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Modeling of value flows in logistics networks. Comparison of basic tools

1. Introduction

In the era of free flow of goods and services, an increasingly important role is played by related entities not only institutionally or industry, but as participants operating on markets, unlimited in space and defined as a network. It appeared a need to modify the approach to the concept of logistics as a "servant" for the core functions of the organization. It also appeared due to in-depth analyzes of the logistic processes themselves, which along with the spreading freedom of material flows are becoming more and more complex. Production processes can be preceded not only by the stage of obtaining raw materials, but often also by the stages of product design and market research. Effective implementation of business ventures therefore requires the involvement of diverse partners and the use of flexible, insightful systems for the analysis of the value creation process. At the same time, the mere interpretation of the concept of value becomes a complex task. Traditionally, the level of transaction costs was one key criterion in the process of creating value in inter-organizational arrangements. This criterion being the basis of the existing analytical systems is not a clear determinant

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of value at present and increasingly the concept of appropriation of value is mentioned (Hurmelinna-Laukkanen, Puumalainen 2007). In addition, the value considered in traditional analytical models based on the value chain is limited to current financial values, which bypasses various aspects of the process of creating future value, e.g. by means of knowledge flows. The third reason for the dysfunctionality of the traditional approach is the fact that during the interaction analysis only the one-way linear approach is considered, omitting the influence of these interactions on the value generated by the entire business system (Daaboul et al. 2014). This situation has led to the necessity of introducing new analytical tools enabling a modern look at the value creation process in logistics networks. The purpose of this article is the critical analysis of these analytical tools. This analysis was carried out on the basis of peer-reviewed scientific studies on the tools under investigation.

2. The essence of logistic networks

When considering the group of facilities running a business, the term "network" is most often used for groups of entities identified by connections resulting from the same type of activity, e.g. commercial networks, transport networks, etc. (Krawczyk 2011, p. 59).

According to J. Brillman (2003), a network can be defined as a set of points in the structure of communication between divisions, either as a set of resources (infrastructure network) and rules (infostucture), enabling entities that have access to them, undertaking joint projects, as long as these measures are appropriate to their needs and are suitable for sharing (infoculture) through this network. The logistic network concept can be understood as meaning a group of independent competing and cooperating companies to improve the efficiency and effectiveness of the flow of products and accompanying information in accordance with the expectations of customers (Witkowski 2003, pp. 20-21).

Participants in logistics networks are entities not only producing the final product, but all those that are in any way involved in the process of delivering the product to the end user. Material flows in production networks are usually carried out from the level of many different enterprises (including service companies) to that which produces the final product. In the case of distribution networks, the situation is quite the opposite, as flows are realized from the level of one enterprise (producer) to many recipients.

Increasingly, in the logistics that is interdisciplinary, the wording reserved so far for concepts in the area of technical sciences appears. Both in the first

and in the second case, flows can be carried out in one or several stages. A significant difference between the analyzed networks refers to the fact that in the production network, raw material streams are transformed into product streams, whereas in distribution networks only the product streams should be referred to. In both cases, services of a more or less material nature may appear. In a situation where flows in the network are intangible, and the final value for the customer is the result of amalgamation of tangible and intangible assets and their transformation into a higher value; the problem becomes even more complex. The very identification of the process of creating value and material flows as well as intangible streams is a research challenge. An additional, it is necessary to determine the flow directions and their role in the processes of creating a new utility value.

Until recently, the logistics partnership was only described using the model proposed by M. Porter based on the so-called "Multi-cell technology" (Stabell, Fjeldstad, 1998). Under this approach, in each phase of the process (production or sale), the value is "superstructured". The implementation of individual phases by various entities creates from them business partners, often of a strategic nature. Relations between entities in the process of value creation can take various forms and have various characteristics (e.g. durability, trust level etc.), they can also contribute in various ways to creating and maintaining a competitive advantage of entities (Ahamed, Skallerud 2013). The development of management sciences in the direction of the network approach made it possible to analyze the process of value creation in a more complex way than just as a simple value chain. This results in the adaptation of traditional analytical tools adequate for a specific way of "chain thinking", and not necessarily adequate in the context of incorporating inter-organizational networks into the analysis, even if the subject of the analysis is the relations of logistic connections (Peppard, Rylander 2006).

3. The value analysis of logistic networks in the traditional approach

One of the basic problems that arise when designing analytical systems in the field of value analysis is the problem of determining the value category. The term 'value' is usually ambiguous; even within a given field and in the case of management science is a methodological challenge. According to J. Daaboul and her colleagues, "Even though researchers agree that focusing on value generation is necessary to compete nowadays, they do not fully agree on a definition of value" (Daaboul et al. 2014, p. 5003), however, these authors

pointed to some methodological assumptions that slightly order the network approaches in the analysis of the value creation process. These assumptions include:

- focus on customer value and subjective perception of it by customers, which prevents the seller from defining it objectively,
- considering the value as a result of exchange (both economic and social), which results in the multicenter approach being inadequate as it is limited only to economic transactions,
- the need to define a category of values for each involved page.

In addition, these authors have noted that value is a concept that can be applied to many criteria (value is treated differently by economists, and differently by representatives of marketing or sociologists). It is also determined by the moment of assessment (e.g. the moment of purchase of the product or the moment when the product is used). According to the authors, „Even though value has different points of view, its creation is not achieved by one party" (Daaboul et al. 2014, p. 5004). Traditional analytical systems point to the party producing the value and the party that consumes it in a definite, unambiguous way. The creation of value consists in the superimposition of utility value through specific parties (participants of the process). The contemporary approach to the concept of value creation is perceived as a more complex phenomenon. The value "emerges" in interactions by integrating resources provided by individual actors, which makes the analytics of the value creation process a complex process. To explain this process; the traditional approach will be analyzed: a value chain that is naturally suitable for analyzing the value process in network logistic systems. The approach proposed by M.E. Porter, which is based on the concept of the value chain, is still one of the most widespread in the analysis process of value creation in the entire economy, especially in logistics systems. Logistic circuits the author refers to all relational systems between partners involved in the implementation (including coordination) of matter flow streams (Porter 1990). The existence of many advantages of this approach, above all the readability, logic of the value creation process, the uniqueness of efficiency criteria and others, has led to such a widespread use that currently many representatives of science treat it as the only way of analyzing the value of all business models "luring" only about its modification (Kaplinsky, Morris 2002). The values of the logistic chain concept as the basis for the analysis of the value creation process are not questioned, and are only subject to modification to other, often complex, business processes.

Due to the above-mentioned arguments, for some time in the scientific literature and business practice the concepts of analytical tools have been described, considering the network nature of the modern process of value creation, based on mediation technology, which describe the interaction of various entities in the process of creating a new value for clients a bit more accurately (Stabell, Fjeldstad 1998). This applies to both analytical models and models that enable the design of business systems between partners, considering the criterion of value. Examples of business layout and flow analysis tools in the logistics network are e3-value modeling, c3-value modeling framework, Value Network AnalysisTM, SimulValor, Modified SimulValor, and tools based on the RIVANS concept. In the following, these models will be subject to a broader analysis.

4. Modern tools for modeling value flows in the logistics network

The modeling of value flows in the business network, including the logistics network, is based on specific elements to which they most often belong (Daaboul et al. 2014, p. 5004):

- activities and processes as key elements of value creation,
- resources, access to which determines the efficiency of the network (so-called performance) and the level of generated value,
- flows of values between partners (both material and non-material),
- organization of partners' relations in the network and configuration of the network system,
- decisions and their impact on activities, processes and partners,
- value: both for a specific party receiving benefits and the mutual impact of values on individual partners.

Table 1. provides a comparison of basic models.

Table 1. The evaluation of basic models

Model	Authors	Basic elements	Value	Limitations
e3-value	Daaboul et al. 2014, Weigand et al. 2007, Gordijn & Akkermans 2003, Gordijn et al. 2000.	Actor, Value Object, Value Port, Value Interface, Value Activities, Market Segment (Exchange Object).	It is built around the notion of value networks, which extends the process modelling.	It answers for the question „What?", but does not answer the for question „Why?"

c3-value	Daaboul et al. 2014, Biem, Caswell 2008, Weigand et al. 2007.	Actor, Value Objects (basic and complementary), Value Port, Value Interface, Value Activities, Exchange Objects (including information).	The introduction of information as a type of exchange object.	Interdependencies resulting from the global economy and underlying the network approach are neglected.
Value Network Analysis	Allee 2009, Daaboul et al. 2014, Biem & Caswell 2008.	Participant, Transactions, Exchanges, Benefits.	The introduction of intangible value flows. Assumption that value network is a continuously changing system that reproduces itself.	Assumption on the unmanageability of the network, focus on exchanges without assigning a purpose to the network (lack of systemic approach).
SimulValor	Elhamdi 2005, Daaboul et al. 2012	Physical flow, Intangible flow, Stock, Activity (transformation), Relation between the values Input flow/ value of an outflow, Relationship of equality between the value flows, Causal influence, Causal structure of the industrial system.	It uses system dynamics, causality and the structure of industrial system.	Complexity and time consuming.
Modified SimulValor	Elhamdi 2005, Daaboul et al. 2013.	Physical flow/ Intangible flow, Stock, Activity (transformation), Relation between the values Input flow/ value of an outflow, Relationship of equality between the value flows, Causal influence, Causal structure of the industrial system, Partner and Resource allocations.	Separation of information flows and material flows. Introduction of new elements: Partner and Resource allocations.	Complexity and time consuming

RIVANS	Anvuur et al. 2011.	The purpose of social exchange, The meaning of values, Network management (price, trust, power and relativity), Network efficiency (environmental, economic and social).	This approach combines perspectives: social, economic and environmental and relational.	It focuses more on strategic flows than on operational performance. There is a need to develop analytic tools which includes systemic economic factors (as recession).

Source: own elaboration

These models include elements such as: identification of partners, interdependencies, risks, costs and roles of activities in the process of creating value (amplification, conversion, etc.). In the modeling process, specific types of language are used. Most often these are: CIMOSA, IDEF (IDEF0, IDEF1x, IDEF3), BPMN, UML, SYSML, GRAI (GRAI Grid, GRAI nets), VSM. Of these languages, GRAI and CIMOSA correspond best with the ISO 19440 standard (Daaboul et al. 2014, p. 5004).

The e3-value model focuses on the identification and analysis of how value is created, exchanged and consumed in a network consisting of many actors. The authors of the method assumptions are J. Gordijn and J.M. Akkermans and J.C. Vliet Van. The basic elements used in this approach are (Gordijn et al. 2000, pp. 40-51):

- identification of the Actor, i.e. an entity possessing economic independence (company, organization or person),
- identification of the Value Object, which represents what is exchanged between the actors (product, service, cash, etc.),
- setting the Value Port, that is the medium (medium or carrier), by means of which the value is exchanged constituting the connection point between the actor and the outside world,
- definition of the Value Interface, or a group of value ports associated in a specific way,
- identification of the Actions - performed by the actor motivated by the desire to obtain certain benefits,
- identification of the Market Segment (Value Exchange)- combining (clustering) of the actors who in a balanced way assign the economic value to the object.

The e3-value model is focused on e-business models run by the Internet, along the logistics chain (conducting sales operations), but also enables the introduction of additional services by the partners. It answers for the question "What?", but does not answer for the question "Why?" (Weigand et al., 2007).

The c3-value modeling framework approach - is an extension of the e3-value model. The basic element of this extension is the introduction of information as a type of exchange object. Within the framework of value objects, two basic types are distinguished: basic value objects and complementary objects, and only the latter can be intangible. In this approach, first of all, such parties as: a direct competitor and a direct client are analyzed, while interdependencies resulting from the global economy and underlying the network approach are neglected or neglected (Biem, Caswell 2008).

Value Network Analysis™ is an analytical system highlighting the following elements (Allee 2009, 2000):

- participant representing a human or group of people (which brings this tool closer to the analysis of social networks),
- (one-way) transactions, which mean the transfer of benefits provided by one participant to another, one-way,
- exchanges (two-way transactions) that are carriers of value,
- the benefits provided can be material (goods, services and income) or intangible (e.g. knowledge or other benefit.

The basic assumption in the value network concept is the lack of network management capabilities, which may limit the strategic analysis (Biem and Caswell 2008). This assumption is debatable and more and more often the so-called network orchestration (Dhanaraj, Parkhe 2006), which forces a different analytical perspective. The second characteristics which limits the model is its focus on exchanges without assigning a purpose to the network (Biem and Caswell 2008).

The answer to the objections to the VN assumptions is to a certain extent the Model (Daaboul et al. 2012, Daaboul et al. 2010). This tool can be particularly suitable for the analysis of logistics networks, as it enables decisions such as the selection of suppliers, the selection of locations for particular utilities and others. In this model, a platform based on SD assumptions (dynamics system) is used. This model, as the object of interest, first and foremost takes on the value of the created and the impact of performance of individual partners on its level. During the analysis of the value creation process, qualitative and quantitative variables as well as their impact on the "performance" of individual activities in the process are used.

This makes it possible to analyze strategic decisions in the context of mutual influence of variables and time delays. The main elements of the model are (Daaboul et al. 2012, Daaboul et al. 2010):

- material flow, which determines the circulation of materials of a specific type (raw materials, semi-finished products, etc.),
- a stock that represents the accumulation of a certain number of material units of a given type,
- transformation block that represents the action,
- a coefficient that reflects the relationship between the values of two flows,
- balancing of receipts and expenses of value,
- a specific approach to the analysis of variables and their cause-and-effect relationships,
- information as an intangible asset whose emergence affects the exchange process, but at the same time it does not take the form of a stock (which results from the theory of knowledge and information management).

The modified SimulValor model, developed by J.A. Daaboul and her colleagues in 2010, involves modifying the SimulValor basic model. The main model modifications include (Daaboul 2010):

- separation of information flows and material flows,
- introduction of new elements to SimulValor language: symbol A (representing partner) and symbol R (representing resource allocations).

A slightly different approach is presented by the authors of the RIVANS concept ("relationally integrated value networks") built on the basis of experience in the field of management in the construction industry (Anvuur et al. 2011). This approach combines three perspectives: social, economic and environmental and relational. This concept takes into account both the multi-cell approach and many aspects of knowledge management. The full concept consists of four elements (Anvuur et al 2011):

- the purpose of social exchange (taking into account also the aspects of economic exchange),
- the meaning of values - the identification of employees in the goals of the organization expressed in terms of values,
- network management (this element includes aspects such as price, trust, power and relativity),
- network efficiency (effectiveness): environmental, economic and social efficiency (so-called well-being).

The RIVANS concept is not only the basis for the design of the analytical system, but also the basis for shaping the style of strategic management.

Through a multi-dimensional approach to values and taking into account values for stakeholders of different categories (e.g. by including environmental values), it is one of the most modern approaches today. There are two major limitations of this model. The first is its focus more on strategic flows than on operational performance. The second is lack of analytics which includes systemic economic factors (as recession).

5. Conclusion

Network models that allow an analysis of the value creation process are not without flaws. The main limitations are: not sufficient explanation of the process of value creation, neglecting important systemic interdependencies, lack of systemic approach, often complexity and time consuming and in some cases emphasizing strategic issues without taking current issues into account.

The other limitation is the omission of important elements of co-opting systems dominating in network systems. With the exception of individual voices (e.g. Shin et al. 2013, Bhattacharyya and G. 2011, Linden et al. 2009), the material presented by various authors is missing a proposal for analyzing the process of interception of value together with extremely important aspects of the appropriation regimes regarding long-term subsistence competitive advantage by individual partners in logistics networks (Hurmelinna-Laukkanen, Puumalainen 2007). In addition, the problem of bargaining power is most often overlooked (with the exception of, for example, Roson and Hubert 2015) which is one of the important elements of the market analysis under coopetition. This situation may result from the unclear reference to theoretical approaches because the discussed approach involves two main and competing perspectives of strategic management: competition in situ, along with the problem of appropriation and bargaining power, and value exchange in terms of the network, which largely derives from resource approach. Therefore, there is a need to develop analytical tools that enable both the analysis of the value creation process and the ability to maintain a competitive advantage by individual partners in the network.

Summary

Modeling of value flows in logistics networks

The article presents the necessity of introducing modern systems for analyzing value flows in modern logistics networks. The essence of logistic networks and requirements for analytical systems have been presented. The main available approaches

to analyzing value flows in the network have been identified: e3-value modeling, c3-value modeling framework, Value Network Analysis™, SimulValor, Modified SimulValor. These approaches (called models) were subjected to a critical analysis on the basis of which the basic directions of their development were indicated.

Keywords: ***logistic networks, value flows, value networks.***

Streszczenie

Modelowanie przepływów wartości w sieciach logistycznych
W artykule przedstawiono konieczność wprowadzania nowoczesnych systemów analizy przepływów wartości we współczesnych sieciach logistycznych. Przedstawiona została istota sieci logistycznych i wymogi stawiane systemom analitycznym. Zidentyfikowano główne dostępne podejścia do analizy przepływów wartości w sieci: e3-value modeling, c3-value modelling framework, Value Network AnalysisTM, SimulValor, Modified SimulValor. Podejścia te (zwane modelami) zostały poddane krytycznej analizie na podstawie której zostały wskazane podstawowe kierunki ich rozwoju.

Słowa kluczowe: **sieci** *logistyczne, przepływy wartości, sieci wartości***.**

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