RESEARCH JOURNAL OF THE UNIVERSITY OF GDAŃSK

Transport Economics and Logistics Vol. 78 (2018)
http://dx.doi.org/10.26881/etil.2018.78.12

Ewa Puzio

Faculty of Management and Economics of Services, University of Szczecin, Poland

THE SIGNIFICANCE OF REVERSE LOGISTICS FOR THE WASTE MANAGEMENT SYSTEM

Abstract

The aim of the article is to present the issues of the waste management system supported by logistic activities. The main emphasis was laid on the role of the systemic approach in the waste flow management concept. The article presents theoretical foundations related to the concept of reverse logistics, defines the waste flow directions in the waste management system and discusses the waste disposal chain.

Keywords: reverse logistics, waste management, system, waste

Introduction

The issues related to waste management are playing an increasingly important role. It should be noted that this is not a new phenomenon. The growth in global consumption is associated with growth in the production of goods which results in an excessive increase in the amount of generated waste. In prehistoric times, nomads produced organic waste that was subject to a natural process of disposal. The remains became a problem when man had started to lead a sedentary lifestyle. The change in the structure, quantity and type of packaging materials used, negatively influenced the condition of the natural environment. The transformation of packaging gave rise to scientific deliberations concerning its partial biodegradation, with the purpose to eliminate factors posing a hazard to the environment and affecting the life of inhabitants of today's urbanized areas.

Review of the literature

According to the Waste Management Act of 14 December 2012 waste management means 'waste production and waste disposal', while waste disposal means 'collection, transport, waste processing, including monitoring of such activities, as well as subsequent procedures for waste neutralization sites and activities of the seller or agent trading in waste.' (Waste Management Act, 2012). According to the above definitions, waste management and waste disposal can be said not to be equivalent terms. The former is a broader concept covering waste and ways how proceed with it, while the latter is about the possibilities of dealing with waste after it has been produced. Waste management and waste disposal issues should be addressed by both theoreticians and practitioners.

Waste disposal is supported by logistics activities which has contributed to the emergence of the reverse logistics concept. This concept has been continuously evolving since the 1980s of the 20th century (Gajewska, Szkoda, 2016). Attempts to systematize this term were made by Szołtysek who has defined the reverse logistics as "all processes of management of waste and information flows, from the place of origin to the place of destination so as to recover its value or dispose of it appropriately and store it on a long-term basis in such a way that these flows should be economically efficient and minimize the negative impact of waste on the human environment" (Szołtysek, 2009). The above definition of reverse logistics shows efficient and effective disposal of waste which is followed by development of waste collection and waste storage systems.

The essence of a systemic approach to the waste management concept

The 'whole-systems thinking' principle, otherwise referred to as the systemic approach is one of the leading principles of the logistics philosophy. It originated from the systems theory, and the *General System Theory* was created by Ludwig von Bertalanffy. This theory allows formulating rules that apply to all systems. There are certain models and laws that can be used for general systems (Bertalanffy, 1984). The systemic approach assumes that activities in respect of the physical flow and storage of raw materials, semi-finished products and finished products in the enterprise should be considered as a whole, and not on a separate basis (Kochański, 2003). The application of the principles of a systemic approach in logistics leads to suboptimization of specific areas and determining their share in the process of rationalization of activities of a logistic system approached on a holistic basis (Blaik, 2010). It is for this reason that the basic object of interest is a system that is the key to understanding the systemic approach. Attempts to define the term *system* were made by Mynarski who has described it as a purposefully ordered set of components and relations between these components and their properties. Properties should be understood as the features of each object, while relations are defined as relationships between specific parts and the whole (Mynarski, 1979).

As far as the systemic approach is applied to waste management, it is the concept of reverse logistics (which is derived from the general concept of logistics) that should be explained, as it is this concept that determines the application of logistic principles to the waste disposal system through the existence of a specific logistic system.

There is no unambiguous term used to define the reverse logistics in the Polish literature. It is such terms as reverse, utilization, waste, reversed, recirculation, recovery, post-sale, downcycling, reuse logistics and ecologistics that are used interchangeably (Kisperska-Moroń, Krzyżaniak, 2009). The approaches applied in the context of understanding the reverse logistics are presented in Table 1.

Table 1. Approaches applied in the context of understanding the reverse logistics

Approach	Author	Definition
Conceptual and functional	Bendkowski, Wengierek	Reverse logistics means applying the logistics concept with respect to the remains so as to bring about an economically and ecologically effective flow of remains including at the same time the spatial and temporal transformation with a change in terms of sort and quantity.
Entity-based and structural	Gołembska	Logistics in the area of waste utilization consists in developing logistics chains linking places of waste production and waste utilization. This covers the following measures: waste sorting, waste transport and storage, waste processing and production of secondary raw materials.
Object-based structural and efficiency-based	Council of Logistics Management	Reverse logistics is a broad term referring to logistics management of skills and activities engaged in recycling, management and disposal of product waste and packaging waste. It covers inverse distribution which makes the flow of goods and information proceed in the direction opposite to the normal logistics operations.

Source: (own elaboration based on: Council of Logistics Management, 1993; Gołembska, 1999; Bendkowski, Wengierek, 2002)

When formulating the definitions of reverse logistics the Polish authors use the conceptual and functional approach where they present logistics as a concept for the management of flows of goods and information based on an integrated system. In the light of the presented definition, waste should be understood as remains. The economic objective is related to reducing the logistic costs and improving the service level of reverse logistics, while the ecological objective should be understood as putting emphasis on the environmental protection with particular emphasis laid on the natural resources and reducing emissions of harmful substances produced as a result of logistics processes.

The entity-based and structural approach is represented by Gołembska et al. according to whom reverse logistics is an integrated process of flows of goods and information.

Foreign authors, on the other hand, use the structural entity-based or efficiency-based approach understood as orientation towards increased efficiency and offering the desired level of logistics services to clients (Szołtysek, 2009).

The subject of reverse logistics are flows of waste and waste-related information. The activities taken are aimed at integrating the flows in time and space to maintain the natural environment in a proper condition while optimising the cost of these flows (Starostka-Patyk, 2016).

A systemic approach to waste management in the economy can be seen in considering the issue in a holistic way, as well as recognizing specific components of the system (subsystems), including explanation of their role and determining the relations between them. Issues related to waste production, utilization and disposal should be considered in a comprehensive way. Environmental, technological, economic and social issues constitute an integral whole (Gajdzik, 2009).

Referring to the systemic approach, a logistics waste disposal system which is often constructed according to functional areas should be identified (Gajdzik, 2009). The main components of the logistics waste management system are shown in Figure 1.

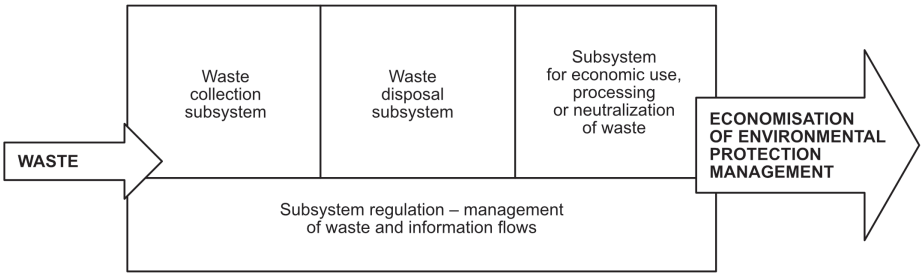

Figure 1. Logistics waste management system
Source: (Szołtysek, 2009)

Figure 1 shows that a logistics waste management system comprises a waste collection subsystem, a waste disposal subsystem, an economic waste utilisation, processing or disposal subsystem.

The system input component is waste, while the output components are: economic management and environmental protection. The logistics waste management system itself is a logistics subsystem of the entire enterprise in which there are interrelations between waste management and such processes as procurement, production and distribution. The directions of flows of generated waste are shown in Figure 2.

Figure 2. shows that products reaching the final consumer are produced as a result of successive technological processes, starting from the supply area, through the manufacturing and distribution areas, ending up with the service area. The recipient receives a small portion of unprocessed natural raw materials. Each phase of the process generates a different type and amount of waste.

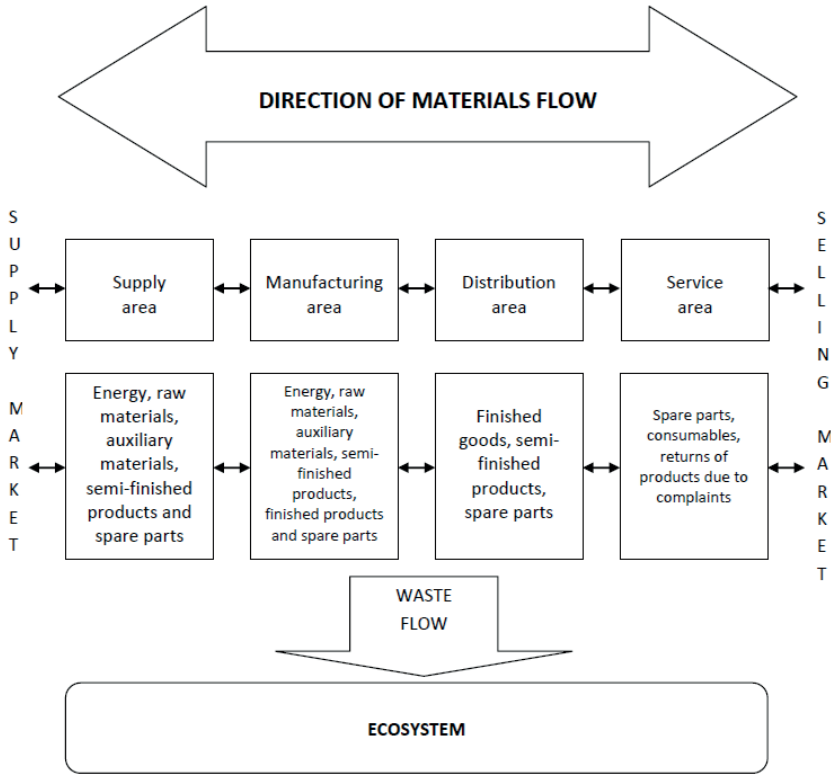

Figure 2. Directions of flows of generated waste
Source: (own elaboration based on: Kisiel, Zwolińska, Gara, 2011)

A logistics waste management system is at the same time one of the subsystems of the logistics system of an enterprise or another organizational unit. Flows of raw materials and waste cover all processes taking place in the enterprise, while the waste market creates residues produced within all the existing subsystems of the enterprise's logistics system, from the supply subsystem up to the subsystem of sales.

The following factors have impact on the functioning of the logistics waste management system (Korzeń, 1996):

1) Quantity, nature and spatial distribution of waste.
2) Regularity and dynamics of waste generation.
3) Binding environmental protection rules.
4) Spatial and urban planning factors.
5) Generally accepted assumptions and local requirements within the permissible loads of environmental components.
6) Strategies employed by supply chain entities.

The waste disposal system operational efficiency depends primarily on the way in which waste is collected, the size and location of the facilities and the adaptation of vehicles to the waste transport routes (Korzeń, 2001).

Reverse logistics and reverse supply chain as waste management components

If the supply chain in waste management is to be considered, the produced waste should be treated as a product that is transported in an efficient way from the place of production to the place of reuse or utilization.

A supply chain should mean a network of links between organizations, suppliers and customers wherein the goal is to develop products and services addressed to final consumers (Łupicka-Szudrowicz, 2004). Logistics provides waste management with solutions in the area of organization, information and technology, it also comprehensively affects the flow of materials whereby a supply chain is created as scheduled and it is referred to as the disposal chain in the waste management system (Przybycin, 2006).

The supply chain in waste management is made up by the following entities (Przybycin, 2006):

1) The resident of the municipality.
2) The waste collecting entity.
3) The waste sorting entity.
4) The landfill.

Having been sorted, the waste that does not go the landfill may undergo some other processing or may be used by third parties. The specific sequence of events in the disposal chain should be noted. Figure 3 shows a common configuration in the waste disposal chain.

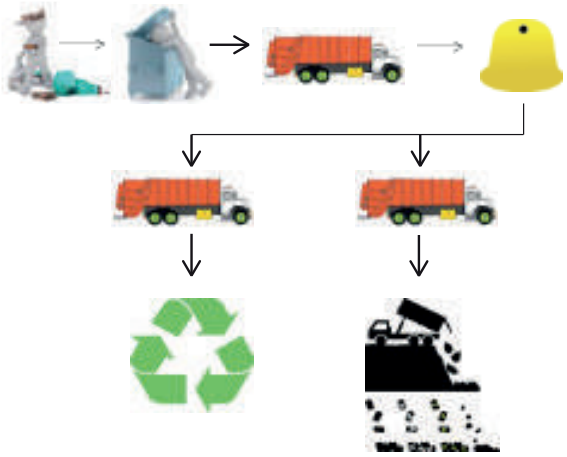

Figure 3. Example of a waste disposal chain
Source: (own elaboration)

Analysing Figure 3. it is possible to identify specific links in the supply chain. The waste produced by the resident is collected by specialized entities operating in the municipality from the place where it is produced. Then, the waste is transported to the place where mixed waste is sorted. Owing to this process it is possible to separate waste that can be used by third parties, therefore, this waste should be transported to places where it will be processed or reused as a raw material. Other waste that cannot be utilized, reused or recycled is transported to the landfill, which is the final link in this chain.

It should be emphasized that the waste is collected directly from the place where it is produced or from the curb. The most commonly used mode of transport for waste disposal is by road. The type of transport used depends largely on the type of containers and the waste collection system. It is also necessary to carefully plan the routes for vehicles collecting the waste which will translate into efficient municipal service and minimization of costs (Matulewski, Konecka, Wojciechowska, 2007). For larger distances, a transshipment station is required as direct transport by dustcarts is no longer profitable. While transhipment stations enjoy great popularity abroad, multimodal transport is rarely used in Poland (Korzeń, 2001).

The component which is a part of the logistics waste management system immediately after waste collection is the subsystem for economic reuse, processing or disposal of waste. The reuse of waste should be understood as the operation whereby "products or components that are non waste are used again for the same purpose for which they were conceived" (Directive 2008/98/EC). The reusable packaging which, in accordance with the applicable Community laws, must meet certain criteria regarding substances used for their production or appropriate labelling may serve as an example. The task of logistics is reduced to limiting the problems that occur in the model process for returnable packaging which can include the lack of detailed control of the condition of packaging, manual counting of packaging units and extended processing time which translates into higher costs (Directive 2008/98/EC). The recycling processes are the substance of reverse logistics.

Entities working together at specific stages aim at achieving the following benefits (Wengierek, 2009):

1) Unity of the existing research and technical capabilities, as well as reducing the research and development costs through participation in these costs.
2) Reaching a new group of customers followed by expansion into new markets.
3) Reaching a new group of customers existing on the already penetrated markets.
4) Extending the existing market by including new transport and logistics companies and new sales representatives.
5) Participation in the costs of distribution, promotion, advertising and transport with respect to the waste unit expressed in tonnes, kilograms, items.
6) Fewer problems and lower costs associated with obtaining waste from the place of its generation.
7) Growing financial potential in enterprises in the waste management system.

Logistic solutions in the waste management system and in the entire disposal chain allow optimizing the routes (setting the routes in such a way as to cover as few kilometres as possible within a defined period of time), use the loading capacity of vehicles for waste originating from sorted collection which is then

shipped to the transfer station, and select the appropriate containers to collect compacted mixed waste, to reduce the cost of transport and fully use the capacity of the containers (Przybycin, 2006).

Conclusions

The rationale for using logistic solutions in the waste management arises from the major logistics issues related to waste management. The area of interest in the waste disposal logistics covers the flows within which it is possible to restore the value from disposed products, and it is also possible to feed a new supply chain as part of the output. The waste disposal logistics is a much broader concept than waste management, which mainly involves waste processing and waste collection. The waste disposal logistics is focussed on processes related to waste management, collection systems, transport and disposal of waste, and particular attention is paid to ecological balances.

References

Bendkowski, J., Wengierek, M. (2002), *Logistyka odpadów*, t. 1, *Procesy logistyczne w gospodarce odpadami* [Waste Logistics, vol. 1, Logistics Processes in Waste Management], Publishing House of the Silesian University of Technology, Gliwice.

Bertalanffy, L. (1984), *General System Theory*, PWN, Warsaw.

Blaik, P. (2010), *Logistyka – koncepcja zintegrowanego zarządzania* [Logistics – Concept of Integrated Management], PWE, Warsaw.

European Parliament (2008), Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives. OJ L 312, 22.11.2008.

Gajdzik, B. (2009), Wprowadzenie do systemów logistycznych gospodarki odpadami w przedsiębiorstwach hutniczych [Introduction to Waste Management Logistics Systems in Metallurgical Enterprises], *Logistyka* [Logistics], 5.

Gajewska, T., Szkoda, M. (2016), Logistyka zwrotna jako nowoczesna forma gospodarowania odpadami [Reverse Logistics As a Modern Form of Waste Management], *Logistyka* [Logistics], 6.

Kisiel, P., Zwolińska, B., Gara, P. (2011), Systemowe podejście do problemu zagospodarowywania odpadów przemysłowych [Systemic Approach to the Issue of Industrial Waste Management], *Automatyka* [Automatics], 15(2).

Kisperska-Moroń, D., Krzyżaniak, S. (2009), *Logistyka* [Logistics], Institute of Logistics and Warehousing, Poznań.

Kochański, T. (2003), *Logistyka jako koncepcja zintegrowanego zarządzania* [Logistics As a Concept of Integrated Management], National Defence Academy, Warsaw.

Gołembska, E. (Ed.) (1999), *Kompendium wiedzy o logistyce* [Compendium of Knowledge on Logistics], PWN, Warsaw.

Korzeń, Z. (2001), *Ekologistyka* [Ecologistics], Institute of Logistics and Warehousing, Poznań.

Korzeń, Z. (1996), Logistyka recyrkulacji odpadów – istota i cele główne [Logistics of Waste Recirculation – Essence and Major Objectives], part 1, *Logistyka* [Logistics].

Łupicka-Szudrowicz, A. (2004), *Zintegrowany łańcuch dostaw w teorii i praktyce gospodarczej* [Integrated Supply Chain in Economic Theory and Practice], Publishing House of the University of Economics in Poznań.

Matulewski, M., Konecka, S., Fajfer, P., Wojciechowski, A. (2007), *Systemy Logistyczne* [Logistics Systems], Institute of Logistics and Warehousing, Poznań.

Mynarski, S. (1979), *Elementy teorii systemów i cybernetyki* [Elements of Systems Theory and Cybernetics], PWN, Warsaw.

Przybycin, W. (2006), Logistyczny system gospodarki stałymi odpadami komunalnymi [Logistic System of Municipal Solid Waste Management], *Recykling* [Recycling], 11.

Reuse and Recycling – Reverse Logistics Opportunities, Council of Logistics Management, (1993), Oak Brook, IL.

Starostka-Patyk, M. (2016), *Logistyka zwrotna produktów niepełnowartościowych w zarządzaniu przedsiębiorstwami produkcyjnymi* [Reverse Logistics of Defective Products in the Management of Manufacturing Enterprises], PWE, Warsaw.

Szołtysek, J. (2009), *Logistyka zwrotna* [Reverse Logistics], Institute of Logistics and Warehousing, Poznań.

Waste Act of 14 December 2012.

Wengierek, M. (2009), System logistyczny odpadów. Sfera regulacji. Marketing i aktywne kształtowanie rynku [Waste Logistics System. Regulatory Area. Marketing and Active Market Shaping], *Zeszyty Naukowe Politechniki Śląskiej,* seria: *Organizacja i Zarządzanie* [Research Bulletins of the Silesian University of Technology, series: Organization and Management], bull. 53, Gliwice.

Wengierek, M. (2011), System logistyczny odpadów. Sfera regulacji. Współpraca uczestników łańcucha dostaw [Waste Logistics System. Regulatory Area. Cooperation of Supply Chain Participants], *Zeszyty Naukowe Politechniki Śląskiej,* seria: *Organizacja i Zarządzanie* [Research Bulletins of the Silesian University of Technology, series: Organization and Management], bull. 53, Gliwice.

Corresponding author

Ewa Puzio can be contacted at: ewa.puzio@wzieu.pl