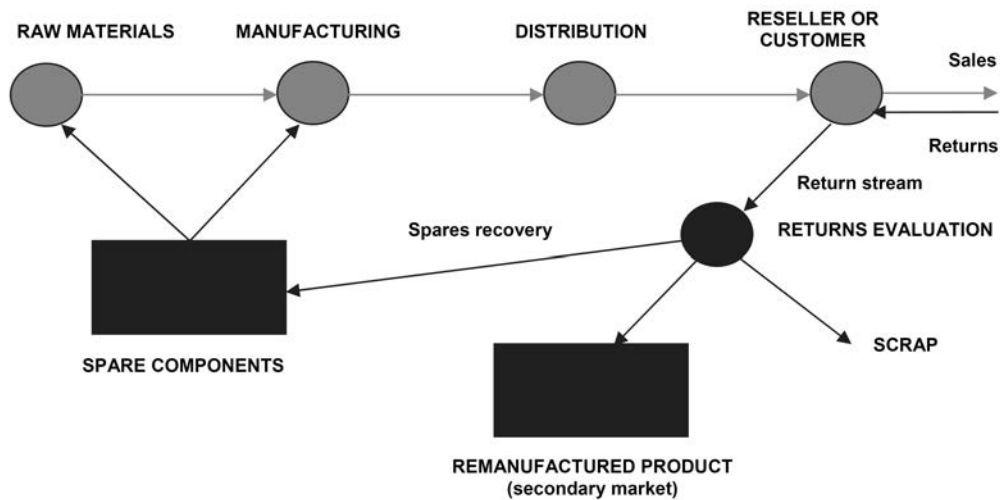


Fig. 2 General scheme of the reverse supply chain [3]

the timing and quality of returned products. Undeniably, making smart decisions early in the chain – will help companies to reduce manufacturing variability and costs.

#### Distribution and sales

First of all, it is necessary to determine whether there is demand for a recycled product or whether a new market must be created if a company wants to sell this product. If there is no demand, the company should expect to make huge investments in consumer education and other marketing aspirations. Potential customers for remanufactured products or components are not just the original purchasers but also new customers in different markets. The company may, for example, pay attention to customers who cannot afford the new products but who search for the chance to buy used versions at lower prices.

Figure 2 presents simplified schematic of a generic reverse supply chain for commercial product returns. Product flows in the reverse supply chain are marked with black. Firstly, customers return products to the reseller (product acquisition), from where they are shipped to the location in order to be evaluated (transportation) for credit issuance and product disposition (inspection and disposition). Diagnostic tests are performed to determine what disposal action recovers the most value from the returned product.

Product returns process shown on Figure 2 determines few possibilities of their use and recovery the maximum value:

- Products are remanufactured if it seems to be cost effective,
- Some returned products may be new and never used; these products are returned to the forward distribution channel,
- Remanufactured products can be sold in secondary markets for additional revenue, often to a marketing segment unwilling or unable to buy a new product,
- Returns may also be used as spare parts for warranty claims to reduce the cost of providing these services for customers,
- Products not reused or remanufactured are sold for scrap or recycling, usually after physically destroying the product.

#### DECREASING VALUE DUE TO THE PASSAGE OF TIME

Maintaining the desired value of returned products is one of the key problems of reverse supply chain management. Managers, who are concentrated only on the forward

supply chain are usually unaware of the loss of the returns products' value due to the passage of time and the effect of other factors, which takes place in the reverse supply chain, despite the fact that the flow of returned products represents a significant stream of assets for many businesses.

Broadly speaking, most of the loss in asset value falls into two categories:

- the returned product must be downgraded to a lower-valued product – a product once valued as new is then remanufactured, salvaged for parts, or simply scrapped as not repairable or obsolete,
- the value of the product decreases due to the time as it moves through the reverse supply chain and its processes to its ultimate disposition.

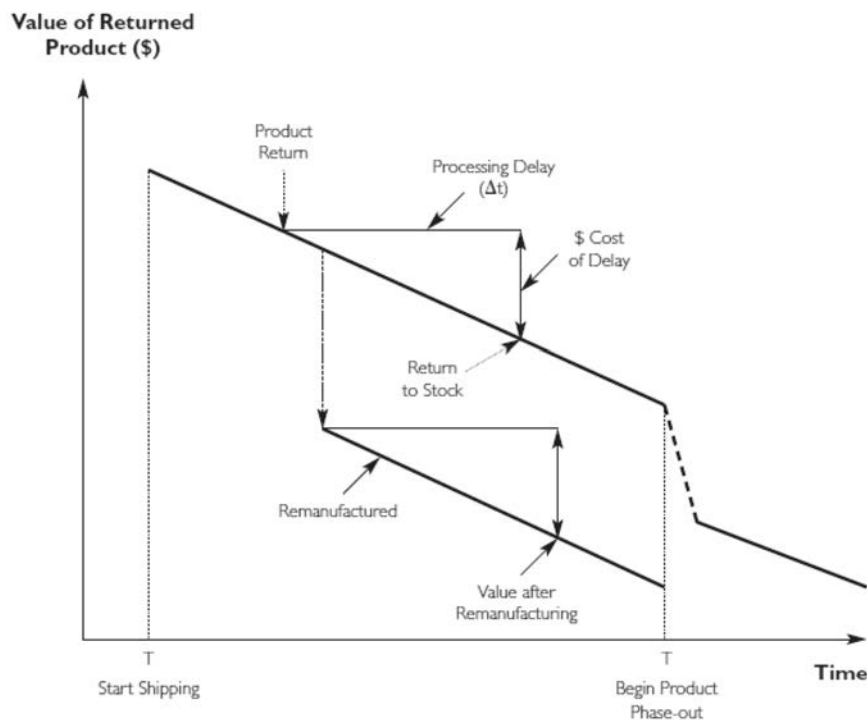
The loss in asset value, caused by the time of products' return to places of their consumption, is firmly connected with their life cycle – covering the period from the entry on the market until it is withdrawn from the market [4]. Effective management processes are difficult due to the fact that product life cycle can range from a few or several months to several years. The length of this cycle is different for different products, and depends primarily on the type and purpose, the impact of competition, the sensitivity to changes in fashion and seasonality, potential modification of the product or packaging, etc.

Product found in the last – the fourth stage of the life cycle, loses its value and taking actions in order to re-enter the market is likely to be economically inefficient. To prevent this situation, the management of the products' returns processes should lead to quick access to the assessment of returns, for example, through good communication with their suppliers and encouraging them to return the goods in the shortest time as it is possible.

In the case of remanufacturing the product and the recovery of useful parts, the loss of the value is unavoidable because only a fraction of returns can be restocked as new items. However, the losses due to time delays represent a significant opportunity for asset recovery. These losses include not only the deterioration in value of a returned product with time, but also the forced downgrading of product due to obsolescence.

Figure 3 illustrates the effects of time delays and product downgrading on asset loss in a return stream.

The upper line in this Figure represents the declining value over time for a new product, which was never used before and is going to be re-introduced into the distribution



**Fig. 3 Influence of the time for the value of returned products [3]**

channel. The value of this product depends on the time at which it passes through the next key phase of reverse supply chain, from transport as the returned product up to its sales and distribution. The lower line shown in the Figure indicates the declining value over time for a remanufactured version of the same product.

Because much of the recoverable asset loss in the return stream is due to time delays in processing, which are returned products transport, inspection and disposition, re-manufacturing and re-introducing the product into the distribution channel, Managers managers should be sensitive to the value of time for product returns and use it as a tool to (re)design the reverse supply chain for asset recovery. A simple, but effective, metric to measure the cost of delay is the product's marginal value of time: the loss in value per unit of time spent awaiting completion of the recovery process. In this paper, the marginal value of time is represented by the slopes of the lines in Figure 3.

Shortening the time duration of the processes occurring in the reverse supply chain can be supported at the stage of product design. A reflection of this idea is the initiative taken by the three largest car manufacturers in the United States – Chrysler, Ford and General Motors. In the Vehicle Recycling Development Center (VRDC), created by them, the construction of vehicles that may be subject to dismantling the more easier and faster way is examined and put under analysis. The workers do research on one of the current trend in manufacturing – Design for Disassembly (DFD). According to it, products must be designed so as to minimize the number of common parts and maximize the number of suitable materials and components quickly merging. Despite the fact that decisions about the materials used are taken in the design of the product, they have a major impact on the entire life cycle, especially in its final development.

#### RELATIONSHIPS WITH AN USED PRODUCTS' PROVIDER

The aforementioned decrease in the value of the product, due to the time as it moves through the reverse supply

chain and its processes to its ultimate disposition, implies taking action to improve the management of processes returns. One of them is to improve communication with the entity providing the returned items. Relations between the supplier of used product and the company where the recycling process takes place, greatly affect the effectiveness of the processes occurring in the reverse supply chain. It often happens that the provider is an individual consumer, who want to get rid of waste products. This creates a need for companies to take action to convince customers to return the products and make them aware of the benefits that entails recycling process – both economic and environmental. It is therefore advantageous to implement the strategy, that would help a company to encourage the recipient to return used or a new product.

An example of an action to facilitate consumers to return used products is the "Lexmark Cartridge Collection Program" developed by Lexmark [11]. The company has implemented this program in order to encourage customers to easily recycle their empty cartridges. Its aim is to ensure that empty cartridges are properly recovered, re-used and processed, which can reduce the amount of solid waste and resource consumption. The Lexmark Cartridge Collection Programs are always free to the consumer and are designed to be easy to use. In order to return the empty cartridge the user must request a recycling bag on the website, pack the used cartridge and return it to the address indicated on the package. Another example is the collection of the used devices by Fujitsu in 27 countries in Europe [12]. The company maintains a flexible program, under which the customer in exchange for the return of an used product can get the amount of money, equivalent to the so-called fair market value of equipment or other product or service. Used equipment is always collected free of charge, the customer only needs to prepare a device for a safe transport (pack and put on pallets) and provide them at a designated place of collection.

## PROBLEMS WHICH OCCURS IN THE REVERSE SUPPLY CHAIN

Currently, in many cases, the steps of the reverse supply chain are treated as a series of independent and isolated actions, without taking into account their integrated nature. What is more, not only in a business, but also in the academic research, there are not a lot of projects to examine and put under analysis strategic issues in the reverse supply chain. Most studies only applies to technical and operational problems, because these areas seem to be the most advantageous and most promising.

The main problems faced by companies implementing reverse logistics, and engaged in the development of reverse supply chain include:

- no system that combines action of the forward logistics with the action taking in the reverse logistics,
- difficulties in estimating the amount and condition of wrecks that will be returned back to the manufacturer,
- lack of research dealing with the impact of reverse logistics on the success of the organization,
- large geographical gap between suppliers of used products and the place of their recycling,
- increased transport costs of waste products because of their relatively small amounts.

In addition, some features of reverse supply chain make it difficult to plan and manage its stages and operations, such as waste products of varying quality occurring in the reverse chain, which cause the need for accurate inspection. There is also a need to remove the collected products, build transportation networks and meet the large amount of returns and the differences in the time duration of the remanufacturing operations.

In order to raise the efficiency of the reverse supply chain it is possible to take measures to help to overcome the problems that arise, such as the creation of the specialized team, whose task will be to keep in touch with suppliers of used products or periodic analyzes of the demand for the return time on the market, especially based on data from the sales department.

## CONCLUSION

Based on the study it can be concluded that in comparison to forward supply chains, design strategies for reverse supply chains are relatively unexplored and underdeveloped. However, growing role that it plays in the contemporary business leads to the situation where more companies

focuses on developing their product returns and the reverse supply chain. Despite the fact that not all reverse supply chains are identical, most of them are organized to carry out five key processes:

- product acquisition,
- transporting products,
- inspection and disposition,
- remanufacturing,
- sale and distribution.

Reverse supply chain design decisions and managing occurring processes are not easy tasks for managers. They are obliged to make decisions which improve the relationship with the supplier and optimize the cost of transporting the products.

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