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THE LOGISTIC NETWORK OF UTILIZATION AND RECIRCULATION AND THE REVERSE LOGISTIC CHAIN

1. Introduction

Up till now the effective and efficient shaping of value creating processes has been a focal point of economic interest. Logistic processes, whose aim is to cater for the needs of purchasers in the best possible way, have been treated as the flow of material and information from the place where goods are created to the place of their consumption. Problems connected with utilizing and/or re-circulation of waste appearing in the spheres of supply, manufacture, distribution and consumption, despite being a natural component of logistic processes, have been treated in a marginal way.[1] However, they constitute part of the overall logistic process, which is becoming more and more important, not only as regards economic aspects, but also legal ones. The latter results, in particular, from instructions issued by the European Union and acts dealing with protection of the environment which are being introduced.[2] Problems connected with the liquidation of objects classified as waste, as well as waste and side-product recycling in order to obtain substances and materials for primary or other use, result from the difficulty of organizing the logistics of utilization and re-circulation [Wildemann, 1996, 311]. This follows from the necessity of considering the problem of waste disposal from a perspective outside the firm. In this context, promoting cooperation and

[1] The reasons for this should be seen in the fact that it was not until recently that either suitable legal regulations were introduced or economic justification to undertake activities of this kind existed.

[2] For instance, the Act on Manufacturers' Duties on Managing Certain Wastes of 11 May, 2001, and the Act on Production and Deposit Charges; also the Act on Waste of 27 April, 2001.

building a network of utilization and re-circulation appears the best solution. A steady growth of interest in network organizations has led to more and more companies seeing in them some real opportunities of obtaining an advantage over their competitors. Cooperation seems particularly significant when the cooperating companies do not themselves want to or do not have the possibility of re-using the waste produced [Kalusa and Blecker, 1996, 379]. Networks make it feasible for the production sector to internally liquidate waste without the need to make use of outside companies that deal with its utilization [Schwarz, 1994, 25].

2. Forms of cooperation between companies with the aim of utilizing and re-circulating waste

The literature on this subject mentions a number of organizational forms of utilizing and re-recirculation. Cases where there are two firms cooperating with each other are termed cells of utilization and recycling waste. Possibilities of cooperation between organizations include a spectrum ranging from informal collaboration up to purposeful cooperation in the field of recycling [Schwarz, 1997, 103]. Economic practice points to considerable benefits resulting from purposeful cooperation between participants in the market. On one hand, this manifests itself in a reduction in transaction costs, on the other hand – in possibilities for investment.[3] Legal contracts are a guarantee of greater certainty and stability in the utilization and processing of waste. It seems justified to many companies, whose material consumption is high, that they should not only build cooperation, but also co-participate in processes of exchange with companies from different sectors. This leads to so-called changeable structures of utilization and waste processing forming around sources of waste, where the waste producer is the only participant to know all the other members of the structure. A characteristic feature of such a structure is cooperation between companies that are not realizing any common strategic project. This cooperation only concerns the extent to which the waste is to be managed [Schwarz, 1997, 105]. A network of utilization and re-circulation of waste forms when there is purposeful, profit-oriented and ecology-oriented cooperation between many companies. In consequence, obtaining a competitive advantage requires taking into account the strategic aspects of effectiveness and operational efficiency. The basic aim of a network is to ensure the re-usability of waste and side products from one company as raw materials in another belonging to the network [Schwarz, 1997, 107]. The existence of

[3] Investment costs are, as a rule, so high that one company is not able to meet them.

a leader-company[4] in the network is a decisive factor in establishing a strategic network of re-circulation, which can be defined as a "long-term purposeful agreement between independent, yet uniformly profit-oriented organizations, which allow them to gain and maintain a competitive advantage" [Witkowski, 2005, 182]. One can also distinguish regional networks composed of small and medium-sized companies, which – due to their strong territorial concentration – resign from having a strategic leader [Kalusa and Blecker, 1998, 1103]. In the literature on the subject, network organizations, whose aim is to collect, utilize and recycle waste, are referred to as networks of re-circulation or utilization. According to Strebel and Schwarz [1997, 326] the following determine the establishment of a re-circulation network:

- mutual knowledge of all the participants in the network,
- knowledge of all material flows,
- existing agreements in the field of the re-usability of waste,
- appearance of a corporate identity within the system,
- formulation of common objectives,

Kalusa and Blecker [1998, 1103] suggest that satisfying all of these requirements is impossible in practice and propose using the term "network of utilization". In the present paper, we will use the term "re-circulation" in regard to the economic usage of waste and the term "utilization" – in regard to the ecological removal of remnants. Seeing that the objective of network organizations, as regards recycling, is to achieve positive effects of both an economic and ecological nature, we will use the most extensive term – a "network of utilization and re-circulation."

3. Logistic management in a network of utilization and re-circulation

Since the sphere of logistics is characterized by immanent system-oriented thinking, it forms – at the same time – a basis for considering ecological problems, irrespective of whether they appear at the entry or the exit stage in the company. Thanks to this, it is possible to make use of all the potential for technical improvement, as well as the economic shaping, of environmentally-friendly processes. This concerns – on one hand – all the functional spheres of the company; on the other hand – it is most clearly visible in the sphere of utilization and re-circulation [Stolzle, 1996, 5]. Thus, network integrated concepts of recycling are promoted by the economics of logistic circulation, which

[4] The dominant company which has the strongest influence on the functioning of the network.

is made use of in the flow of materials. Consequently, the efficient working of a network of utilization and re-circulation requires broadening the connections between participants in the reverse logistic chain of creating value to include the central elements of the liquidation and re-usage of waste [Kauf and Bruska, 2006, 258].

The logistics of utilization and re-circulation involves tasks that exert an ecological and economic influence on all spheres of logistics (supply, production, sales). This requires the very best use of potential and the development of economically viable and ecologically-oriented logistic systems. Companies which do not agree to bear the costs of ecological orientation often witness a conflict of goals between the ecological and economic shape of the concept of logistics. Within the framework of ecologically-oriented logistic systems, apart from planning and controlling the processes of transportation and storing – the identification of the type and amount of waste, as well as the place and time of its production is acquiring considerable significance [Blecker, 1994, 101]. The task for inner-company logistics, as regards the sphere of waste management – is to collect, store, segregate and distribute the waste produced in the process of manufacture and consumption [Schulte, 2000, 131]. Implementation of a reverse logistic chain requires forming cooperative links with other participants in the market, who could co-participate in the processes of utilizing and processing waste. One should count suppliers, manufacturers, trading agents and specialist companies dealing with utilization and re-processing as potential partners [Wildmann, 1996a, 311].

One can classify network organizations into vertical, diagonal and horizontal according to the direction of cooperation in the utilization and re-circulation network. Vertical networks are formed by cooperating companies within the same branch, yet at different levels of the chain of creating value. Diagonal networks are composed of companies from different branches at different levels of the chain of creating value. Horizontal networks are the result of cooperation between companies within the same branch at the same level of the chain of creating value [Götzelmann, 1994, 1111]. In this case, complete recycling of waste is not possible. The participants in a horizontal network should invest in specialist combustion installations which lower the costs of individual organizations. Such networks, as a rule, make it impossible to re-circulate waste. Re-usage of waste entails the necessity of its processing. This requires transformation processes and the elimination of space-time disproportions. The realization of these actions and processes is greatly hampered by various factors, including the place and time of waste production. Such a situation necessitates the minimization of the quantity of waste produced, which may be obtained thanks to the appropriate realization of ecologically-oriented logistic actions within a company, as well as the creation of logistic networks of utilization and re-circulation [Kauf and

Bruska, 2003, 262]. In consequence, it is necessary to apply a strategy which closes processes realized in linear structures or replaces linear structures with circulatory structures [Blecker, 1998, 106]. Closing linear structures, through recycling, should lead to the re-usage of waste raw materials. For technical, power engineering and economic reasons, the complete closure of such a system is impossible. The application of circulatory structures leads to the elimination of waste products. There are no new processes introduced into these structures, as the old ones are simply replaced. An example of this is using re-usable packages instead of disposable ones. The logistics of utilization and re-circulation differs from other logistic sub-systems as regards the following [Blecker, 1998, 108]: the type of products (waste as side products appearing in the sphere of production, consumption and transfer processes), the direction of the flow of products (opposite to the direction of supply flows), the targets (apart from basic economic objectives, ecological aims are becoming more and more significant).

Vital tasks of logistics in the sphere of waste management include: the evidencing, collection and segregation of waste, as well as the selection of containers to store waste. Collection and segregation are indispensable in the case where produced waste is processed in several firms within the network. Also, the choice of containers is dictated by the requirements of partner companies with respect to waste storage and/or re-usage. The use of an integrated, decentralized production planning system is an ideal solution in such situations. Such systems take reverse flows into account and facilitate the appropriate application of re-circulation instruments. One aim of a circulatory economy is the re-introduction of previously used raw materials into the chain and the basic task of the logistics of re-circulation is to form economically viable and ecologically friendly reverse flows (re-distribution). This goal can be achieved by lowering the quantity of waste and the optimization of recycling processes [Wildemann, 1997b, 243]. This requires active intervention at all levels of the chain of creating value and refers not only to a single company, but to all the organizations co-participating in this chain. It also requires, in a way analogous to the concepts of managing a chain of supply, the creation of a suitable system for the exchange of data and information [Wildemann, 1997b, 614].The logistics of utilization and re-circulation is based, as mentioned in the introduction, on legal regulations which impose the duties of re-using waste and waste reduction on companies. Procedures which avoid generating waste are thus preferred to procedures requiring its utilization and re-circulation [Schulte, 1999, 417]. In the case of a network, one ought to thoroughly analyze whether the "production" of waste can contribute to attaining profits (goals) of an economic and environmental nature, due to the possibility of its re-usage in partner companies (see Table 1).

Table 1. The economic and ecological aims of the logistics of utilization and re-circulation

Economic aims	– providing attractive services connected with utilization and re-circulation in the sense of time, timeliness and flexibility; – minimizing the general costs connected with utilization and re-circulation.
Ecological aims	– reduction in the use of natural resources (the entry stage); – reducing the levels of pollution emissions and imissions (the exit stage).

Source: Schulte [1999, 419].

4. The contribution of logistics and re-circulation to the realization of a reverse logistic chain

The configuration of a utilization and re-circulation network should be oriented at temporal, spatial and quantitative aspects of the production of waste and the suitable localization of treatment and recycling installations. The physical form of the logistic system determines the basis of the structure of the re-circulation system and possibilities of the logistic processes connected with it. This makes it necessary to take the following into account [Pfohl, 1994, 138; Ziems and Koschay, 1996, 34]:

– intensity of redistribution – regarding to the question of whether the sub-system created should only accept the waste produced within one network organization, or offer to receive a limited amount of waste of similar kinds

– degree of centralization
  • horizontal, which determines the number of places at which waste is collected and received,
  • vertical, referring to the number of repositories and dismantling stages,

– indirect or direct redistribution – concerning the form of waste in the period between its production and recycling, *e.g.* direct liquidation or liquidation interrupted by reloading, storage-related processes,

– the principles of "bring" – where the owner delivers the waste at least as far as to the place of its initial utilization, the principle of "hol" – comprising collection and transport of the waste by companies obliged to take it, or a mixture of the two systems [Stolze 1993, 188].

The removal of waste resulting from production, distribution and consumption requires the suitable coordination of activities and optimization of physical and information processes among all the members of the network, as well as the integration of all levels in the chain of production of value from manufacturers to target users. The economic use of synergic effects may be achieved, for example, in the processes of recycling by using the same means of transport, containers and agreeing on transport routes. One may classify

recycling according to the criteria of re-usage and preparation for re-circulation (see Table 2).

Table 2. Classification of forms of recycling

Re-circulation / Preparation for re-circulation	... within the area of initial use	... within a new area
No	Re-circulation	Further usage
Yes	Secondary processing of regained materials	Further usage of regained materials

Source: based on Meffert and Kirchgeorg [1989, 256].

Re-circulation refers to, for instance, the repeated usage of packages without requiring any recycling processes. Waste can also be used in a different way to its initial use, for example bio-degradable material can be composted. Secondary processing of regained materials refers to, for instance, the re-granulation of plastics or re-circulation of waste glass in the process of glass manufacture. Waste can provide secondary raw materials or be a source of energy. In consequence, it can be subjected to the process of material, chemical or thermal recycling. Further usage of waste and waste products refers to, for example, worn out tires, which can be still used in playgrounds, whereas further usage of regained materials concerns, for instance, waste paper that can be used to manufacture cardboard [Kauf and Rajchel, 2004, 172]. The biggest problem in the process of utilization and re-circulation arises in connection with materials which do not appear in nature, yet are more and more often used in a conscious or unconscious way. Such materials, as a rule, are not suitable to be re-processed and constitute burdensome waste, which should be liquidated in a direct manner (stored in a waste dump). Appropriate forms of the further usage of this kind of waste should be found.

One of the elements dealt with by the logistics of utilization and re-circulation is production waste – waste produced in the process of manufacture. The task to be accomplished by the system of recycling post-manufacture waste is to return it to the production process in a direct or indirect way (in the form of raw materials or energy). Re-circulation of waste requires taking into account the heterogeneous nature of recycling, as well as the quantitative and qualitative changes in the application of production factors, including the resulting gains [Corsten and Reiss, 1991, 618]. From the point of view of planning and controlling production processes, it is vital to select the place within the network which will be the most suitable for carrying out the recycling of production waste. Another aspect of the reverse logistic chain that aims to make use of waste as recycled resources, is taking such recycling into consideration while

planning and realizing tasks in the sphere of supply logistics. From the point of view of securing production flow and/or full use of the production capacity of recycling processes, the problem of the varying rate of waste production is of major importance. This results in the necessity to create storage reserves, whose optimization is possible due to use of integrated production planning systems providing extensive information on the level of production and the amount of waste produced. The supplies department should purchase raw materials that are easy to recycle. In order to do this, lists of pro-ecological raw materials should be made, which are used to assess the influence of production processes and logistics on the natural environment. In order to obtain positive economic effects, experience from the realization of recycling processes should be communicated to the departments concerned with construction and production planning. It is at this stage that decisions concerning the characteristics and properties of products, quality of raw materials used, as well as the production process, are taken. Thanks to the close cooperation between companies forming a network organization, utilization and re-circulation networks create a better framework for the exchange of information than companies that do not cooperate with one another. The considerations presented above enable us to conclude that the logistics of utilization and re-circulation determines, to a great extent, the shape of sub-logistic spheres and contributes to the economic and environmental shaping of recycling in business enterprises. If, from an economic, environmental or technological point of view, recycling is possible to implement, then the logistics of supply and redistribution constitutes a closed circle in the flow of materials and – as argued above – supports the development of a culture of recycling.

5. Conclusion

The steadily growing amount of waste, insufficient number of waste dumps, growing environmental awareness of purchasers, as well as stricter legal regulations on the protection of the environment, have led to a rise in the demands placed on manufacturers as regards the management of waste and unused raw materials. Moreover, companies are faced with the challenge of having to apply new technical and logistic solutions. Logistics, in essence its supra-functional and supra-organizational role, contributes considerably in the shaping of a chain of closed circulation (so-called logistic circulation), whose final link is the collection and preparation of waste for re-processing. These activities involve the temporal and spatial transformation, as well as the clearance, of waste. In recent years the importance of such actions has increased significantly. In the future, linear processes will be replaced by closed ones, as seen in ecosystems. Introducing a reverse logistic chain will enable the optimal use

and preservation of natural resources. In order to close the circulation cycle, the recycling of waste is of utmost importance. Thanks to recycling, waste can be returned to the production sphere. Individual companies, as a rule, do not have the potential to return all their produced waste to the production sphere, which forces them to enter cooperation with those capable of processing or utilizing waste. Cooperation between many companies leads to appearance of a network, which provides the greatest capacity for recycling the waste produced at each stage of the reverse logistic chain of creating value back into the production sphere. Improving the effectiveness and efficiency of the functioning of the utilization and re-circulation network requires integrated systems of production planning and control involving networks of companies. Similarly, the consistent realization of ecological management requires the appropriate use of knowledge of environmental issues in production planning systems. Moreover, systems of production planning and control should take into account problems of planning and dismantling. Summing up, it should be concluded that the form of an effective and efficient network organization which would support the development of reverse logistic chains, demands that solutions which are sub-optimal for individual companies are necessary, in order to achieve the optimal solution within the whole of the network. It is also necessary to work out the optimal strategic configuration of the network. At the same time, however, the goals of the whole network should override the aims of individual participants. Such a formulation of the aims may lead to short-term losses. Nevertheless, in the medium- and long-term perspective it will contribute to a rise in competitive potential. Guaranteeing an undisturbed flow of information requires, on the one hand, the complete participation of all the partners involved, together with the use of compatible systems, on the other hand – it is indispensable to guarantee the flexibility of information systems.

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