REVERSE LOGISTICS PROCESSES IN STEEL SUPPLY CHAINS

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Abstract
The role of reverse logistics in creating added value for producers in metallurgy is presented here. The premise is the choice of reverse logistics for steel supply chain on the one hand, considering their versatile applications. On the other hand, an extremely important issue is that their production is characterized by high dynamics, has a significant impact on the environment, contributing significantly to the use of the valuable resource. This paper will focus on the economical and environmental optimization of reverse logistics processes in steel supply chain. The presented article is part of a research on developing application methods for the settlement of environmental-economic support for reverse logistics processes aimed at reducing consumption of energy and raw materials by metal manufacturers, which ultimately translates into added value in terms of so-called environmental benefits.

Keywords: Logistics, Reverse Logistics, Recovery, Steel Supply Chain

1. INTRODUCTION

The process of waste disposal can be significantly boosted by logistics, and especially by the logistics of recovery, which is “fixed” in traditional logistics and yet is representative of the ecological orientation of logistics and therefore very well suited to the imperative of sustainable development. Reverse logistics enables the realization of the idea of a circular economy, which is a departure from the linear model of raw material flow, to a model of closed material-energy cycles, which significantly reduces the high entropy of the modern economy while enhancing the overall utility rate.

Logistics systems activities require the assurance of adequate economical and environmental efficiency levels on the demands of sustainable development [1]. Reverse logistics – because of the complexity and increasing importance in logistics processes – has become one of the most important areas of the eco-efficiency rise. New system solutions are observed as essential to increasing the eco-efficiency level of reverse management.

Current thinking about supply chain is focused on logistics flows from raw materials to finished goods, and therefore those processes which primarily lead to interest in creating and developing supply chain.

The global market, technology improvement and sustainability development has involved new models of supply chain. A new trend in logistics is observed [2]. In recent years, in the context of sustainable resource management, there is a new concept, that of reverse logistics, for which there are synonymous terms such as: reverse logistics, Ecologistics, logistics in the field of recycling, or waste logistics. The problems of waste
management are increasingly falling into the field of logistics – this is reflected in the growth of reverse logistics.

Sustainable development, as defined by the EU, stands for meeting the development needs of present generations without jeopardizing the ability of future generations to meet their own development needs. Sustainable development does not focus solely on environmental issues, but broadly captures the different dimensions of development. Traditionally, sustainable development is conceptually considered in terms of three main pillars:

- environmental sustainability
- economic sustainability
- social sustainability.

There is obvious to maximising the environmental, social and economic benefits of human activities, while minimising the negative impacts, as far as possible.

The implementation of the concept of sustainable development into business practice and the need to meet the challenges of the twenty-first century, at the root of which lies the widespread awareness of the profound global ecological crisis, are now causing particular attention to be given to issues related to environmental quality and cost-effective exploitation of resources [3].

The assumptions of sustainable development clearly indicate that the search for new solutions to technical, technological and logistical resources, and rationalization of the economy, energy and waste should be a priority for all business sectors and services [4].

2. CHARACTERISTICS OF STEEL INDUSTRY

In 2007 and 2008, the global steel industry was estimated to grow at about 6.5% – 7% a year, in terms of both supply and demand [5]. It has been reported by [6] that world’s production of crude steel in 2007 amounted to 1.344 billion tonnes, up 7.5 percent from 2006 - the highest yearly spurt in history, and the second consecutive year in which the world's output of crude steel rose by more than 7 percent. On the other hand, world steel consumption grew from 1.121 billion tonnes in 2006 to 1.198 billion tonnes in 2007, representing a 6.8 percent increase [6]. The global steel industry once again underwent major readjustments in 2007 and 2008. Since 2006, China, who used to be a net importer of steel, has become a net exporter of steel, and its exports have risen significantly during the past year. To counter this, the Chinese government issued a number of export restriction measures, including higher export taxes on semi-products and lower export rebates on steel products [7]. The domestic production capacity in China was also reduced. In response, the prices of both semi-products and finished products in the world market jumped up sharply[8].

Apparent steel use (ASU) in Poland was 12M tonnes in 2007. In 2009 steel market turned to worse – adverse global crisis spillover hit Poland badly. Steel consuming sectors’ downturn made its painful mark on steel output and steel revenues. Poland’s ASU was merely 8.19M tonnes in 2009, down 32% as compared to 2007. 2010 saw Poland’s economy picking up again. GDP growing at 3.8% was to a high degree built by increasingly high internal demand and investments coming back. Positive impact was brought about by projects co-financed from Cohesion Found. 2010 saw all steel-consuming sectors growing production, and in effect Poland’s spiked 20% vis-a-vis 2009 [9].

3. THE STEEL SUPPLY CHAIN

Over the past decade, many of the steel industry studies have been carried out. Most of them aimed to improve the performance of the industry [10, 11]. However, the results provided by those papers laid us to an understanding of the supply chain in steel industry. The steel industry has distinct characteristics that separate it from other industries [12] as follows:
- High capital needed to be invested.
- Long life of products.
- Lots of players in the global market

Therefore, this industry needs a well designed of methodologies or techniques to manage and integrate the supply chain leading to control cost while still having a competitive advantage.

A schematic of the steel supply chain and current technologies used in national steel industry is shown in Fig. 1.

**Figure 1. A Schematic of the steel supply chain [own analysis]**

The steel supplier can be classified as a general steel producer who converts steel scrap into billets, which are then rolled into a variety of steel products. The end user sources their material from a steel stockholder who performs a break bulk role within the supply chain. They order in large quantities from the main producers on long lead times and then sell the material in small quantities on short lead times, according to the customer’s requirements [13, 14].

For steel supply chain it is typical that many European metallurgical companies are forced to import iron ore from remote destinations. For these companies it is necessary to determine the amount of iron ore that will have to be ordered and to create such a delivery schedule so that the continuous operation of blast-furnace plant is not disrupted and there is no exceedingly large stock of this raw material [15].

The world steel industry applies the principles of reduction, reuse and recycling in many ways, in order to improve the sustainability of the industry.

4. REVERSE LOGISTICS, RECYCLING AND RECOVERY

The problems of waste management are increasingly falling into the field of logistics — this is reflected in the growth of reverse logistics.

Recovery means any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy. Recycling means any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations.

Logistics covers the planning, coordination and control both in the aspect of time and space, the course of actual processes in the realization of which organization is a participant, for the purpose of efficient and effective goal achievement by an organization [16, 17]. It particularly concerns spatial and timely arrangement (where?), state (how much and in what configuration?) and flow (where from, where to and by what means of transmission?) of goods constituting the components of these processes, i.e. people, material goods, information and funds [18].
Reverse logistics is defined as 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 [19]. More precisely, reverse logistics is the process of moving goods from their typical final destination for the purpose of capturing value, or proper disposal.

Remanufacturing and refurbishing activities also may be included in the definition of reverse logistics. Reverse logistics is more than reusing containers and recycling packaging materials. Redesigning packaging to use less material, or reducing the energy and pollution from transportation are important activities, but they might be better placed in the realm of “green” logistics. If no goods or materials are being sent “backward,” the activity is probably not a reverse logistics activity.

Reverse logistics also includes processing returned merchandise due to damage, seasonal inventory, restock, salvage, recalls, and excess inventory. It also includes recycling programs, hazardous material programs, obsolete equipment disposition, and asset recovery [20].

In recent years a marked increase in interest in the optimization of logistic processes in support of various types of recovery value of the products in the phase of postconsumer waste, including through reuse, regeneration, recycling and processing can be noted. In the wake of the emergence of new areas of logistics: reverse logistics and recycling.

Defining these new areas requires a reference to the classification of the types of recovery process assigned to the various stages of integrated supply chain, which is presented by Thierry et al. - (Fig. 2).

There are 8 types of recovery/disposal options. Direct reuse/resale, repair, refurbishing, remanufacturing, cannibalization, recycling, incineration, and landfilling. Each of the product recovery options involves the collection of used products and components, reprocessing and redistribution. The main difference between the options is in reprocessing. Repair, refurbishing, and remanufacturing upgrade the product. What they differ in is the degree of upgrading [21].

![Figure 2. Different kinds of recovery in integrated supply-chain [21]](image-url)

The aim of repairing is to return the used products to working order. Quality of the repaired products is more likely less than the original. It requires limited disassembly and remanufacturing. This operation can be performed anywhere. Durable product manufacturers (e.g., IBM, DEC, and Philips)
The aim of refurbishing is to bring used product to a specified quality level. Quality is less rigorous compared to the new products. It consists of fixing the improper modules and replacing them with working or technological ones. Military aircraft are examples of refurbished products.

The aim of remanufacturing is to bring the products to the quality level of new products, that is, to make them "as new". Used products are completely disassembled to the parts level. All parts are extensively tested. Worn-out or outdated parts are replaced with the new ones. Repairable parts are extensively tested. Approved parts are subassembled to the module level, and approved modules are subassembled to product. BMW has been remanufacturing for a number of years.

Cannibalization. In the past three options, the identity of the used product was preserved. In this case, only a small amount of used products, which are recoverable, is taken out of the old product and reused. This is sometimes called selective disassembly. Those parts are used in repairing, refurbishing and remanufacturing activities. Quality of cannibalized parts depends on the process in which they will be used. Aurora, a US Company, is engaged in cannibalizing integrated circuits.

As opposed to the previous activities, in recycling neither product nor part identity is preserved. The aim is to reuse the materials from used products. Quality required depends on the process in which the recycled material will be used. 75% percent of the metals from discarded parts are recycled in European countries, such as Germany, U.K.[21]

The World Steel Association has estimated the recycling rates for products that contain a significant portion of steel, and identified target rates for 2050 (Tab. 1).

<table>
<thead>
<tr>
<th>Market</th>
<th>2007</th>
<th>2050 Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>85%</td>
<td>90%</td>
</tr>
<tr>
<td>Automotive</td>
<td>85%</td>
<td>95%</td>
</tr>
<tr>
<td>Machinery</td>
<td>90%</td>
<td>95%</td>
</tr>
<tr>
<td>Appliances</td>
<td>50%</td>
<td>75%</td>
</tr>
<tr>
<td>Containers</td>
<td>69%</td>
<td>75%</td>
</tr>
<tr>
<td>Total</td>
<td>83%</td>
<td>90%</td>
</tr>
</tbody>
</table>

The strategic objective of waste management planning is the handling of waste in accordance with the principles of the waste management hierarchy, i.e. firstly the prevention and minimization of waste generation and to reduce their hazardous properties and, secondly, maximum utilization of material and energy components of the waste, and where waste cannot be subjected to recovery processes, to be neutralised.

5. SUMMARY

Recovery logistics in waste management systems meets the demands of the new Framework Directive of the European Parliament and Council 2008/98/EC of 19 November 2008 on waste (OJ. EU of 22 November 2008 No. L 312 / 3) whose primary task is to develop instruments to promote the idea of a "recycling society", seeking to avoid waste and to use waste as a resource.

Bearing in mind that in the hierarchy of waste management it is essential to prevent its formation, the Member States are supposed to prepare by 2013 national waste prevention programs, which may become an element of waste management plans. Their primary goal is to stop the directly proportional relationship between economic growth and the amount of waste generated. However, the European Commission aims to develop indicators to measure waste prevention and to create a system for exchanging information on best practice in waste prevention.

In light of the requirements, which introduced a new framework directive on waste is a particular challenge to introduce efficient and effective recovery logistics systems, in spatial, organizational, and information fields. The task of these systems is to direct all waste to designated storage locations, while maintaining the
hierarchy of recovery values, which the legislature based on the principle of sustainable development pointed to.

REFERENCES


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