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## LOGISTIC TASKS IN THE FIELD OF RECYCLING AND SUSTAINABLE DEVELOPMENT

### 1. Introduction

The obligation to utilize used goods and products, which is being more and more often imposed by law, creates a new scope of problems that require many technical and logistic solutions [Balderjahn, 1994, 481]. Legal regulations force both manufacturing and trading companies to change their policy connected with, among other things, collecting the packaging they make use of, sorting it and recycling it. In consequence, this problem area that so far has been second-rank, has been coming to the forefront and the ecological aspect of the functioning of companies and the logistic system has ceased to be dealt with solely through the prism of costs.

Therefore, the aim of the present paper is to show the relation between logistic systems and the environment, with special attention paid to areas of production such as transport, storage, packaging and realising orders which potentially exert a negative influence on the environment. Furthermore, tasks and logistic principles that lead to a complete elimination or considerable reduction in the negative effects of the sphere of logistics on the environment will also be presented. In the final part, instances of activities undertaken by companies taking into account ecological goals in their logistic strategies will be discussed.

### 2. The ecological dimension of material management

The management of material supplies constitutes the basic sphere of company management directed towards protection of the environment.

The aim of pro-ecological material management is thus to purchase materials according to criteria of their soundness to the environment, not only according to the conventional criteria in the form of quality, service, price, or efficiency of delivery. If the problems pertaining to protection of the environment are already solved in the sphere of making purchases, then a considerable reduction in the costs of a company's activities may be attained.

The economic benefits that are found in the foundations of the Just-in-Time (JIT) concept in the sphere of purchase (reduction in stocks or manipulation costs) are becoming more and more strongly criticized, since they lead to the creation of a considerable burden on the natural environment [Schulte, 1995, 159; Hahn, 1990, 88 ff.]. The basic drawbacks of JIT include the following:

- purchase of materials according to needs, which causes the loads being shipped to be smaller, thus entailing a growth in the intensity of transporting movements (stocks maintained in the form of "stores on wheels");
- the occurrence of a greater number of journeys without a load;
- a shift to road transportation.

That is why it is necessary, in the sphere of logistics, to settle the dilemma: to allow a considerable rise in the pollution caused through a steady rise in the transportation movement yet, on the other hand, to improve the conditions of the functioning of a company, *e.g.* by making use of the possibilities of influencing the level of logistic services rendered in the given place of localization [Jeger, 1993, 36-7]. The basic possibilities available in the area of decreasing level of pollution caused by logistic services are comprised by the selection of environmentally-sound transport means, *e.g.* railway and water transport are more environmentally-sound than by air or road, as well as trying to achieve an increase in the effectiveness of logistic systems, which manifests itself in a decrease in the size of load being transported and frequency of movement [Pfohl et al., 1992, 43].

Despite all the objections mentioned above voiced in reference to JIT, the consistent realization of this concept in securing supplies leads, nonetheless, to a reduction in transport streams, since it means transporting only those materials which are actually in demand [Ihde, 1990, 160]. Due to manufacturing on order, which minimizes the risk of faulty prognoses, it is possible to avoid ordering more materials than required and the necessity of returning the surplus. Moreover, by transferring the control activity to the supplier, it also facilitates manufacturing a smaller amount of irrelevant elements [Schulte, 1995, 160]. Reduction in the burden on the environment may also consist in the optimisation of

the sizes of good streams in the sphere of purchasing supplies (e.g. the elimination of unnecessary journeys, or decreasing the load of materials to be transported) [Pfohl et al., 1992, 96 ff.]. A growth in effectiveness may simultaneously materialize in a reduction of costs.

An increase in the effectiveness of environmentally-sound supply logistics could be obtained through the co-ordination of particular partial logistic plans. These comprise localization plans, transportation courses and packaging.

### **3. Possibilities of shaping environmentally-sound logistic processes**

The rise in the ecological awareness of purchasers, as well as suitable changes in legal regulations, is influencing company policy to a greater and greater degree. On the one hand, it concerns materials and semi-finished products to be made use of during the process of manufacture, on the other hand it determines the policy connected with packaging [Pfohl et al., 1992, 43]. The ecological dimension thus contributes to broadening the range of the strategic analysis of the chain of values. The perspective of connections between individual participants of the chain of values becomes complete with central elements connected by utilization of waste and re-cycling. The ecological demands of the purchaser in reference to products offered to him underline the necessity of thinking in terms of complex optimisation. Ecological problems thus confront the sphere of logistics, bringing about the following challenges [Diruf, 1994, 72]:

- an increase in the number of markets covered by rendering services within the sphere of the logistics of the management of waste;
- a rise in political pressure on the development of ecological systems of packaging and transportation;
- a growing threat to the quality of service and cost effectiveness of previously used logistic networks, in particular within the scope of city-logistics and other crucial transportation processes.

The aim of logistic actions oriented towards environmental protection is shaping companies' systems of supply and distribution as they need to take into account not only criteria such as the quality, service, price and effectiveness of supplies, but also the impact on the natural environment. Environmentally-sound products exert a significant influence on the purchaser's readiness to buy products and services offered to them. At the same time the readiness to purchase such goods should be assessed as steadily growing. This means that environmentally-sound logistic services raise the customers' loyalty to a brand. The readiness to

purchase is dependent, however, on the purchaser's acceptance of higher prices or lower quality of environmentally-sound services.

It can thus be acknowledged, that the structure of logistic goals ought to be enriched by the economic aims of reverse logistics (e.g. recycling), which comprise the following [Schulte, 1999, 419]:

- a guarantee to the purchaser of attractive services connected with reverse logistics in the sense of punctuality and flexibility, and also
- minimising the costs connected with reverse logistics.

It should be added here that one of the ecological aims of a logistics system regarding input consists primarily in a reduction in the use of natural resources, while output should enable, adequately to legal requirements, shaping the effects of the emission of pollutants which are formed during the realization of reverse logistic processes.

Due to the problems mentioned above, it can be said that the tasks of reverse logistics are based on traditional areas, that is on logistics in the sphere of supply, production and distribution, including both transportation, reverse logistics, storing and information flows, which accompany material flows and are connected with realizing orders.

This aspect of environmental protection ought to be taken into account both during construction and maintenance of storage facilities. In reference to making use of storage areas, the decisions concerning the company's choice of internal means of transport or fork-lift trucks should take into consideration the burden on the natural environment resulting from their functioning. Considerations concerning the localization of warehouses are linked very closely to the question of transportation, if localization is treated as a transportation problem [Schulte, 1999, 94]. Specific features of a given localization, e.g. the presence of railway routes or waterways, provide a number of possibilities of changing the transportation carriers. Apart from this, while choosing a localization, one should take into account the manner in which large concentrations of population and housing estates in urbanized areas may be relieved or in what way, through removing congestion, it is possible to reduce contamination of the natural environment. Decisions in the sphere of warehouse maintenance are also dependent on the method of preparing materials and products. Here, we can differentiate between three basic forms of preparation:

- individual supply at the moment of the occurrence of demand;
- supply from storage: in this case along with a rise in the number of warehouses, the amount of capital involved rises. Each warehouse aims at carrying out its function, which is guarantee supply. At the same time, there may be a threat that the supply which is not in demand anymore may become waste;

– supply conforming to the requirements of production: in this case companies undertake attempts to function without keeping stocks. This is carried out by supplying smaller and smaller quantities of materials in shorter intervals, provided there are suitable spatial and infrastructural conditions. Such activities lead, however, to a greater consumption of energy and a produce greater burden on the environment [Jeger, 1993, 36].

Methods of detailed identification of supply within a policy of maintaining stocks create the possibility of avoiding excessive stocks, hence avoiding the unnecessary engagement of capital and lowering the emission of pollutants, as well as creating less waste.

Among the damage done to the natural environment by logistic activities, we should particularly mention the damage caused by transportation activities, which can affect the environment in two ways:

- at input – demand for energy in communication;
- at output – damage caused by the emission of pollutants and by means of transport.

Indirect pollution of the environment is a result of noise and accidents. In addition, use is made of resources designed to maintain the transportation infrastructure and means of transport [Kalusa and Pasckert, 1994, 108]. Ecological logistic action is hence characterized by a tendency to minimise the burden on the natural environment. One of the possibilities here is, as already mentioned, changing the means of transport. It follows from the assumption that various means of transport pollute the natural environment to a differing degree and that the overall burden per transport unit may be reduced by changing means of transport. Such a change may be obtained by a shift of transportation to means that are more environmentally-sound. Apart from this, attempts at lowering the level of transportation streams can be undertaken by forming more effective logistics systems. This can be achieved by relieving means of transport, which manifests itself in connecting transportation processes or journeys by the company's fleet that do not render any services, but which are indispensable for their realization [Pfohl, 1992, 96]. Liquidation of transport flows is supported by, *e.g.* an improvement in the efficiency of transportation, still it is necessary to avoid area of high intensity of transportation activity and peak hours [Kirsch, 1972, 492 ff].

Packaging is discussed in the aspect of transforming it into waste by the user. The share of packaging in rubbish per household amounts to about 35% of the total weight, which, in turn, makes up about 50% of the volume [Pfohl et al., 1992, 99]. The basic cause of the formation of such an amount of waste is the fact that packaging does not only carry

out logistic functions, but also promotional ones within the marketing activity. Also within this scope, we can enumerate a series of actions which can contribute to a reduction in the amount of waste, as follows:

- avoiding unnecessary packaging;
- creating packaging for repeated usage;
- making use of materials which are easy to utilize and designed for recycling.

The function of packaging within the sphere of logistics is, among other things, to form logistic units [Pfohl, 1990, 149 ff.]. In such a system it seems purposeful to make use of packaging which is adjusted to the requirements of the logistic concept and which realizes the functions of this concept along the whole logistic chain (with the assumption that pro-ecological action is included in the logistic aims). In this way logistics may contribute to a reduction of waste from packaging.

In turn, realization of orders contributes to satisfying the qualitative, quantitative and temporal requirements in reference to the preparation of the necessary information that accompanies and also follows the processes of goods flow. The aim of preparing information is the mutual adjustment of all the actions in the logistic chain [Ibid., 78–9]. Thanks to that aims related to environmental protection can also be realized, if, for instance, it is possible to avoid a situation in which products turn bad before the set time for their consumption ends through appropriate use of information. This mainly concerns food products with a short shelf-life, *e.g.* vegetables and fruit. In this way carrying out orders responsibly can contribute to the minimisation of created waste.

The considerations above point to the fact that in the sphere of logistics, there is great potential for improving environmental protection.

The potential of success mentioned above can be made use of thanks to a profound analysis of the motives of pro-ecological purchase, as well as shaping buyers' preferences [Marburger Verbraucher Studie, 1995, 146]. In other words it means that mal-informed purchasers should be better informed, customers with limited expectations regarding the usability of products ought to be convinced, while customers characterized by a weak readiness to purchase – motivated. However, in reference to current purchasers, there ought to be endeavours undertaken to retain their loyalty. In addition, it is impossible to “sell” the arguments connected with environmental protection without an ecologically-oriented re-engineering of the offer, including the logistic structures. The greatest competitive benefits will be obtained by those companies, which participate in the chain of the creation of value – from the supplier to recycling – introducing innovation and modernization of existing, products including their ecological aspects.

#### 4. Ecologically-oriented logistic strategies

Formulating pro-ecological logistic strategies is connected with the long-term direction set for management of individual organization units towards environmental protection. In particular the following question arises: in what way can, through getting involved in environmental protection, potential for success be made use of and as such contribute to obtaining a long-term advantage regarding company's competitiveness [Meffert, 1994, 246]. Setting requirements for shaping products, packaging and ecological processes is very popular today, due to the rising ecological consciousness of the purchaser. The characteristics of a product referred to as 'environmentally-friendly' more and more often influence a decision of purchase of both products and services.

Logistics belongs to the functions of the company related to environmental protection through the elimination and reduction of pollution [Pfohl, 1995, 10]. Although logistics puts considerable burden on the environment,<sup>1</sup> it still also offers a vital source of innovative ecological solutions, which open the possibilities of gaining new developing markets at the same time. Because the actions mentioned above, such as transportation, storing, reloading of goods or packaging, exert a direct influence on the natural environment [Göpfert, 1996, 56], it is necessary to formulate logistic strategies that contribute to both lowering the burden on the natural environment and rendering indispensable logistic services.

Strategies which contribute to the development of innovative solutions of an environmentally-sound character, may be divided into ones in terms of content, form and behavior towards the offer (see Fig. 1).

The essence of the dimension of the 'ecological opportunities and dangers' of functioning in the market and the dimension of 'burdens and threats to the environment' posed by the company, conditions the manner of proceeding, which can be aggressively innovative or, initially – rather defensive [Göpfert, 1996, 56].

Decisions connected with the choice of the moment to enter a market with ecological logistic services do not differ from ones related to the introduction of other innovations. This also refers to the course of life cycle and strategic alternatives which follow from it. A rise in the significance of ecological aspects causes the classical market spheres of logistics to change. One may require, for instance, the replaceability of means of transport by multi-modal transportation models and a combination of re-

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<sup>1</sup>Industrial and trading companies estimate that the ecological effect of logistic activities is equal to that of production and is even more significant in comparison with the functions of purchasing and organization [Göpfert et al., 1994, 80].

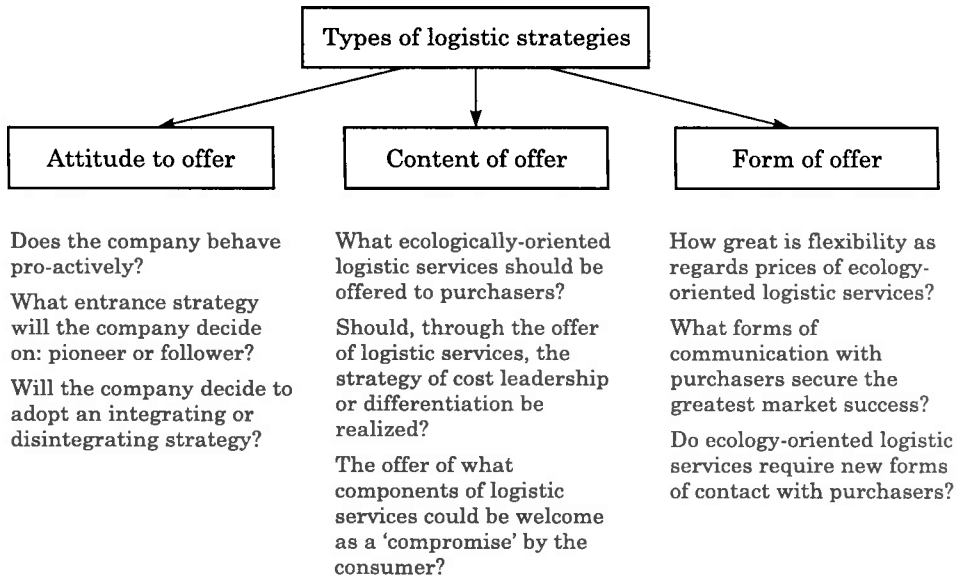


Fig. 1. Systematics of ecological logistic strategies

Source: Based on Göpfert [1996, 55].

verse and purchase logistic services [Zöllner, 1990, 47 ff.]. This concerns both physical logistic services within the sphere of transportation (environmentally-sound means of transport making use of modern technologies lowering the level of pollution and noise, vehicles equipped with catalytic converters, transport of especially hazardous waste, reliability of shipment), within the sphere of packaging (the concept of avoiding or minimising packaging through its standardization, choice of packaging materials, using package designed to be used several times, recycling), as well as within the sphere of the logistics of utilization (organization of systems of accumulating products and packaging destined for utilization or recycling, and also preparation of bins for collecting waste) [Göpfert, 1996, 56]. The strategic area of the forms of offers covers, in particular, decisions connected with communication and pricing policy. However, the classical instruments also comprise logistic services of ecological nature.

Therefore the adequacy of environmental logistic solutions determines classical components of a service, such as: readiness, effectiveness, ability and flexibility of deliveries, readiness on the part of the purchaser to purchase, as well as the actual behaviour of the purchaser. With regard to the components mentioned above, a the general set of instruments may be also applied in the process of planning an offer on the part of ser-



vice-providers to ecologically-oriented companies [Göpfert and Wehbers, 1994, 70]. It can then be possible to state that the ecological orientation of logistics contributes to creating new opportunities of entering the market. The ecological problem area may thus intensify or pacify competition or influence the strength of suppliers and purchasers in an auction [Meffert, 1994, 339 ff.]

## 5. The strategic options of reverse logistics

The effectiveness of ecology-oriented logistic strategies is dependent, in particular, on the scope of the use of potential, which results from the realization of differentiation or cost leadership [Göpfert and Wehberg, 1994, 82]. In order to achieve this, it is necessary to have a highly specified strategy, which takes into account both aspects of the service connected with recycling as well as the physical and organizational structure of reverse logistics [Stölze, 1996, 33]. The notion of reverse logistic services can be presented on the basis of '6w' orientation towards the logistics of supply. According to this principle, reverse logistics should deliver appropriate waste of the appropriate quantity and type at the appropriate time, to the appropriate destination and in the appropriate condition [Pfohl and Stölze, 1993, 573]. On the basis of supply services particular elements of reverse logistic services, such as time, exactness, availability and flexibility can be defined.

The significance of reverse logistic services as a secondary product of manufacturing and trading companies is dependent on the waste material designed for recycling, its owner and producer, time and spatial capacity, as well as on the situation in competitors' market [Zems and Koschay, 1996, 34]. If reverse logistic services assume an equal position to supply services in future, then it will also constitute a crucial element of the marketing mix.

By analogy to supply service, a differentiation may be made between services and servicing within the sphere of reverse logistics. This differentiation will enable both better satisfaction of the needs and demands of purchasers and savings as regards costs.

The differentiation between the time in reverse logistics and its exactitude is purposeful, due to an external orientation aimed outside the firm (*e.g.* inclusion of trading companies into the logistic chain), since it contributes to storing individual amounts of production waste. The time and place of recycling, at least according to such an external orientation, may be equated to the time and exactness of supplying deliveries. The availability of recycling comprises, on the other hand, apart from waste, exactness and reliability of the processes connected with recycling

[Stölze, 1993, 184]. Flexibility, as a component of the service, thus concerns the flexibility of actions within reverse logistics, realized within the system of rendering services [Vogel, 1993, 168]. On the one hand, we understand by this the ability to satisfy the rapidly changing requirements of supply, on the other – a decrease in the amount of waste.

Cost reduction potential can be realized through a conscious departure from the realization of reverse logistic services. As a rule, stopping such a service is an act contributing to differentiation, which may become oriented at given groups of purchasers, regions or temporal structures of creating waste.

The tasks of reverse logistics in the plant comprise collecting, sorting, transporting, recycling, as well as storing waste [Balderjahn, 1994, 489].

A logistic system directed at waste recycling serves the needs of the realization of a reverse logistic strategy. The configuration of this system should be oriented at temporal, spatial and quantitative aspects of the formation of waste, as well as towards the localization of utilizing and recycling installations. Due to the fact that the physical shape of a logistic system determines the bases of the structure of reverse logistics and recycling abilities connected with it, it is indispensable for the proper course of individual logistic processes to take into account, in the aspect of the strategy of competitiveness realised, the following decisions connected with collecting used goods [Pfohl, 1994, 138; Zems and Koschay, 1996, 34]:

– intensity of redistribution – requires answering the question of whether the logistic sub-system of recycling created should accept just its own waste or should offer collecting a limited amount of other waste of a similar type;

– degree of centralization, with two problem areas to be differentiated as follows:

- horizontal centralization, determining the number of sites for admission and storage of waste;
- vertical centralization referring to the number of warehouses and stages of dismantling;
- indirect or direct redistribution, this aspect considers problems connected with the form of waste appearing at the place of recycling, *e.g.* direct liquidation or interrupted by processes of reloading or ones of storage;
- making use of the principle of 'bring', 'hol' or a mixed system. The 'hol' system means that collecting and transporting waste is a task for companies which are obliged to dispose of waste, the one of 'bring', on the other hand, has the owner, acting out of his

own initiative, dispose of waste at least to the place of its initial utilization [Stölze, 1993, 188].

## 7. Conclusion

The considerations presented above imply that the main interest area of logistics is improving actions and activities connected with the circulation of goods at different stages of processing in an economy. Striving for better results in logistic activity may lead, however, to restricting the problem of the effectiveness of logistics to looking for optimal costs and level of the servicing flows rendered. In consequence, there appears to be a risk of neglecting the question of logistics which influences ecology. Without going deeply into an analysis of the current degree of threats to the balance (or a lack of such) in the natural environment, attention must be paid to the fact that logistic activity may additionally contribute to destabilizing it. At the same time hazards resulting from continuing logistic activity (particularly in the sphere of transport) are minimised through suitably designing logistic systems and also by accepting pro-ecological principles for the functioning of these systems.

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