THE ASPECT OF REVERSE LOGISTICS OF PLASTICS ON THE WASTE MANAGEMENT IN PACKAGING

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Abstract

The research concerns a very important area of management, namely, reverse logistics, as the ecological conditions of the transition from the traditional model of material flows to the modern approach of logistics, as a closed cycle of materials and energy. This subject is very timely in light of the strategy pursued by the European Union for sustainable development, based on the concept of the system of "Integrated governance" which consists of a triad: society - economy - environment (ecosystem). Logistics systems activities require the assurance of adequate economical and environmental efficiency levels on the demands of sustainable development The main aim of the paper is to present the concept of reverse logistics and recycling in the context of sustainable development and also focus on the economical and environmental optimization of reverse logistics processes in plastics packaging. The presented article is part of 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 manufacturers of plastics, which ultimately translates into added value in terms of so-called environmental benefits. The process of waste disposal can be significantly boosted by logistics, and especially by reverse logistics, 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.

Keywords: Logistics, reverse logistics, sustainable development, plastics

1. INTRODUCTION

The current thinking about supply chains is focused primarily on logistics flows from raw materials to finished products, therefore those processes which primarily lead to interest in creating and developing supply chains. The global market, technology improvement and sustainability development has involved new model of supply chain. A new trend in logistics is observed [1]. 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.

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. The definition contained in the Act on Waste of 14 December 2012 should be noted- “waste is all articles or substances which the holder discards, intends to dispose of or is required to dispose of.”[2]

It should be stressed that current knowledge on the relationship between resource availability and the implications generated by their use and subsequent recovery is still only partial knowledge, and these relationships are significantly changing under the influence of both technological and social development.

2. REVERSE LOGISTICS

In waste management, it must be recognized that the "substance", which for one holder is waste, for another, or even the same operator, at another place and another time can be a useful raw material or intermediate, and this means that waste should be recovered and used effectively, in accordance with the philosophy contained in both Polish legislation and in the framework of the European Council Directive on waste 2008/98/EC of 19 November 2008. A new definition describes the packaging as all the products composed of materials of any nature to be used to contain and protect certain goods, from raw materials to finished products, to enable their handling and their delivery from producer to consumer or user and to ensure their submission. The directive also specifies with details for each category, what can and cannot be considered packaging. The role of packaging is broadening and may include functions such as attracting attention, assisting in promotion, providing machine identification (barcodes, etc.), adding essential or additional information, and helping in utilization.

The process of waste disposal can be significantly boosted by logistics, and especially by the reverse logistics, 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 (recovery 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.

One of the instruments for the comprehensive assessment of the environmental impact of plastics production, coupled with their recovery and recycling is the ecological balance. The popularity of this tool is shown by the methodology of unification in the global ISO standards 14000x - as art (LCA) Life Cycle Assessment - Life cycle assessment (ISO 14040 and ISO 14044) [3].

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 [4].

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 probably is 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 [5].

3. THE PACKAGING INDUSTRY

Over the past few years, production of plastic packaging has taken on a particularly dynamic character. The development of quantitative production of plastics has been accompanied by parallel changes in the development of quality and range, mainly in terms of individual packages.

The plastic packaging successfully competes with the other traditional packaging materials (sometimes even displacing them from the market - such as paper and cardboard, glass). The main drawback of plastic packaging is its non-biodegradability and the limited potential for recycling because of the variety of polymers (especially in the absence of selective waste collection). The largest share in the packaging industry is occupied by polyolefins, among them: polyethylene - PE, polypropylene-PP, and others: polyvinyl chloride - PVC, polyamide - PA, polystyrene - PS, polyethylene terephthalate - PET.

The value of packaging industry in Poland is still growing and is about (in euro currency) 7600 million (2013), 8130 million (2014) and 8620 million (2015) Of course, in the packaging industry as with any industry, the Polish market consists of manufacturers producing packaging based on plastics, but also based on paper and cardboard, glass, wood, metal and textiles. Due to the materials used, however, plastic packaging dominates production (37.3%), followed by paper and cardboard (32.7%), metal (12.2%), glass (11%), wood (6.6%) and textiles (0.2%) - for the year 2013. The forecast (2020) is as follow: plastics (39.3%), paper and cardboard (36.2%), metal (9.5%), glass (8.2%), wood (6.3%) and textiles (0.5%). [6]

The development of a dynamic packaging market has created a significant problem in ecological terms, associated with the management of packaging waste. In accordance with national regulation Article 3, paragraph 8 of the Act on Packaging and Packaging Waste of 13 June 2013, packaging waste is defined as all discarded packaging (withdrawn from re-use), which is waste within the meaning of the Waste Act (14 December 2012), except for waste generated in the process of packaging production.

As indicated by research conducted by the European Environment Agency (EEA), the increase in the amount of waste is now one of the most important environmental problems of the EU. The member states produce about 1.3 billion Mg of waste annually, of which 14% is communal waste. In 1995, the average European citizen produced about 460 kg of municipal waste; in 2004 this number increased to 520 kg per person, and it is expected that by 2020 it will reach 680 kg. Packaging waste accounts for around 50-60% of the volume of municipal waste, and its number increases proportionally to the increase in wealth and population of the EU, a continuation of current trends in consumption patterns. [7]

There are many different types of cartons, cups, tubes, bags, bottles, cans, jars, and so on. Bags constitute up to 60% of the European landfill. In Poland, the amount of packaging waste by weight of municipal waste is estimated at about 30% by weight and 50% volume [7], although some estimates say about 50% by weight and 70% by volume. Appropriate management of packaging waste is therefore a serious environmental problem within economic development, and requires more and more improved waste management systems. These systems apply to packaging waste collection, transport, recovery and recycling.

Mass produced and recycled packaging waste in Poland over the selected years is presented in **Table 1**. It can be seen that despite the technological advances in the field of packaging, consisting of, for example, significantly reducing packaging weight as a result of the requirement for enterprises to meet PN-EN 13428:2005 [8], in the projections for 2014 the weight of packaging waste is expected to increase to about 6910.17 thousand Mg in relation to previous years. By 2014 the dominant mass of packaging waste is paper and cardboard waste, glass, plastic, composite and metal packaging.

Table 1 Mass produced and recycled packaging waste in Poland over the selected years [7]

No	Material Type	Amount of packaging waste in Poland [thousand. Mg / yr]				
		2000	2004	2006	2010	2014
1.	Paper & Textiles	1226.47	1182.00	1729.91	2199.91	2989.55
2.	Glass	956.59	914.70	1205.57	1422.92	1743.10
3.	Plastic	473.54	663.30	656.89	828.78	1114.14
4.	Composite Materials	137.74	b. d.	194.28	247.06	335.74
5.	Sheet Steel	134.01	121.00	162.26	185.56	220.92
6.	Aluminium	39.11	47.00	46.89	53.26	62.84
7.	Wood & Natural Materials	488.00	485.00	399.64	418.32	443.88
8.	Total	3455.46	3413.00	4395.44	5355.81	6910.17

In the near future, innovations will become available such as printable RFID tags that provide warnings of changes in temperature and humidity levels that might affect the integrity of the product. Absorbers and emitters of natural occurring gaseous substances that prolong shelf life are already entering the market. In the future, biosensors that detect bacteria and viruses will pave the way to safeguard the quality and safety of food for consumers whilst further reducing food waste.

According to the UK's Advisory Committee on Packaging: [9]

- An unwrapped cucumber loses moisture and becomes dull and unsaleable within 3 days. Just 1.5 grams of plastic wrapping keeps it fresh for 14 days.
- Selling grapes in trays or bags has reduced in store waste of grapes by 20%. When buying a product, consumers like to see its appearance and to be sure it matches their expectations. Plastic packaging provides this transparency and helps reduce bruising and other potential damage caused when handling products such as strawberries.
- In-store wastage of new potatoes reduced from 3% when sold loose to less than 1% after specially designed bags were introduced.

Generally the relevance of the environmental impacts of packaging seem to be overestimated by far: Only 1.7 % of the total consumer carbon footprint is related to all domestic and commercial packaging materials used in the EU27+2. The use of plastic packaging is related to only 0.6 % of the average carbon footprint of the European consumer (the use benefits, which are at least 5 times higher than the production burden, are not included here). Only 1.5% of all oil and gas consumed in Europe is used as a raw material to produce plastic packaging whereas 90% of it is used for heating, transportation and energy generation. If food was packed using other materials than plastics, the related energy consumption would double and greenhouse gas emissions would nearly triple. This would also be accompanied by a 360% increase in the weight of the packaging.[10]

The plastics industry is committed to constantly reducing the amount of plastics used in its products without compromising performance and durability. Ten years ago, the average plastic packaging weight was 28 % higher than today and even more for some applications.

4. RECOVERY AND RECYCLING OF PLASTICS

Whilst overall consumption levels rose by 20% between 1999 and 2004, the total weight of plastic packaging consumed rose by 4%. This means that plastics help reduce the impact of a rapidly growing consumption. The character of the main findings (more energy demand & more GHG emissions when plastic packaging was substituted by other materials) is not changed by re-cycling scenarios. Current plastic recycling levels reduce life-cycle energy demand by 24 % and GHG emissions by 27 %. Even with no plastic recycling, plastic packaging would cause less GHG emissions than alternative materials. If plastic packaging was substituted by other materials [10]:

1) the respective packaging mass would on average increase by a factor 3.6
2) life-cycle energy demand would increase by a factor 2.2 or by 1,240 milion GJ per year, which is equivalent to 27 Mt of crude oil in106 VLCC tankers or comparable to 20 million heated homes
3) GHG emissions would increase by a factor 2.7 or by 61 million tonnes of CO2-equivalents per year, comparable to 21 million cars on the road or equivalent to the CO2-emissions of Denmark.

The directive of 9th March 2005 on packaging and packaging waste 2005/20/EC (Official Journal. L No. 70), replaced Directive 94/62/EC introduced in the Member States for the recovery and recycling of packaging waste. This obligation came in the wake of the requirements of the Directive entered into Polish legislation - in particular, the draft law on the management of packaging and packaging waste, which replaces the existing provisions of two laws: the Law of 11th May 2001 on packaging and packaging waste (OJ 2004. 011 097) and

the Act of 11 May 2001 on obligations of enterprises in the management of certain waste and on the production and disposal charges (consolidated text. OJ 2005.033.291). The draft new law takes into account the need for the economy to adjust packaging and packaging waste to meet the provisions of the Directive of 9 March 2005. - 2005/20/EC of the European Parliament and Council amending Directive 94/62/EC on packaging and packaging waste. Annex 1 of the project, in the Act of 27 May 2011, sets forth the level of recovery and recycling of packaging waste by 2014 - see **Table 2**. [7]

Table 2 Proposed levels of annual recovery and recycling of packaging waste from 2014 [7]

No.	Type of packaging, from which waste arises	2010 % level		From 2014 % level1)	
		recovery	recycling	recovery	recycling
1.	Packaging (together) (2)	min. 60	min. 38	min. 60	min. 55
2.	Plastic Packaging		min. 18		min. 22.5
3.	Aluminium Packaging		min. 45		min. 50
4.	Steel Packaging, including Sheet Steel		min. 35		min. 50
5.	Paper & Textile Packaging		min. 54		min. 60
6.	Recycled Glass packaging, excluding ampoules (1)		min. 49		min. 60
7.	Wood Packaging		min. 15		min. 15

1) does not apply to packaging materials in direct contact with medicinal products as laid down by the Pharmaceutical Law

In the field of plastic packaging, the previously discussed new law will introduce a recycling fee on plastic bags, which would take effect from 1 January 2015. The relatively long period of grace for the introduction of the fee is intended to create opportunities for manufacturers of plastic bags to change the production profile. The primary objective of the introduction of this fee (maximum level of 40 / gr per piece) is the reduction of plastic bags, of which Poland consumes about 6 billion per year. These bags are an extreme burden towaste segregation stations and waste in landfills and to the environment; they pollute ecosystems, and are a threat to animals (especially birds) - a significant reduction in their number is also an important activity of the social point of view. Revenues from the fees will be used by the Marshal offices to finance waste collection and recycling systems, and education in this field .

5. CONCLUSION

Plastics seems to be more and more important for our daily life and also for econymy. In the UK, plastic milk bottles currently contain up to 10% of recycled materials, and this share is expected to increase to 1/3 in the near future. According to the German federal environmental agency, new plastic carrier bags often contain up to 80% recycled material. Used plastics are also a very cost-effective and efficient way of providing heat and power in cities around Europe. Plastic packaging is essential for processing, storing, transporting, protecting and preserving products. Plastic packaging is not harmful to the environment if properly disposed of. Plastic packaging means more with less: less waste, less energy, less resources used, reduced cost and lower GHG emissions across the full life-cycle of the product. [9]

The need for action to effectively manage resources on an international scale was addressed during the Second World Summit on Sustainable Development (WSSD) in Johannesburg in 2002, where it was agreed that “protecting and managing the natural resource base for economic and social development are overriding objectives of sustainable development and also the essential requirements of it.” 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. [1].

This assumption has become an inspiration to undertake research on the use of natural resources in a sustainable manner, meaning not only ensuring long-term availability, but also taking into account the environmental effects of their use. At the same time, those effects should be analyzed in a full cycle of processing of resources (at all stages of the value chain) - from the extraction of raw materials and their use as a production factor, through to the processes of transformation in production, to consumption and followed by the logistics process of returning used goods in circulation in economic and / or environmental terms.

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