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ECOLOGICALLY RELATED TRANSFORMATION OF THE LOGISTICS THEORY: DIRECTIONS AND CONTENT

Abstract

In the context of sustainable development, the need to improve the models of functioning and development of society, as well as the scientific knowledge underlying them is urgent. In particular, an ecologically oriented improvement of logistics science is needed to ensure the full use of its tools to resolve the modern socio-ecological and economic problems of resource use. In this regard, it is important to identify the directions and content of the ecologically related transformation of theoretical and methodological foundations of logistics, which is the purpose of this article.

The paper outlines the main directions of logistic theory change in the context of the sustainable development paradigm. These changes embrace the improvement of the methodological basis of logistic science on the ground of provisions of ecological economics, environmental ethics, and principles of industrial ecology, etc. As a result, modern logistic management goals and objectives include environmental and social targets, and wider interpretation of material flow allows to manage the waste, emissions, secondary materials, and flaw components. The improvement of a methodical framework of logistic decision-making is associated with the environmentally adjusted calculation and analysis of total costs, proceeding from the assessment of environmental aspects of flow processes through the use of material flows analysis and life cycle assessment tools. Thus, the conceptual provisions of logistics may be used to solve various tasks in the context of sustainable development, in particular: to minimize the negative environmental impact of certain production process, enterprise, network (supply chain), as well as to form the regulatory framework for the promotion of eco-industrial parks.

Keywords logistics, green logistics, logistic management, sustainable development, logistic concept, logistic theory

JEL Classification Q01, M40

INTRODUCTION

Sustainable development paradigm defines the goals and objectives of society's development from the standpoint of the triunity of social, ecological, and economic aspects of social life. It determines the need for the corresponding improvement of models of society's functioning and development, and the scientific knowledge underlying them as well. In its modern sense, logistics is interpreted as a science of management of complex flows in networks rather than simply as a narrow functional area concerning transportation and inventory management issues. This allows both to ensure economic effectiveness of resources movement in the socio-economic system and to consider logistics as an element of a system of scientific disciplines aimed at the achievement of sustainable development goals. In view of this, an ecologically related improvement of theoretical and methodological foundations of logistics is urgent to ensure full use of logistic methods to resolve the existing complex problems.

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1. THEORETICAL BASIS

The modern way towards SD Goals is associated with the implementation of "circular" economy models, based on the principles of ecological economics, industrial ecology, etc. The keynote of the "circular" economy concept is integrated management of complex material and energy flows in networks, which is aimed at reducing the environmental burden in an industrial system through closing resource (material and energy) cycles (Korhonen et al., 2017; Mishenin & Koblianska 2017). In this context, logistics gains special attention as a scientific discipline focused on the study and regulation of material flows in a socio-economic system. It is precisely the supply chain, as a model of organization of economic actors' interaction based on the logistic principles, which is the form of the practical implementation of industrial ecology ideas. This forms prerequisites for the successful development of eco-industrial parks, where environmental goals of functioning and development of companies' network are important (Seuring, 2004; Sarkis, 2012; Mishenin et al., 2018). Freeman (1995) notes that logistics forms the basis for taking into account the "voice of Nature" in industrial processes in case of environmental aspects that are seen among the problematic issues constituting the scope of the discipline. The logistics concept also provides the solution for resource saving problems, in particular, ensures the efficient management of by-products and waste flows within the framework of reverse and recycling logistics (Stock, 1998; Rogers & Tibben-Lembke, 2001; Sarkis, 2012). Recent studies focus on organizational issues of creation and development of the "green", "environmental", "sustainable" supply chain (Seuring, 2004; Sachan & Datta, 2005; Jayaraman et al., 2007; Sarkis, 2012; Leigh & Li, 2015; Zhang & Wang, 2015). Given the above, there is a need for detailed scientific analysis and assessment of change of logistics knowledge in the context of SD paradigm. Specifically, the purpose of the article is to identify the directions of an ecologically related transformation of the fundamentals of logistics and their content as well.

2. RESULTS

First of all, one should note that logistics has evolved from a simple analytical discipline, focused mainly on transportation and inventory management problems to the comprehensive and normative philosophy of flow management (Møller, 1995; Malindžák, 2015), which explores strategic, organizational and behavioral aspects of complex networks' functioning (Møller, 1995; Klaus, 2009; Delfmann et al., 2010). Logistics is a science that studies the issues of formation, dynamics, and control of integrated flows in networks and thus contributes to the strengthening of "wealth of nations" (Klaus, 2009).

In general, the logistic approach proceeds from the systemic nature of logistic processes (Novack, 1992) and presupposes their effective coordination within logistic systems and chains. Logistics is interdisciplinary in its sense (Møller, 1995; Klaus, 2009; Brzozowska et al., 2016), its methodology rests on general systems theory, cybernetics, modeling, and forecasting of economic processes, etc. (Malindžák, 2015). The logistic approach provides a transition from the management of individual functions related to the formation and maintenance of logistic flows to the management of a set of such functions (Mishenin et al., 2013). The specific features of management activities based on the logistic approach transform it into logistic management. Specifically, it is the "flow thinking", which is the basis of logistics as a scientific discipline (Stentoft & Halldorson, 2002; Sachan, 2005; Malindžák, 2015; Mishenin et al., 2015). As such, logistics examines the flows of materials, information, finances, and services along the vertically and horizontally organized value chains (supply chains) and aims to coordinate these flows from a holistic point of view (i.e. single goal) (Sachan, 2005). Traditionally, logistic flow is a controlled movement of a substance (material) between the cooperating elements (i.e. machines, operations, people, workplaces, etc.), which integrates them into a single process of supply – storage – production – sale – distribution with the formation of system, chain or network. It is supported by related information and finances (Malindžák, 2015). However, the modern understanding of logistics expands the range of logistic flows, covering the human flows and intangible substances, such as knowledge (Klaus, 2009). The flow vision of economic processes functioning shifts the focus on the management of inter-organizational issues and relations and makes necessary to study the logistic form of organization (system, chain, network) as a single entity (Sachan, 2005). The purpose of logistics is a holistic optimiza-

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tion of flow process based on the minimum of total logistic costs, as a rule. At the same time, there are other criteria to use, in particular: the maximum of capacity utilization or profit, the minimum of production cycle time (Malindžák, 2015). Thus, logistics is viewed as an applied science of strategy, tactics, and the art of system integration and resource management (with regard to natural, human, physical and functional resources), ensuring optimal operations within the production system (Freeman, 1995).

Logistics immanently links to the sustainable development concept. In particular, issues of material flows' regulation and management constitute the problem aspect of modern research in the field of sustainable development due to the fact that an increase of material flows is the root cause of many modern environmental and social problems (Fiksel, 2006). In this view logistics serves as a tool to achieve SD Goals, providing the optimization of human, information, matter and energy flows and increasing the economic efficiency of the use of resources, including natural ones (Brzozowska et al., 2016). In turn, the implementation of sustainable development principles within the framework of logistics leads to the formation of "sustainable" logistics (Brzozowska et al., 2016; Wichaisri & Sopadang, 2017), which is aimed also at minimization of the negative environmental impact and improvement of the quality of human life (Brzozowska et al., 2016). The integration of the principles and ideas of the "lean" concept and logistics leads to the formation of "sustainable lean logistics" (Wichaisri & Sopadang, 2017) providing the elimination of all operations that do not add value (in terms of economic, environmental and social value). It contributes to the achievement of long-term effects in the process of organization of resources' movement, in particular, the reduction of the use of natural resources and cost, and the rational use of labor as well (Wichaisri & Sopadang, 2017). The consideration of environmental goals within the framework of logistic management practice leads to the formation of "green" logistics management systems. This constitutes the main trend of the XXI century in the development of logistics (Zhang & Wang, 2015), and embraces the corresponding "green" transformation both of individual logistic operations (transportation, packaging, production processes) and of the logistic management process as a whole through the articulation of resource conservation and nature protection objectives (Zhang & Wang, 2015).

Given the above, one should note that sustainable development paradigm induces the ecologically related improvement of logistics theory (Figure 1).

Commenting on the data presented in Figure 1, it should be pointed out first and foremost that SD paradigm determines the ecologically related transformation of methodological basis of logistics. As Zhang and Wang (2015) point out, the provisions of ecological economics and environmental ethics should be seen among the main guidelines underlying the modern logistics theory (Zhang & Wang, 2015). Alongside this, the principles of industrial ecology and industrial symbiosis as subdisciplines within the framework of ecological economics (Kronenberg, 2006) compile the content of "green" (Sarkis, 2012) and "environmentally sustainable" (Leigh & Li, 2015) supply chain management concept.

Ecological economics and environmental ethics background induce the transformation of the goal and objectives of logistic structures functioning and development. In the context of sustainable development, logistic management should focus not only on the satisfaction of private economic interests of business entities, but also at ensuring of resource conservation and environmental safety (Zhang & Wang, 2015). Moreover, the economic, environmental and social objectives should be considered as equally significant for different logistic structures at all levels of the hierarchy (Delfmann et al., 2010).

The above determines the transformation of the object of logistic management, associated with the extended interpretation of the range and composition of logistic flows. This is important as the understanding of logistic flows content affects the way they are perceived and managed (Sarkis, 2012). In this case, there is noted the extension of the range of logistic flows, in particular, by considering flows of service, knowledge, and waste among the objects of green supply chain management (Sarkis, 2012). In addition, each type of flows is transformed too, covering new elements, essential in view of the SD concept.

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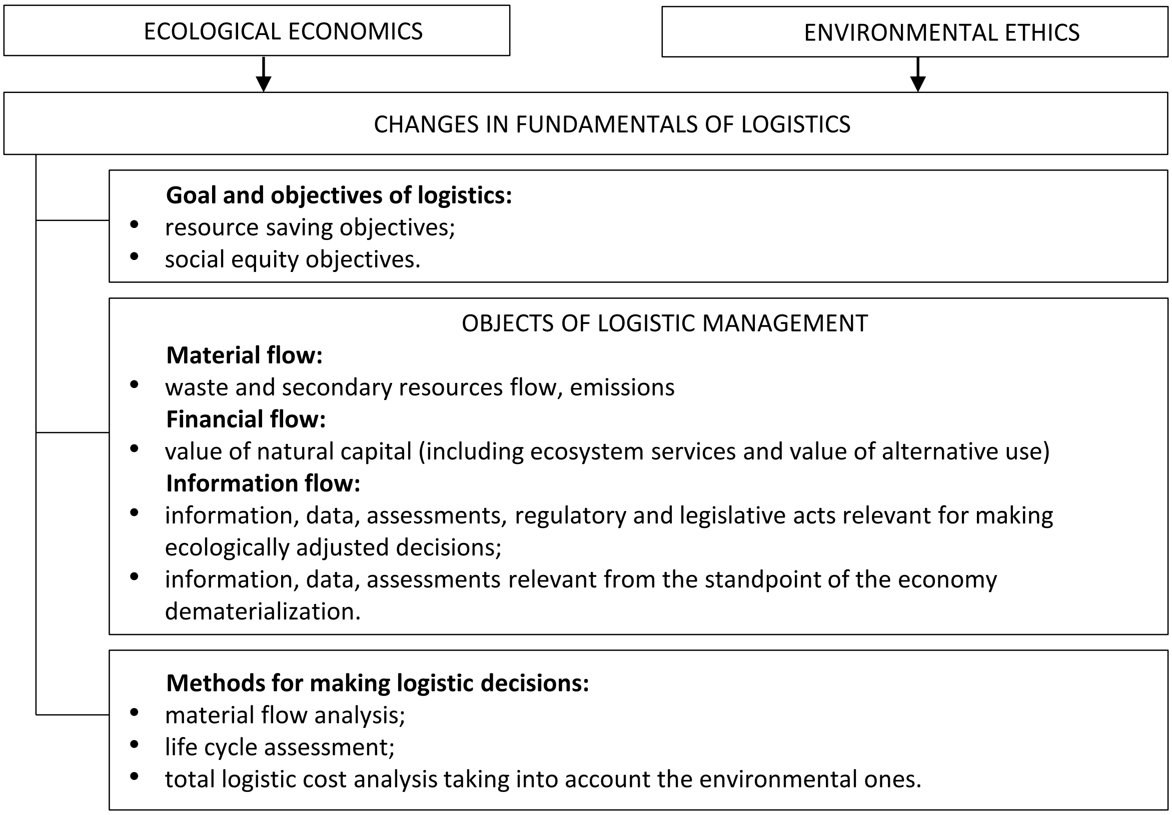

Figure 1. Directions and content of ecologically related transformation of logistics knowledge

An extended interpretation of material flow lies, primarily, in the consideration of waste and secondary materials as elements of its composition (Stock, 1998; Rogers & Tibben-Lembke, 2001). It is also advisable to include flaw, gas and energy emissions, and wastewater generated in production processes (Mishenin at al., 2013). These elements can serve as the basis for establishment and facilitation of industrial symbiosis cooperation. The expediency of such an approach is demonstrated in the example of Kalundburg (Ehrenfeld, 2000), where the complex use of resources provides the reduction of the environmental burden of industrial production and consumption. Consideration of flaw, secondary material resources, waste, and pollutants' emissions as essential elements of material flow composition causes the transformation of views on the logistic system, in particular, its structure and functions, which is associated with the formation of new functional areas of logistic management. For example, reverse logistics focuses on the planning, organization, and control of flows of raw materials, work in progress, goods and related information moved from the consumer to the primary source in order to ensure effective value restoration or, at least, proper waste disposal (Rogers & Tibben-Lembke, 2001). Reverse logistics embraces all logistic activities on the way from used products to the source of their reuse and is a key functional area of logistics in the SD context (Sarkis, 2012). Concerning the financial flow extension, one should note the importance of taking into account the real value of natural capital (Sarkis, 2012). However, this is currently quite problematic due to the lack of a unified approach to its assessment. The significance of ecologically related improvement of information flows is twofold. On the one hand, the information flow ensures the implementation of the logistic management mechanism, integrating all its parts. In this context, the environmental legislation, the level of R&D and technology development, the sufficiency of environmentally targeted funding, as well as the level of environmental culture of business structures and society are important for planning, analysis, control, and regulation of logistic flows in the field of environmental protection and management. Consequently, information logistic flow should include the input environmental information, as well as internal information significant for making environmentally adjusted logistic decisions (Mishenin at al., 2013). On the other hand, information flows can, to a certain extent, replace material flow, thus helping to reduce the environmental destructive impact of industrial operations and functions (Sarkis, 2012) and contributing to the dematerialization of public production.

The transformation of the methodical framework for logistic decision-making is primarily associated with the use of environmental life cycle assessment tools and material flows analysis (MFA) (Sarkis, 2012). The MFA is one of the recent methods for the assessment of environmental aspects of supply chain functioning and development (Sarkis, 2012). Life cycle assessment has been already used for more than half a century for logistic cost calculation and analysis (Freeman, 1995). However, currently, the environmental LCA gains special attention (Seuring, 2004; Quariguasi Frota Neto et al., 2006; Sarkis, 2012) as a tool allowing to identify sources of environmental destruction along the entire product cycle or supply chain. That forms the basis for another important direction of ecologically oriented improvement of the methodical framework of logistics, that is the need to take into account various costs and benefits associated with environmental practices (i.e. waste management, pollution control, and prevention) while calculating and analyzing of total logistic costs (Seuring, 2004; Sarkis, 2012). In this case, it is important to make allowance for the effects of resource exhaustion, emissions, and waste generation (Jayaraman et al., 2007). Quariguasi Frota Neto et al. (2006) demonstrate the necessity and expediency of such an approach. The scientists use an integrated approach, that simultaneously optimizes the costs and environmental impact of the logistic network functioning. This allows making optimal strategic and operational decisions regarding the structure and location of the logistic system both in terms of costs and nature protection (Quariguasi Frota Neto et al., 2006). System projection of total, environmentally adjusted logistic costs may also serve as a component of the decision-making system concerning the development of eco-industrial parks (Freeman, 1995).

CONCLUSION

In the context of sustainable development paradigm, the ecologically related improvement of logistics knowledge takes place, in particular, concerning the methodological basis of logistic theory, goals of logistic management and its objects, as well as methods used for decision-making. The influence of ecological economics and environmental ethics stipulates the change of the goal of logistic management with regard to a set of socio-ecological and economic objectives of resource use. This determines the need for a wider interpretation of logistic objects. In particular, waste flows, secondary materials, flaw, by-products, emissions are considered important components of material flow. Ecologically related data become of prime importance for the management of logistic activities, as well as for material flow replacement, contributing to the economy dematerialization. The wider interpretation of financial flow lies in the need to take into account the natural capital value as possible. There is also needed the transformation of a methodical framework for making logistic decisions compliant with SD principles. This lies in the use of material flow analysis and environmental life cycle assessment, as well as environmentally adjusted calculation and analysis of total logistic costs.

The ecologically improved logistics theory may be used to solve various tasks, in particular: to minimize the negative environmental impact of certain production process, enterprise, network (supply chain), and to form the regulatory framework for the promotion of eco-industrial parks as well. The latter can be seen as a regional logistic system with an optimal flow structure, found on the base of a minimum of total public costs associated with the resource flow. In this context, further research in this field should involve studies of methodical approaches to the assessment of the real value of natural capital with regard to its socio-ecological significance, and the use of these estimates for the logistic flows regulation.

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