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DEVELOPMENT OF AUTOMOBILE DISTRIBUTION NETWORKS ON THE BASIS OF MULTI-CRITERIA EVALUATION OF DISTRIBUTION CHANNELS

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Abstract. The days when a buyer was forced to choose from what is being offered have passed. These days, buyers demand a product that would answer their exclusive expectations at a time of their preference and at an acceptable price. Therefore, manufacturers aiming to survive the competition battle have to rethink their operation strategies. Special importance is attached to the process of development and reconstruction of supply chains, and the process which may feature particularities, depending on the branch of industry. Automobile manufacturing is the biggest the fastest industry developing across the globe. New automobiles are listed as luxury commodities and are, therefore, subjected to very strict requirements with regard to various logistic operations and technologies, which are vital for ensuring efficient automobile delivery to the final users. Due to the growing demand for brand-new automobiles and the distance to the user, automobile manufacturers are constantly searching for solutions to the development and support of an efficient distribution network. Strategy shaping of distribution network requires evaluation of a number of criteria, which influence the distribution system. The article analyzes the development of automobile distribution networks on the basis of multi-criteria evaluation of distribution channels.

Keywords: distribution channel, multi-criteria evaluation, automobile market, supply chain, strategic solution.

1. Introduction

Europe has exclusively large automobile production capacities (Fig. 1), accounting for 34.6% of new automobiles in global output each year (The Automobile Industry… 2010). More than 16 million new automobiles are sold in Europe per year. The extremely high demand for automobiles in Europe and the rest of the world requires more than development of technological innovations – it calls for new solutions that would help to ensure the safe and unimpeded provision for markets with automobiles. Heavy traffic is one of the most important problems these days. The objective of clearing the road network is achieved by the way of reducing the transport flows on roads, shifting them to the railway or sea transport. Initiated by the European Union (EU) to improve the capacity for the road network, the project of the trans-European road network TEN-T, intermodal transport promotion program Marco Polo and Motorways of the Sea are used for reducing traffic congestion, pollution and car accidents rate on the roads. These projects are a part of various instruments used to achieve objectives.

The European Union's policy diminishes restrictions upon free movement of commodities. Instruments, such as creation of the Schengen visa-free zone and lifting the restrictions on coasting haulage, facilitate the carrying of cargo by the road transport. Nevertheless, in order to ensure cohesive interaction of cargo transport systems, it is vital to bear in mind that the instruments listed above add an appeal to road transport, as opposed to other types of traffic, which lose attractiveness due to the more complex technological process of haulage. Furthermore, increasingly fierce competition of road transport leads to a deficit of cargo, thus disturbing the import-export balance. This leads to idle time, under shipment and empty mileage, which causes a general loss of operations, energy, environment, etc. Therefore, certain measures are necessary to help all the parties concerned (particularly, service providers or manufacturers) to reach the desired efficiency level of operations and cut costs. The logistics science suggests that this can be done with the help of management of the supply chain and the development of distribution channels built on successful application of the management scheme.

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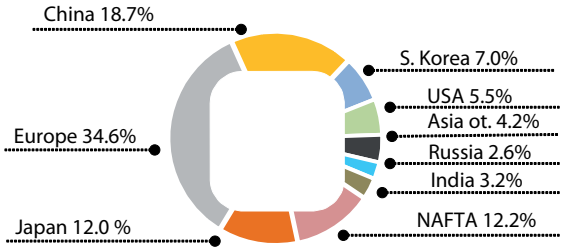

Fig. 1. World passengers' car production (% share)

Decisions regarding management of supply chain are not possible without information that would thoroughly define the distribution channels. As a rule, the information is generated by in-depth evaluation of distribution channels.

From the manufacturer point of view, selection of an optimum network sets a complex of multi-criteria condition, when a decision has to be made following evaluation of a broad specter of criteria. Scientists who have analyzed the suitability for multi-criteria evaluation maintain that the main scientific and practical issue lies in the application of the multi-criteria complex evaluation method – formation of the system of evaluation criteria (Ginevičius and Podvezko 2005, 2009; Brauers *et al.* 2008; Ginevičius *et al.* 2008; Šelih *et al.* 2008; Zavadskas *et al.* 2008, 2010a, 2010b; Jakimavičius and Burinskienė 2007, 2009a, 2009b; Liaudanskienė *et al.* 2009; Liu *et al.* 2009; Turskis *et al.* 2009; Antuchevičienė *et al.* 2010; Kapliński and Janusz 2006; Saaty 1977, 1980; Ustinovichius *et al.* 2007; Zagorskas and Turskis 2006, etc.).

2. The Analysis of Problems in Distribution Channels and Networks

A great variety of channels for moving products is observed in today's economic systems. Various branches of industry or even separate product groups have specific distribution channels (Christopher 2005; Bowersox *et al.* 2002). A distribution channel is a term used to define measures for shifting a product from its production site to the site where it will be consumed (Koplin *et al.* 2007). The development of a supply channel is of the utmost importance to manufacturers. Solving the issue involves two contravening tendencies: the product should reach the maximum number of intermediaries and, at the same time, involve minimum costs of product movement (Bowersox *et al.* 2002). Literature sources suggest that there are a few alternative ways of choosing a distribution channel. Differences may come from the types of brokers in a channel, the number of brokers and the level of distribution intensity (Christopher 2005). At the same time, specialists identify characteristics that are common for all channels. The features should envisage the process of creating the channel, as this is the only way of ensuring efficient operations for the channel. A distribution channel can be listed as being efficient when:

- products are easily accessible to intended clients;
- an opportunity for expanding sales is envisaged;
- any type of cooperation opportunities on a channel are envisaged;
- the level of services requested by the client is ensured;
- general costs of product movement are minimized;
- a sufficient level of feedback is ensured (Barrat 2004; Kabadayi *et al.* 2007).

To put the above-mentioned characteristics into practice, many companies over the past decades shifted their focus on activities, such as management of supply chains. This helped many manufacturers gain competitive advantage.

Management of a supply chain is a process to establish chain infrastructure that will be necessary for satisfying client needs (Kabadayi *et al.* 2007; Vasilis Vasiliauskas and Jakubauskas 2007). At the same time, the supply chain is defined as a process, which connects various companies that creates added value to products as they travel to sources of raw materials to the location of final consumption (Christopher 2005). According to another definition, a supply chain is a collection of operations that create added value and connect suppliers to manufacturers and management to suppliers (Chopra and Meindl 2003). Evidently, a manufacturer is in the middle of the supply chain, connected to suppliers on one side and to clients on the other. Therefore, to achieve objectives of its economic and commercial activities, such companies must develop adequate distribution networks.

Network planning is a process when a company structures and manages its supply chains with the objective of:

- finding a balance among stock, haulage and production costs;
- harmonizing supply and demand in a way of adequate distribution of stocks;
- efficient use of resources in a changing environment (Goetschalckx and Fleischmann 2002; Simchi-Levi *et al.* 2003).

In essence, the network structure development covers configuration of infrastructure of supply chains. This involves strategic solutions, therefore, the process consists of evaluation of a number of factors that can be divided into the following categories:

- market characteristics;
- product characteristics;
- channel characteristics;
- competition characteristics;
- company resources (Chen and Paulraj 2004).

Selection of an alternative distribution channel is of a great importance to strategic management and development of a supply chain. On the theoretical and practical level, this phase of the process requires special attention as the key part of the process that generates added value. In this actualization, multi-criteria evaluation of distributional channels leads to creation of a high-quality distributional channels and efficient management of the channel. Complex multi-criteria evaluation is relevant for distributional channels assessment as it does not restrict the number of alternatives under the evaluation and a number of evaluation criteria. Complex evaluation allows:

- evaluating the meaning of established criteria and calculating a single complex criterion for generalized description of entire solution;
- decision-making considering certain criteria of contravening character;

– establishing the impact of separate criteria upon evaluation results based on values of the criteria.

Main problems include the development of the evaluation criteria system, determination of criteria values and merger of criteria into a generalized value. The article examines the system of evaluation criteria that describes automobile distribution channels.

3. The Evaluation Criteria for Description of Distribution Channels

The distribution network is influenced by a number of factors, which are rather difficult to evaluate due to the abundance of criteria. Therefore, a three-level system for evaluation of distribution channels is worked out, with an evaluation which integrates a complex criterion of automobile distributional channels on the top level. The second level provides integrated groups of criteria in the following categories: characteristics of distribution channel, resources of automobile manufacturers, competitive abilities of distribution channel and market characteristics (Table 1). The third level includes initial evaluation criteria. The table below provides initial evaluation criteria of recommendatory character, which are relevant to the evaluation of distributional networks on the automobile market.

3.1. Characteristics of a Distribution Channel

Logistics of manufactured automobiles has certain technological peculiarities. The distribution process involves vehicles of specific structure and specially-designed automobile terminals that cannot be adapted for universal use. Expanding network of automobile dealerships and growing production volumes have transformed terminals into an integral part of the distributional network.

Geographical location of a factory is vital for the assessment of transportation costs. Therefore, distribution costs have to be divided into delivery price to/from terminal, port and the cost of delivery to the final client. A few providers of logistics services are often chosen for long-distance routes. However, when receiving services to transport companies from various companies, it is vital to consider the potential considerable differences in price due to some reasons, such as cheaper labor force, fuel, lower taxes, management costs, etc.

Depending on the capacity of factories and geographical location, a new automobile is delivered to any destination in Europe in an average of ten weeks (So lange müssen… 2009). Together with automobiles, storage, haulage and preparation for use it takes two weeks approximately. The remaining time costs go towards registration of client order, delivery of necessary parts and production processes. Additional time costs may be required due to other factors, such as customs procedures, insufficient availability of transport, traffic accidents or *force majeure*.

Application of various transportation alternatives allows distribution networks to be flexible. The use of various types of transport, considering their advantages and disadvantages, may help solving a number of transportation problems caused by large quantities of production and geographical breaks (Holweg and Miemczyk 2003). Transportation distance is directly related to all the criteria mentioned above. Nevertheless, characteristics of transport network infrastructure and capacity should be mentioned as having an effect on safety and haulage speed of cargo.

3.2. Resources of Automobile Manufacturers

When considering the influence of production volumes upon formation of a distributional network, it is vital to consider the size of the factory and the output manufactured per day in order to plan automobile distribution and create a supply of cargo. A considerable increase in demand for transport services is observed before various

Table 1. Integrated groups of criteria and initial evaluation criteria describing distribution channels

1. Characteristics of a Distribution Channel	1.1. The number of warehouses
	1.2. Delivery price to/from terminal, port
	1.3. Delivery price to client
	1.4. Transport time
	1.5. Number of transportation alternatives
	1.6. Transport distance
2. Resources of Automobile Manufacturers	2.1. Production volumes
	2.2. Shipment size
	2.3. Storage costs
3. Competitiveness of a Distribution Channel	3.1. Service quality
	3.2. Ecology
	3.3. Value added services
4. Market Features	4.1. Sales volume
	4.2.Transport supply
	4.3. Risk factor

holidays, factory vacations and before the end of quarters of calendar years. Amid higher volumes of haulage, the recommendation is to divert production flows to multimodal transport. This helps evening out the flows, however, extends the time of delivery. The loading factor of vehicles used in the multimodal haulage chain depends on the type of transport. A specialized sea ferry can carry 2000–5000-automobiles, in comparison to the train car and its capacity of 16–20-automobiles and 8–11-automobile capacity of an autotransporter (Financing the Recovery: a Comprehensive… 2010).

In an effort to boost production volumes, the majority of automobile manufacturers have revised territorial layouts of their production facilities. Production warehouse areas within factory territory were cut to the minimum to make more room for production facilities, which were equipped with additional production lines. This helped solving the problem of increasing production speed and capacity. Nevertheless, curtailment of factory warehouses required finding a solution for optimum distribution output to avoid accumulation of large amounts of stock. Production storage leads to time loss; therefore, it is vital to come up with ways of diminishing unreasonable resources waste.

3.3. Competitiveness of a Distributional Channel

The quality loss of transport services can be divided in three groups, namely: loading, haulage and unloading. Every additional transport operation influences the factor of cargo damage. Transport leads to losses not only of time and price but also that of quality; therefore, improving services quality requires a particular attention. Excessive loading of roads, traffic intensity and environmental pollution are among the most burning problems these days. Multimodal solutions when the part of transport flows are shifted from road transport to sea or railways can be applied to solve overload of the road network. When planning the automobile distributional network, it is important to take into consideration the use of ecological means of transport to reduce environmental effects (Koplin *et al.* 2007).

Logistical services that create added value can be divided in two groups, i.e., the first one is physical services that include automobile storage, assembly and preparation for use; the second group comprises supply chain management services such as cargo tracking and route planning that ensure efficient use of resources and improve the control of logistical processes.

3.4. Market Features

More than 16 million brand-new cars are sold in Europe per year. Nevertheless, sales volumes are subject to the seasonal factor, which is caused by a drop in purchasing volumes. According to the 2006–2009 statistics (Fig. 2) published by the European Automobile Manufacturers' Association (ACEA), a decrease in automobile sales by an average of 25 percent is observed in the July–September period (New Vehicle Registrations… 2010).

Securing an uninterrupted transport flow is a rather difficult task. Many carriers try to avoid specialized haulage due to extremely high requirements for automobile logistical processes and non-versatility of specialized vehicles. Nevertheless, to reduce transport deficit automobile manufacturers are forced on raising the tariffs for their services to keep carriers concerned with profitability of their operations. Furthermore, it is vital to take into consideration a number of political, legal and geographical restrictions, as well as any other restrictions to commercial transport, which can have direct effect on transport service supply. The risk factor is very important for generation of the distributional channel – certain global developments may lead to a drop, because of production need, the change of distribution chain or because the carriers may leave the market or other developments may bring destruction into established processes.

4. Multi-Criteria Evaluation of a Distributional Channel

Multi-criteria evaluation of distributional channels under a proposed system of criteria is started by determining the values of original evaluation criteria in every group of original criteria. Criteria listed in one group are compared against each other, a small number of criteria analyzed at a time, which makes it easier to establish the values.

After establishing the values of original evaluation criteria, distribution channels are the first being evaluated by every original criterion. The evaluation is performed in a line with modification of the expert evaluation method – decision-making in groups by way of consensus, which was applied in the surveys of Bivainis and Zinkevičiūtė (2006), and Žvirblis and Zinkevičiūtė

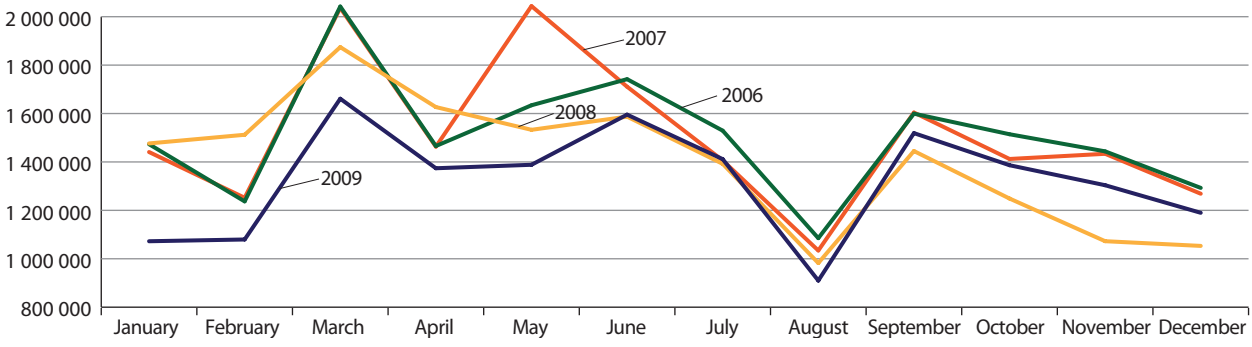

Fig. 2. New vehicle sales in Europe in the period of 2006–2009

(2008). With specific evaluation objects, it may be difficult to avoid opinion differences. In this case, the advantage of decision-making in groups lies in faster determination of differences in expert opinions, which helps bringing the evaluations closer together. The object of evaluation determines the difficulties in establishing the precise value of evaluation by original criteria. This is mainly due to insufficient specific character of information. Another benefit of an evaluation reached by consensus of a group of experts is that no additional time or attention is required for determining the compatibility level of expert opinions. The experts provide a joint evaluation of distribution channels by every criterion.

Distribution channels according to qualitative criteria are assessed in the interval from [0, 1]. Applying this interval, the highest evaluation is attributed to one, zero is attributed to the lowest evaluation. In marginal interval the valuation is set to every decision. The latter rarely matches the value of 0 and 1. In such cases, transitional values are used arranging them in the interval [0, 1] in logical sequence.

According to the primary quantitative criteria, distribution channels are assessed at rating the values of determining indexes on every criterion of content. It can be of absolute and relative magnitude. Trying to reach the rated index as criteria compatibility (note: it can be realized in different measure units), they are normalized, i.e. translated into dimensionless and right for comparison shape. To normalize the rate in the interval [0, 1] as a tool for further rating the following formulae are applied:

maximizing criteria values:

$$N_i = 1 - \frac{N_i^* - N_{it}}{N_i^* - N_i^0}; \quad (1)$$

minimizing criteria values:

$$N_i = \frac{N_i^* - N_{it}}{N_i^* - N_i^0}, \quad (2)$$

where: N_i – normalized rating value in interval [0, 1]; N_i^* – the highest possible evaluation value; N_{it} – factual evaluation value; N_i^0 – the lowest acceptable evaluation value.

The value of complex integrated criterion is calculated according to such formula:

$$\begin{aligned} R_1^* &= \omega_{11}R_{11} + \omega_{12}R_{12} + \omega_{13}R_{13} + \omega_{14}R_{14} + \\ &\quad \omega_{15}R_{15} + \omega_{16}R_{16}, \\ R_2^* &= \omega_{21}R_{21} + \omega_{22}R_{22} + \omega_{23}R_{23}, \\ R_3^* &= \omega_{31}R_{31} + \omega_{32}R_{32} + \omega_{33}R_{33}, \\ R_4^* &= \omega_{41}R_{31} + \omega_{42}R_{42} + \omega_{43}R_{43}, \end{aligned} \quad (3)$$

where: R_1^*; R_2^*, R_3^*, R_4^* – the value of partial integrated criterion; 1, 2, 3, 4 – the index of partial integrated criterion; ω_{ji} – a primary criterion weight; R_{ji} – normalized value of a primary criterion; j – the group number of primary criterion; i – the number of primary criterion in the group.

Evaluating the integrated complex criteria values of distribution channels such formula is calculated as follows:

$$R' = \omega_1^* R_1^* + \omega_2^* R_2^* + \omega_3^* R_3^* + \omega_4^* R_4^*, \quad (4)$$

where: ω_1^*, ω_2^*, ω_3^*, ω_4^* – weight of a partial integrated criterion; 1, 2, 3, 4 – index of a partial integrated criterion.

After a complex multi-criteria evaluation of distribution channels, a manufacturer can choose a distribution network for automobiles in accordance to the results of evaluation. The advantage of the method lies in the segmentation of the difficult complex problem into more simple operations, application of the method does not require very complicated solution systems. The method is also suitable, as evaluation of distribution channels enables to choose the best versions for design or redesign of a distribution network, if circumstances in a specific environment dictate quick changes a manufacturer has to respond to.

5. Conclusions

1. The European Union's policy, which is intended to ensure harmonious interaction of cargo transport systems, does not always prove efficient, and the strategic instruments that are often applied to make the road transport look more attractive than other types of transport, which tend to become less appealing due to the complex technological process of haulage. Therefore, instruments are needed to help automobile manufacturers to achieve the required degree of operations efficiency and cut costs. Supply chain management and generation of distribution channels are listed as one of the instruments.
2. Selection of an alternative distribution channel plays a key role in strategic management of a supply chain and development of a distribution channel. It is a strategic solution; therefore, the process requires assessment of a number of factors that could be divided in the following groups: market features, channel features, competition features and company resources.
3. Efficiency of distribution channels is influenced by a number of factors, and evaluating them is a rather difficult task because of criteria abundance. Therefore, the article provides a three-level system for distribution channels assessment where the top level envisages an integrated complex criterion for evaluation of automobile distribution channels. The second level presents integrated groups of examined criteria. The third level gives the original evaluation criteria, which are provided in the article as a recommendation for the automobile industry.
4. Multi-criteria evaluation is suitable for selection of distribution channels, as there is no restriction on the number of evaluation alternatives and evaluation criteria. The article provides a recommended system of criteria for the automobile industry and a multi-criteria evaluation algorithm that enables calculating the complex criteria by specific values of original criteria, considering the importance of it in groups

and the importance of the group for the final result. Results of the integrated complex evaluation in distribution channels could lead to the development of a high-quality distribution network and efficient management, at the same time bringing added value for the manufacturer and for the final consumer.

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