An innovative approach to support interests' alignment in the context of transport management using semantic differential

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Abstract

PURPOSE: *Our study aims to develop an innovative approach to scientific substantiation and practical balance of interests of cargo owners and transport companies, which will serve as a tool for freight management.* ***METHODOLOGY:*** *A specific algorithm of actions is proposed, which initially provides the creation of a system of indicators to study transportation management. The research methods include a complex method of semantic differential modeling, which integrates correlation-regression analysis, cluster analysis, and expert evaluations. The basis of such a complex method is the integration of three components: i) a system for monitoring the satisfaction of consumers of transport services; ii) the assessment of the density of connections between cargo turnover by type of transportation and the leading transportation indicators; iii) a multidimensional assessment of the homogeneity of factors by*

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hierarchical clustering. ***FINDINGS:*** *Semantic differential modeling can serve as an effective tool in strategic planning, not only for transport companies and railway enterprises, but also for those institutions where it is necessary to identify the most important areas of activity.* ***IMPLICATIONS:*** *The use of semantic differential based on the involvement of quantitative methods of mathematical modeling allows increasing the degree of validity of management decisions. The harmonization and balancing of interests in the field of B2B take into account the results of modeling the semantic differential in management. The proposed methodology consists of main indicators of rolling stock transportation and certain economic indicators; we advise to focus on. These indicators were obtained through cooperation with an expert group of participants in the transportation process. Application of the created model allows defining priority directions in the field of freight owners' service by the Ukrainian railways in the dynamics by types of cargo and transportation and substantiating the corresponding management decisions by freight carriers.* ***ORIGINALITY AND VALUE:*** *Innovation is a complex interdisciplinary integration of research methods based on the philosophy of semantic differential, allowing the integration of approaches to harmonize the interests of transport companies and consumers of their services with the results of cooperation in the field of freight transportation. Therefore, the developed innovative methodology can be used not only for railway transport but also for other types of transport and business.*

Keywords: *modeling, harmonization of interests, semantic differential, freight transport, cargo owners, innovative approach, cluster analysis, correlation-regression analysis, transport management*

INTRODUCTION

In today's world, the issue of balancing the interests of businesses and consumers of their goods and services is very relevant. This is due to increasing competition, complicating economic systems, and changing consumer preferences. Moreover, this is typical not only for B2C but also for the B2B market. Thus, harmonizing the interests of transport companies and cargo owners is one of the very important fields of research.

An essential aspect of modern organizations' activities is to consider the mutually beneficial partnership interests of business process participants. For all types of business, the infrastructure industries are system forming. A typical representative of the infrastructure sectors is the transport field as an integral part of B2B in freight transport. A number of works devoted to methods of ensuring successful coordination of transport services market participants based on structural aspects of communications and changing the organizational management structure were written (e.g., Vlaar et al., 2008; Cornelissen et al., 2014; Mattsson & Jenelius (2015). Their authors contributed to the study of the problem of analysis of transport dynamics.

In their opinion, the use of non-traditional methods of research based on time slices in communication dynamics is promising. Moreover, they also emphasize the need for greater interdisciplinary cooperation between government, transport market operators, and scientists to transform knowledge into practical strategies that will enhance the stability of the transport system. However, besides the cooperation between the different participants of the railway market, the problem of harmonizing the interests of carriers and cargo owners as participants in the B2B chain becomes especially relevant, but this problem is still under researched for now. In this regard, Bala Myneni and Dandamudi (2019) proposed a new approach to clustering social graphs to predict passengers' opinions on assessing the quality of railway services. Also, the mood factors of users of these services were researched using semantic analysis in this study. However, to identify the latent properties of interaction in this area, it is necessary to apply a non-traditional paradigm. The concept of semantic differential can become such a paradigmatic shift. Therefore, the purpose of our study is to develop a model of the semantic differential as a tool for harmonizing the interests of consumers of transport services (cargo owners) with a supplier in the field of freight transportation (JSC "Ukrzaliznytsia"). Application of the created model allows defining priority directions in the field of cargo owners' service by the Ukrainian railways and substantiating appropriate management decisions to consider the opinions of consumers as a significant factor that influences the management of transportation work.

Our study is characterized by both scientific novelty and innovative approach. The novelty is applying classical methods (correlation-regression analysis, expert estimates, and cluster analysis) with their further integration into modeling the semantic differential as a tool for harmonizing the interests of a transport company and consumers of its services. Equally important is the innovative approach that characterizes our work. Its essence is to use the potential of the scientific paradigm of semantic differential based on the creation of the authors' three-dimensional methods of analysis to modelling the harmonization of interests of transport companies and consumers of their services. The fundamental basis for semantic differential application in science was laid in the middle of the last century (Osgood et al., 1957). However, the semantic differential was proposed without standard concepts or universal scales for measuring phenomena, and it is a "highly generalized" technique. Nevertheless, this work provided prospects for using the semantic differential in various fields of science.

The inconsistency of the goals of B2B and B2C market participants is due to the synergistic influence of different vector factors on the coherence of interests in business partnerships. This issue is not sufficiently studied in the

modern scientific literature. Therefore, the proposed innovative approach allows solving the part of management problems related to supporting the interaction of market participants. In turn, it encourages the search for new harmonization methods to reconcile the goals and models of doing business.

The rest of the paper is structured as follows. The next section presents a literature review devoted to the analyzed topic. In the methodology section, we present the research methods used in our study. This is followed by the research results and discussion consisting of: i) a study of empirical data on the results of one of the largest carriers of Ukraine, i.e. JSC "Ukrzaliznytsia; ii) generalized results of the survey of cargo owners on the quality of cooperation with railway companies; and iii) grouping the effects of railway companies by areas: exports, imports, transit, and domestic transportation. The paper ends with conclusions.

THEORETICAL BACKGROUND

The problem of cooperation and management in the transport field is the topic of a broad debate in the literature and has been analysed by numerous scholars for many years. Pech et al., (2021) studied the relationship between the characteristics of enterprises of different sizes and the relationship between suppliers and consumers, as well as properties of complex network relations as an element of strategic management. The authors concluded that there are differences between enterprises in size rather than industry. They emphasize that the long-term perspective of partnership contributes to a higher quality of relations and future integration. In turn, Nyulásziová and Paľová (2020) emphasize the need for continuous improvement of data processing methods in enterprise management and stagnant innovative approaches to business process management. It is worth adding that the authors present their conclusions based on the analysis, modeling, and optimization of business processes for transport companies, which, in their opinion, will help improve the management system in the field of transport services. In the direction of harmonization of relations in the B2B field, the work of Barile et al. (2020) is also relevant as it identifies strategic drivers and critical aspects of the service ecosystem through common ideas, development, training, value creation, and innovation. And the ideas presented by Gabryelczyk and Hernaus (2020) on the management of modern organizations, based on a process approach and innovative thinking, involve harmonizing all management systems. In addition, Schipper and Gerrits (2018) studied the differences and similarities in structuring the disruptions management process on the example of five European countries. They classified the management of failures in the

activity structure of railway transport and, based on cluster analysis, came to conclusions about the similarities and differences for the studied objects. And lastly, the methodology of dividing sections of the railway network by categories proposed by Stoilova (2019) has prospects for the analysis of the state of the railway network, planning of reconstruction activities, etc.

Another set of research on the topic is the one devoted to the widely understood cooperation among the participants of the system. In this regard, the document Smart-Rail Consortium (2016) contains a detailed study of the current state and areas for improving cooperation in rail freight to develop new business models. This document deals with studying the relationship between individual infrastructure objects and partly takes into account a sectoral collaboration.

Many researchers used clustering and other methods of multidimensional analysis for studying the complex system of cooperation in the B2B sphere. For example, for standardization in railway infrastructure, cluster analysis is proposed, which helps obtain a set of technical solutions (e.g., Fei et al., 2019; Khan et al., 2021). However, the projected cost reduction, which is attributed to technical solutions, seems debatable. Some of them are discussed in detail by Shpak et al. (2019 a, b). Noteworthy is the idea of combining a questionnaire of public maritime transport customers and cluster analysis to estimate the level of satisfaction with the services of this transport presented by Ekinci et al. (2018). Furthermore, Shpak et al. (2018) use multidimensional methods of statistical analysis, particularly taxonomic analysis, to substantiate the status of railway companies in the field of transit and the field validity of personnel. Similar methods were used to verify the hypothesis for grouping the means of transport offers. Such an approach permits to identify the groups of transport offers in EU countries (Poliak et al., 2021).

Some scholars (e.g., Gonzalez-Feliu & Morana, 2011; Gonzalez-Feliu & Salanova, 2012; Gonzalez-Feliu et al., 2013) believe that integrating standard views of transport participants is the basis of cooperation between cargo owners and transport companies. However, one study underlines also the barriers of cooperation, which, especially in the B+R sphere, are significant (see Cygler & Wyka, 2019). Among them are cultural and language barriers, insufficient brand/company recognition, difficulties in estimating the potential costs and benefits of cooperation, risk of losing independence and control of the company, limited financial resources, etc. In particular, the method of assessing collaboration in logistics and freight urban transport was proposed by Gonzalez-Feliu et al. (2013). Their study used a combination of cluster analysis methods and a scenario approach to illustrate the difficulty of approaching the consensus of transport participants. But the authors themselves point out the problem in achieving common goals for stakeholders.

Therefore, the limitation of this method is the concept's lack of harmonization of the interests of the parties. Other researchers, such as Nugymanova et al. (2021), offer a game-theoretic approach to strategic planning as a basis for modeling the interaction of cargo owners and freight forwarding companies to decide on the agreement to cooperate. In this approach, which uses binary unknowns, other variables of traffic indicators (congestion, tariff, etc.) are not used. The practical application of the proposed ideas is recommended for use in road haulage. In turn, Jian and Bao (2014) substantiated the effectiveness of cooperation between individual infrastructure elements in maritime transport based on a balanced scorecard method and used the grey relational degree method. It allows the identification of weaknesses in cooperation between relevant infrastructure but cannot be used to assess the effectiveness of cooperation of participants in the transport process. In this work, they are used only to consider the importance of indicators of the hierarchical structure.

Huang et al. (2019) constructed correlation matrices between technical and consumer metrics to assess relationships. Moreover, freight forwarders themselves have not been involved in the transportation process but freight forwarding companies and cargo owners have. The results obtained by the researchers can be used exclusively for intermediaries (forwarding companies) in the market of transport companies and they do not harmonize the interests of direct participants (cargo owners and carriers) of the transport process.

It is worth emphasizing that the method of ensuring cooperation in freight transportation is proposed by Vargas et al. (2018). In particular, they present the theoretical approach to assessing the business model of collaboration by identifying key components, strategies, and forms of allocation of resources and income. An operational decision support system has been proposed to support the validation of the current activities of transport companies, which asymmetrically considers the interests of the parties to the transportation process. However, one seems that such a theoretical construction does not fully harmonize the interests of cargo owners and carriers.

The study by Nagi and Kersten (2022) examined the problem of cooperation between stakeholders in the transportation process in seaports. The authors declared the idea of creating a model of the risk management process of stakeholders, which are grouped into natural and those that take place in the supply chain. The researchers used the potential of the expert survey and conducted a large-scale field study by forming appropriate focus groups. However, this study did not implement real scenarios for the practical verification of the model.

Also noteworthy is the study conducted by Abidi et al. (2019) to ensure vertical and horizontal integration for logistics service providers using an

analytical network process. Using analytical hierarchy (Saaty method) and expert evaluation to identify the criteria and their weights, the researchers concluded that there are reasonable differences in the hierarchy of criteria for different forms of cooperation in logistics chains to assess strategic partners. According to them: i) the distribution of profits and risks in horizontal integration inherent in the transport sector is a source of conflict; ii) vertical integration allows to harmonize the relationship between supplier and customer; iii) applying an analytical network process model increases the degree of validity of management decisions on establishing partnerships or their continuation. However, this study shows no signs of universality of application, due to the need to adapt the criteria's weights for the specific cooperations between the transport company and the client.

The deliberations presented on harmonization of interests of transport companies and consumers of their services referred to the so-called traditional approach. However, currently it is necessary to apply a non-traditional paradigm in order to identify the hidden properties of interaction in this area. We believe that the concept of semantic differential can become such a paradigmatic shift. As stated earlier, the fundamental basis for semantic differential application in science was the work of Osgood et al. (1957). Theoretical development of this concept was highlighted by Fishbein (1967), where the author argues that the semantic differential allows one to scale quantitatively the views and attitudes to something. According to him, the attitude has direction and intensity, and can be adapted to a bipolar continuum with a neutral or zero resistance point, which provides evaluative judgments. Thus, the category of semantic differential was used by Dokic (2017) to improve the company's marketing activity, better recognition of the company's image by consumers, improve marketing communications, and measure the company's image. And Schipper and Gerrits (2017) discuss approaches to managing rail transport services using statistical and semantic analysis.

Other authors, such as Ding and Ng (2008), have developed semantic differential scales for measurement, which reduce bias in management decisions in the construction industry. Based on semantic analysis, methods of collective interaction in the context of change management research are considered by Merkus et al. (2016). The authors' approach seems to be interesting. The adoption of management decisions to solve communication problems in rail transport is due to the ambiguity of organizational reality. Modeling the semantic differential is a set of quantitative methods, one of which is cluster analysis, founded by Robert Tryon (see Tryon, 1939; Tryon & Bailey, 1970). This analysis has been used to optimize logistics networks in the city's transport system (Hairui et al., 2020; Ducret et al., 2016; Akbar et al., 2020). Intelligent Transport System technologies have concentrated

in recent years on this problem too (Badura, 2017), despite barriers to implement them (Tomaszewska, 2021). One cannot also forget that transport contributes to noise, air pollution and climate change (Hajduk, 2018).

The analysis of the literature on modeling of harmonization of interests of transport companies and consumers of their services, demonstrates the importance and relevance of the problem and the interest in solving it. It also allows one to draw several conclusions. First of all, there is no doubt that the issue is a matter of wide scientific debate. Scientists, researchers, and practitioners have tried to involve different approaches and methods (or combinations of them) to achieve research interest and the practical implementation and development of specific recommendations in the field of horizontal and vertical cooperation. They have used a set of mathematical, static methods, general scientific, cluster analysis, and linear and nonlinear programming methods in various combinations. But their disadvantage is the lack of a single fundamental approach that would harmonize the potential of each of these methods to improve the effectiveness of cooperation between cargo owners and carriers. Second, the matter is a complex issue, multidimensional (not one-dimensional) and is therefore analyzed from different points of view. Third, one underlines the issue of cooperation between the parties involved. This cooperation may take the form of coopetition. And fourth, they use different methods and instruments in their analyses. Among the most popular methods are the following: correlation-regression analysis, expert survey, cluster analysis, simulation, optimization methods, and others. Thus, a paradigmatic shift was made towards creating a concept of harmonization of interests of transport companies and consumers of their services based on the semantic differential.

Railway transport in Ukraine

With regard to the railway transport, one should state that it belongs to the most important sectors of the Ukrainian economy. Railway transport of Ukraine has an operational length of railways that is more than 20,000 km and it occupies a prominent place among railway companies in Europe. Ukraine's rail transport ranks fourth in the cargo transportation ratings on the Eurasian continent. Only China and India are ahead by this indicator. Seven countries of the world are neighbors of Ukraine (Belarus, Poland, Hungary, Russia, Slovakia, Romania, Moldova) with which it is connected by rail transport corridors, including more than 50 border crossings. Of all modes of transport, the lion's share of cargo transportation belongs to railway transport and it is almost 82%. Only 18 % of these transportations are realized by other modes

of transport (road, water, air) (The main aspects of the Development Strategy of JSC "Ukrzaliznytsia" 2017-2021, 2021).

From 2013 to 2020, the railways of Ukraine reduced the volume of transportation by all types, except imports (Directory of key performance indicators of regional branches of JSC "Ukrzaliznytsia," 2021). For reference, import transportation growth in 2020 (20225,4 million tkm) compared to 2013 (17845,4 million tkm) was about 13,34 %. While transit transportation decreased in 2020 (14276,14 million tkm) compared to 2013 (33903,2 million tkm) almost by 57,9 %, domestic (in 2020 – 63246,4 million tkm; in 2013 – 78768,9 million tkm) – by almost 19,7 %, export (in 2020 – 77838,8 million tkm; in 2013 – 93916,5 million tkm) – by almost 17,12%. There were no significant jumps during the analyzed period, and there were steady trends to reduce freight turnover, excluding imports ones. Among the reasons for freight turnover reduction is the occupation of part of the territory of Ukraine. Therefore, some elements of the infrastructure of Donetska and Prydniprovska railways were on the territory that is not controlled by Ukraine. Such a situation has complicated the management of transportation and negatively affected transportation volumes.

Considering that freight by railways is the cheapest type of transportation for JSC "Ukrzaliznytsia" as a state corporation, it is important to stabilize the turnover indicators and promote mutually beneficial cooperation with cargo owners. It is becoming more relevant under conditions of growing competition with other types of transport. In particular, during the study period, the share of railway freight turnover compared to other types of transport decreased only by 2,13 % (State Statistics Service of Ukraine, 2021). In this regard, there is a need to stabilize the negative trends that lead to a deterioration of the production and economic activity indicators of JSC "Ukrzaliznytsia".

METHODOLOGY

In our study, we proposed modeling of the semantic differential as a tool for managing the transportation by railway transport. The research methods included an integrated system of methods: structural-dynamic analysis, correlation-regression analysis, expert assessments, and cluster analysis for modeling the semantic differential as a tool for managing the transportation by the railway. Modeling of the semantic differential involves the sequential implementation of the following steps:

I. Study, identification, and systematization of the main (essential) factors influencing the transport work of railway transport by four

types of transportation (export, import, domestic transportation, transit) and the main types of cargo (18 groups of cargo)

This stage is based on applying structural and dynamic analysis of the transport work of JSC "Ukrzaliznytsia" in the field of freight. The complex use of expert assessments, correlation-regression, and cluster analysis made it possible to identify the most significant factors influencing freight turnover by transportation type and study their structure. The created system of indicators for research of results of transportation work in dynamics for eight years with 18 groups of cargoes includes:

1. The number of available wagons units (X_1) by types of transportation ($X_{1import}$, $X_{1transit}$, $X_{1export}$, $X_{1domestic\ transportation}$).

2. Weight of transported cargoes (X_2), thousand tons by types of transportation ($X_{2import}$, $X_{2transit}$, $X_{2export}$, $X_{2domestic\ transportation}$).

3. Fare, thousand UAH (for exports, imports, domestic transportation) and thousands USD (for transit transportation) (X_3) by types of transportation ($X_{3import}$, $X_{3transit}$, X3export, $X_{3domestic\ transportation}$).

4. Income rate, UAH for 10 tkm (for export, import, domestic transportation) and USD USA for 10 tkm (for transit transportation) (X_4) by types of transportation ($X_{4import}$, $X_{4transit}$, $X_{4export}$, $X_{4domestic\ transportation}$).

5. Average distance of transportation, km (X_5) by types of transportation ($X_{5import}$, $X_{5transit}$, $X_{5export}$, $X_{5domestic\ transportation}$).

6. Average loading, tons (X_6) by types of transportation (X_{6impor}t, $X_{6transit}$, $X_{6export}$, $X_{6domestic\ transportation}$).

7. Freight turnover (Y) by types of transportation (Y_{import}, $Y_{transit}$, Y_{export}, $Y_{domestic\ transportation}$).

To study the relevant relationships, calculations were made using official statistics of JSC "Ukrzaliznytsia" (Official site of JSC "Ukrzaliznytsia," 2022).

II. The modeling information base included the conduction of "field" research to define the degree of satisfaction of the cargo owners of the Ukrainian railway by using a questionnaire

A questionnaire was developed to conduct an expert survey of customers (consumers) as essential stakeholders of JSC "Ukrzaliznytsia." For this reason, an anonymous survey of the management of 30 carriers, which have agreements on the organization of domestic and international transportation, was conducted. To form the sample size, the principles of small samples and information adequacy were chosen. Among other main parameters of the questionnaire survey concerned the study of the assessment of the state of transport work of railway transport, the quality of management of transport work, the degree of their satisfaction with the cooperation with the railways of Ukraine. The following are highlighted: a form of conducting – anonymous individual survey, frequency of performing for this study – one-time, type of expert assessment – opinion poll. The questionnaire consisted of 10 questions. The questions were in open and closed formats. The survey results allowed us to estimate the level of satisfaction of cargo owners with the quality of services provided by JSC "Ukrzaliznytsia" in the field of freight.

III. Modeling the obtained empirical data and assessing the adequacy of the accepted models

The proposed research work uses the potential of the semantic differential method, which is a method of psycholinguistics. We also used the interdisciplinary approach proposed by Gonzalez-Feliu (2012). This paper is devoted to studying the network of transport systems and includes optimization calculations to optimize traffic on the criterion of minimum costs in cooperation simulation. The authors conclude that the social aspects of the interaction of participants in the transport process are essential to successful cooperation. At the same time, there are restrictions on the lack of efficiency in adapting the proposed model to customer needs. Another limitation concerns the lack of realism of modeling tools, which are limited by the distance factor and do not include economic factors in the study. Such factors can be involved in modeling by creating a monitoring system that will harmonize the relationship between cargo owners and transport companies. However, the relevant theoretical constructions in our study are based on the potential of the theory of semantic differential.

The classic case for the semantic differential application is quantitative and qualitative indexing with the help of scale development procedures. For the purposes of the achievement of the proposed study, the semantic

differential should include three components (expert assessment, density of the connection, multidimensional assessment of factors homogeneity). From this point of view, the sequence of application of the semantic differential as a tool for managing the transportation by railway transport of Ukraine in the field of freight provides the following procedures:

1) Expert assessment.
2) Implementation of the system of monitoring the satisfaction of cargo owners with the level of service of JSC "Ukrzaliznytsia". Such a system includes the development of a questionnaire with a list of questions to ensure appropriate feedback from cargo owners with the transportation management system. The system of transportation indicators includes the number of wagons (X_1), weight of cargo (X_2), fare (X_3), income rate (X_4), average distance of transportation (X_5), and average load (X_6). Therefore, part of the questions of the proposed questionnaire contains references to these indicators.
3) Processing of results with grouping of answers of cargo owners.
4) The density of the connection.
5) Mathematical modeling of the dependence of cargo turnover by types of transportation on the leading indicators of transportation: i) The correlation-regression analysis conduction for the purpose of defining the density of connection between cargo turnover by types of transportations and the basic factors. ii) Systematization of the obtained results based on the hierarchy of the level of influence of the main factors of transportation work on the indicators of cargo turnover by types of transportation. iii) Multidimensional assessment of the homogeneity of factors. This includes cluster analysis of the formation of homogeneous groups of indicators to determine the hierarchy of the level of influence of indicators of transportation work on freight turnover by type of transportation.

RESULTS AND DISCUSSION

Our study presents analysis of the data for the period from 2013 to 2020 and provides the following classification of types of 18 groups of goods: wagons; grain, grinding products; coal; coke; non-ferrous metals and articles thereof; forest cargoes; scrap ferrous metals; mineral building materials; machines and equipment; oil and oil products; iron and manganese ore; colored ore, sulfur; salt; chemical and mineral fertilizers; chemicals; cement; ferrous metals; other cargoes. The practical implementation of the proposed modeling sequence is presented in the subsequent sub-sections.

Expert assessment

The expert assessment was carried out by developing an appropriate questionnaire, content and form, which was agreed with the heads of the functional departments of JSC "Ukrzaliznytsia". After the formation of the necessary Google form for the survey conduction, it was sent to cargo owners, top managers, and managers of freight companies and other shippers. The results of the questionnaire were processed and they are presented in Figures 1-6.

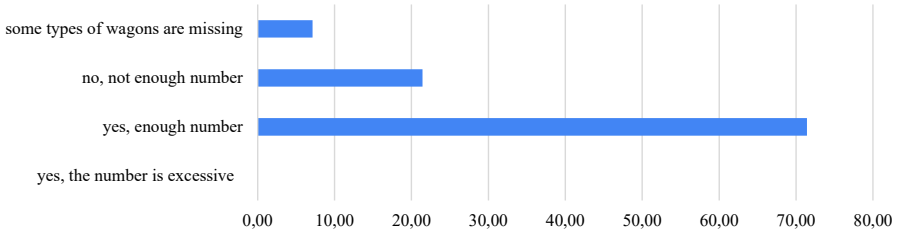

Figure 1. Is the required number of wagons available to transport your cargos?

More than 70% of respondents (cargo owners) believe that the enterprises of JSC "Ukrzaliznytsia" provide wagons in sufficient quantities (Figure 1). But for more than 20% of respondents this service is not enough.

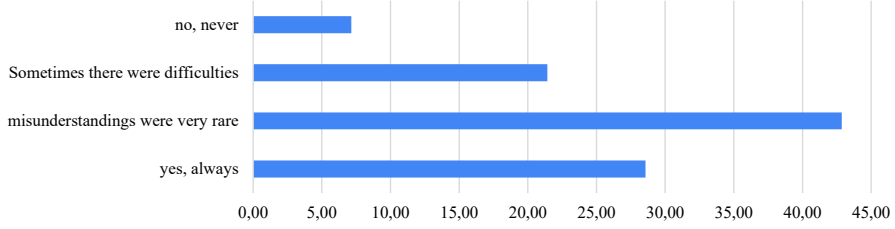

Figure 2. Could you always order the transportation for the amount (weight) of cargo that you planned?

Answering the question "Could you always order the transportation for the amount (weight) of cargo that you planned" (Figure1), only 42% of respondents stated that misunderstandings were very rare. But one in five cargo owners sometimes had difficulties, and one in three always had difficulties with transportation of the required amount of cargo.

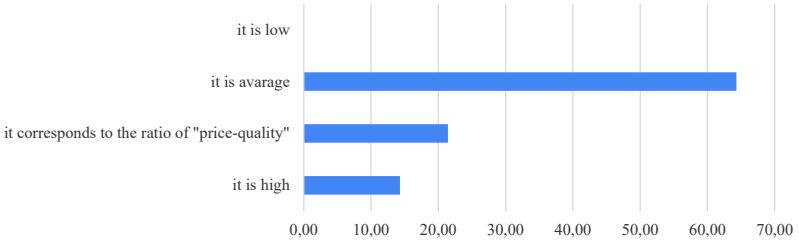

Figure 3. How much do you think the freight fare meets your expectations?

Only 20 % of respondents stated that the fare for the cargos transportation corresponds to the ratio of "price-quality". On the other hand, more than half (almost 65%) of respondents stated that the fare is average. It can be supposed that these cargo owners have experience of cooperation with other types of transport. The balance of 15% of respondents believed that the fare is high (Figure 3).

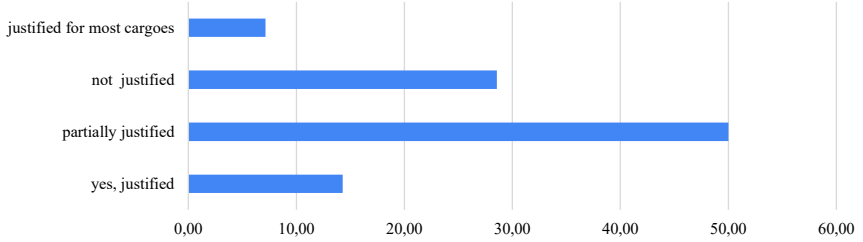

Figure 4. Is the value of the income rate of JSC "Ukrzaliznytsia" justified by the types of cargo transported by your company?

Half of the respondents answered that the income rate is partially justified, 28% - not justified. Only 14% of the respondents consider this indicator to be fully justified, others - partially or not justified at all.

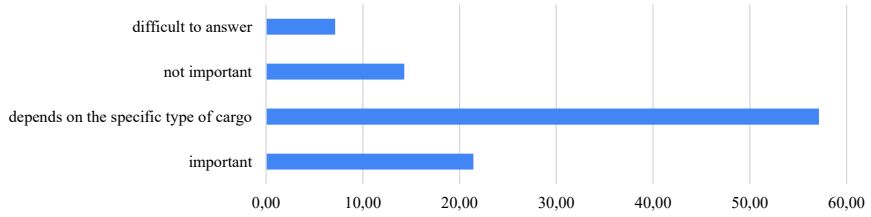

Figure 5. How important is the average distance of freight transportation by railway for you?

The indicator of average distance of cargo transportation is important for every fifth cargo owner. For more than half of the respondents, it is important, but depends on the type of cargo.

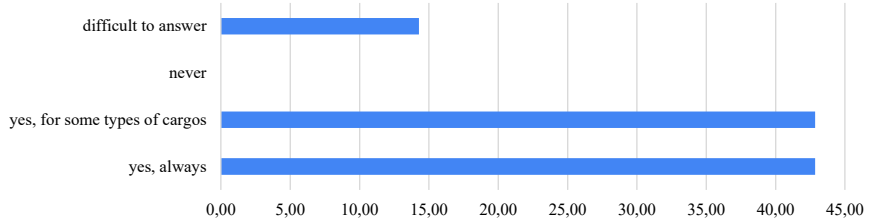

Figure 6. Does the average load of one wagon meet your needs?

One can conclude from Figure 6 that the average load of one wagon meets the needs of more than 85% of respondents. Implementing such a system for monitoring the level of satisfaction of cargo owners with the service of JSC "Ukrzaliznytsia" allows them to find flexible solutions to improve their cooperation. But to avoid subjectivity in assessing the level of such cooperation, it is necessary to make full use of the potential of the semantic differential as a tool for managing transportation.

The density of the connection

Qualitative characteristics of the dependence of freight turnover by type of transportation on the main factors are given on the basis of the correlation coefficient by the Chaddock scale. This scale is quite conditional: you can find several variants of scales in different sources. However, the scale makes it possible to "transform" the numerical (quantitative) value into a qualitative characteristic. We used the version of the scale that has more gradations.

Conclusions on the strength of the correlation by different values of the correlation coefficient, absent (0), weak (0.1–0.3), moderate (0.3–0.5), medium (0.5–0.7), high (0.7–0.9), rather high (0.9–0.99), close to functional (1), are given in the comments to Tables 1 – 4.

Table 1. Dynamics of dependence of cargo turnover (import) in 2013-2020 by types of cargo on the main factors

Years	Factors					
	Number of wagons (X_1)	Weight (ths. tons) (X_2)	Fare (ths. UAH) (X_3)	Income rate UAH per 10 t-km (X_4)	Average distance of transportation (km) (X_5)	Average loading, tons (X_6)
2013	0,6150	0,9996	0,6869	-0,2038	-0,0249	0,0993
2014	0,3246	0,6321	0,6321	-0,1343	0,0611	0,1165
2015	0,3274	0,6321	0,6460	-0,0964	0,0053	0,7890
2016	0,3438	0,9964	0,6447	-0,0964	0,2527	0,1372
2017	0,5571	0,9945	0,6853	-0,1738	0,1283	0,0635
2018	0,6490	0,9680	0,7016	-0,1905	0,2450	0,0372
2019	0,7007	0,9777	0,7890	-0,1808	0,2472	0,0587
2020	0,5958	0,9913	0,7848	-0,1540	0,3463	0,0081
min	0,3274	0,6321	0,6321	-0,2038	-0,0249	0,0081
max	0,7007	0,9996	0,7890	-0,0964	0,3463	0,1411

The correlation coefficients of the dependence of cargo turnover (imports) on the main factors allowed one to establish the most significant of them. The most influential factors that determine the volume of cargo turnover are the weight (X_2) and the fare (X_3) (Table 1). There is a moderate connection between the number of wagons (X_1) and cargo turnover. Income rate (X_4), average distance of transportation (X_5), and average loading (X_6) practically do not influence cargo turnover on import.

The correlation coefficients of the dependence of cargo turnover (transit) on the main factors allowed one to find out the most significant of them. The most influential factors that determine the volume of transit traffic in the study period are the weight (X_2) and the fare (X_3) (Table 2). The number of wagons (X_1), the average distance of transportation (X_5) and the average loading (X_6) have a moderate effect on freight turnover. The income rate (X_4) has almost no effect on transit transportation. But interestingly, the relationship between the income rate and transit cargo turnover is inverted during the study period.

Table 2. Dynamics of dependence of cargo turnover (transit) in 2013-2020 by types of cargo on the main factors

Years	Factors					
	Number of wagons (X_1)	Weight (thous. tons) (X_2)	Fare (thous. UAH) (X_3)	Income rate UAH per 10 t-km (X_4)	Average distance of transportation (km) (X_5)	Average loading, tons (X_6)
2013	0,4553	0,9939	0,8646	-0,2915	-0,2547	0,2647
2014	0,4577	0,8410	0,8410	-0,2541	0,2203	0,2478
2015	0,4694	0,8410	0,8386	-0,2186	0,2805	0,1725
2016	0,4311	0,9883	0,8125	-0,2186	0,2752	0,2547
2017	0,4408	0,9854	0,6309	-0,1599	0,3109	0,3137
2018	0,4709	0,9909	0,6012	-0,1355	0,4193	0,3358
2019	0,4872	0,9910	0,6859	-0,1631	0,3631	0,3450
2020	0,4981	0,9977	0,7642	-0,1441	0,3279	0,3891
min	0,4311	0,8410	0,6012	-0,2915	-0,2547	0,1725
max	0,4981	0,9977	0,8646	-0,1355	0,4193	0,3891

Table 3. Dynamics of dependence of cargo turnover (export) in 2013-2020 by types of cargo on the main factors

Years	Factors					
	Number of wagons (X_1)	Weight (thous. tons) (X_2)	Fare (thous. UAH) (X_3)	Income rate UAH per 10 t-km (X_4)	Average distance of transportation (km) (X_5)	Average loading, tons (X_6)
2013	0,8305	0,9538	0,8620	-0,3825	-0,2253	0,3665
2014	0,8764	0,8402	0,8599	-0,3663	0,0381	0,3547
2015	0,9059	0,8599	0,8784	-0,3665	0,1903	0,4020
2016	0,9446	0,9779	0,8962	-0,3665	0,1984	0,3898
2017	0,9603	0,9841	0,9197	-0,2793	0,0358	0,3427
2018	0,9109	0,9748	0,9148	-0,2620	0,0679	0,3231
2019	0,8858	0,9703	0,9167	-0,2644	0,0466	0,3266
2020	0,8747	0,9743	0,9415	-0,2374	0,1569	0,3203
min	0,8305	0,8402	0,8599	-0,3825	-0,2253	0,3203
max	0,9603	0,9841	0,9415	-0,2374	0,1984	0,4020

The correlation coefficients of the dependence of cargo turnover (export) on the main factors allowed one to find out the most significant of them. The most influential factors that determine the volume of export cargos turnover in the study period are the number of wagons (X_1), weight (X_2), and fare (X_3) (Table 3). A moderate connection exists between the average loading (X_6) and the export cargos turnover. The income rate (X_4) and the average distance of transportation (X_5) have practically no effect on the export cargos turnover.

Table 4. Dynamics of dependence of cargo turnover (domestic transportation) in 2013-2020 by types of cargo on the main factors

Years	Factors					
	Number of wagons (X_1)	Weight (thous tons) (X_2)	Fare (thous. UAH) (X_3)	Income rate UAH per 10 t-km (X_4)	Average distance of transportation (km) (X_5)	Average loading, tons (X_6)
2013	0,6141	0,9837	0,8970	-0,4013	-0,3004	0,2896
2014	0,4101	0,8312	0,8452	-0,3613	0,3652	0,2921
2015	0,3953	0,8452	0,8629	-0,3277	0,2829	0,2940
2016	0,3890	0,9950	0,8240	-0,3015	0,3783	0,2429
2017	0,3598	0,9930	0,7955	-0,3557	0,2573	0,2666
2018	0,3872	0,9921	0,8054	-0,3829	0,1731	0,2674
2019	0,3347	0,9895	0,7590	-0,3880	0,2278	0,2963
2020	0,3096	0,9846	0,7531	-0,3309	0,2592	0,3130
min	0,3096	0,8312	0,7531	-0,4013	-0,3004	0,2429
max	0,6141	0,9950	0,8970	-0,3015	0,3783	0,3130

The correlation coefficients of the dependence of cargo turnover (domestic transportation) on the main factors allowed one to find out the most significant of them. The most influential factors that determine the volume of domestic traffic are the weight (X_2) and the fare (X_3) (Table 4). But unlike other types of transportation, for this type of transportation there are no factors that are not important from this list. All other factors (number of wagons (X_1), income rate (X_4), average distance of transportation (X_5), average loading (X_6)) have a moderate influence on the volume of domestic cargos turnover. A comprehensive assessment of the density of the impact of key factors on the volume of freight turnover by type of transportation allowed us to reach such results:

- It identified the most influential factors for all types of transportation - weight (X_2) and fare (X_3).
- It identified that, for imports, exports and transit transportation, a moderate connection with the factor a number of wagons (X_1) exists.
- It identified that, for imports, exports and transit transportation, a weak connection with factors an income rate (X_4) and the avarage distance (X_5) exists.

Multidimensional assessment of the homogeneity of factors

Modeling of the semantic differential involves a cluster analysis of the main factors influencing the volume of cargo turnover. This procedure involves the application of the method of hierarchical clustering (the method of "closest convergence," in some sources this method is called the method of "nearest neighbor"). The calculations were performed using the program SPSS (Statistical Package for the Social Sciences). Figures 7 – 10 show clusters (homogeneous groups) as a result of multidimensional grouping of transportation indicators by types of transportation for eight studied years.

Figure 7. Dendrogram of transportation work (import) of JSC "Ukrzaliznytsia" during the period 2013-2020

According to Figure 7, the most similar groups formed variables X_4, X_5, X_6 (cluster 1) and X_2, X_3 (cluster 2), with a small distance from the variables X_4, X_1. These two clusters illustrate the differentiation between these indicators. The results illustrate the conclusions made in Table 1.

Figure 8. Dendrogram of transportation work (transit) of JSC "Ukrzaliznytsia" during the period 2013-2020

One can conclude from Figure 8 that the indicators X_2 and X_3 form a cluster (1), which is the most independent. Cluster 2 is formed by homogeneous indicators by the degree of impact on transit cargo turnover – X_1, X_5, X_6. And a separate cluster of distances, which differs from other clusters, is formed by variable X_4. This conclusion coincides with the conclusions made in Table 2.

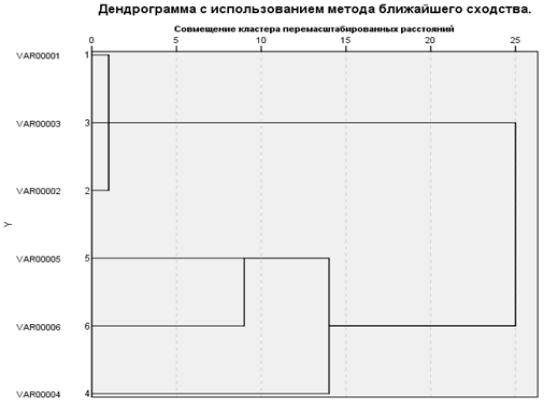

Figure 9. Dendrogram of transportation work (export) of JSC "Ukrzaliznytsia" during the period 2013-2020

One can conclude from Figure 9 that the indicators X_1, X_2 and X_3 form a cluster (1), which is the most independent. Cluster 2 and cluster 3 are formed by homogeneous indicators on the degree of impact on export cargo turnover – X_4, X_5, X_6. This conclusion coincides with the conclusions made in Table 3.

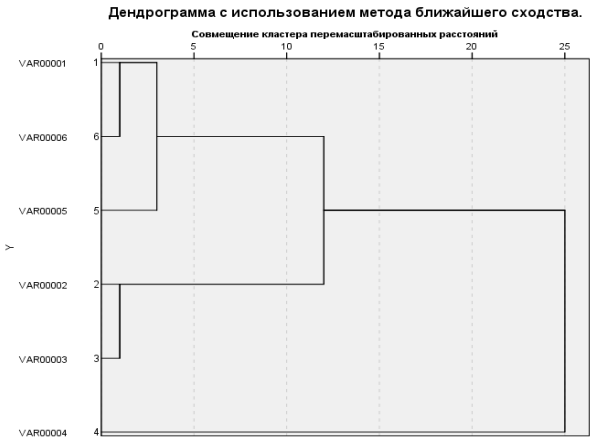

Figure 10. Dendrogram of transportation work (domestic transportation) of JSC "Ukrzaliznytsia" during the period 2013-2020

If we analyze the indicators of the impact degree based only on the correlation analysis, the indicators X_1, X_4, X_5, X_6 approximately equally determine the cargos turnover of domestic transportation (Table 4). But the results of hierarchical clustering (Figure 10) show that indicators X_2 and X_3 form a homogeneous group (cluster 1), while the indicators X_1, X_5, X_6 form cluster 2. And the distance of X_4 indicator from others is the largest. Thus, this gives grounds to claim that the income rate indicator for domestic transportation needs further research. Because it shows indirect connection, that is, with the growth of the income rate, domestic cargo turnover decreases.

CONCLUSION

In our paper, the semantic differential method as an innovative tool for the harmonization of interests for transport companies and consumers of their services, as well as managing the transportation by railway transport of Ukraine in the field of freight transportation, was proposed. And this is the essence of the innovative approach of our study. It involved performing certain procedures. The content of the procedures involved the practical implementation of the three-dimensional basis of the semantic differential. The first dimension is conducting an expert assessment. Based on the results of its practical implementation, the importance of transportation work indicators for clients of JSC "Ukrzaliznytsia" services was identified. According to the received results of the survey, a number of problems were diagnosed,

in particular: 20% of respondents are not satisfied with the available number of wagons for cargo transportation (X_1); more than 50% of cargo owners have claims that concerns the possibility to transport the desired amount of cargo (X_2); only 20% of respondents believe that the fare for cargo transportation corresponds to the ratio of "price-quality" (X_3); the validity of the income rate is obvious only for 14% of respondents (X_4). The second and the third dimensions of the semantic differential provide an opportunity to avoid subjectivism in assessing the quality of service of JSC "Ukrzaliznytsia". The second one is the determination of the density of the connection. According to the results of correlation analysis, the most influential indicators of transportation work by types of cargo and types of connections (import, transit, export, domestic transportation) were established. It was discovered that the most influential indicators of transportation work are the weight of the cargo (X_2) and the fare (X_3). The third dimension is a multidimensional assessment of the homogeneity of factors. It is concluded that the variables X_2 and X_3 for all types of transportation get into one cluster (for some types of transportation they were joined by other variables). This allows us to state the importance of the general conclusions for the management of JSC "Ukrzaliznytsia" in the strategic planning of transportation, we advise to focus on these indicators. Semantic differential modeling can serve as an effective tool in strategic planning not only for railway enterprises, but also for those institutions where it is necessary to identify the most important areas of activity.

Many researchers determine the degree of influence of factors only using the Chaddock scale. Depending on the purpose of the study, this may be justified. But our authors' approach to the study in terms of semantic differential involved the use of the Chaddock scale as a null hypothesis (H_0) and an alternative to it (H_a), and subsequent testing of this hypothesis by the method of hierarchical clustering. Thus, the source of our research is a questionnaire conducted on cargo owners on the degree of satisfaction with the level of management of transportation work. Evaluation of this result contained a complex structure and included three components. The first is a system for monitoring the satisfaction of consumers of transport services. The proposed monitoring system consists of an appropriate questionnaire and processing of results. The second component is the assessment of the density of connections between cargo turnover by type of transportation and the leading transportation indicators. The third one is a multidimensional assessment of the homogeneity of factors by hierarchical clustering. The implementation of the proposed procedures in the complex is a modeling of the semantic differential as a tool for managing the transportation by railway transport of Ukraine in freight transportation.

It is necessary to point out that the use of the semantic differential has its limitations, which are limited by the multiplicity of interpretations that arise in the mind and psyche of the researchers. We made attempts to minimize subjectivism in management decisions made in the study. The use of semantic differential based on the involvement of quantitative methods of mathematical modeling allows increasing the degree of validity of management decisions. The semantic differential can be applied to all B2B companies, not only to the transport industry. In our understanding, the harmonization and balancing of interests in the field of B2B take into account the results of modeling the semantic differential in management.

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Abstrakt

CEL: Celem naszego opracowania jest wypracowanie innowacyjnego podejścia do naukowego uzasadnienia i praktycznego wyważenia interesów właścicieli ładunków i firm transportowych, które posłuży jako narzędzie do zarządzania frachtem. METODYKA: Zaproponowano konkretny algorytm działań, który wstępnie przewiduje stworzenie

systemu wskaźników do badania zarządzania transportem. Metody badawcze obejmują złożoną metodę semantycznego modelowania różniczkowego, która integruje analizę korelacji i regresji, analizę skupień oraz oceny eksperckie. Podstawą tak złożonej metody jest integracja trzech komponentów: i) systemu monitorowania satysfakcji konsumentów usług transportowych; ii) ocenę gęstości powiązań między obrotem ładunków według rodzaju transportu a wiodącymi wskaźnikami przewozowymi; iii) wielowymiarową ocenę jednorodności czynników poprzez hierarchiczne grupowanie. WYNIKI: Semantyczne modelowanie różniczkowe może być skutecznym narzędziem planowania strategicznego nie tylko dla firm transportowych i kolejowych, ale także dla tych instytucji, w których konieczne jest zidentyfikowanie najważniejszych obszarów działalności. IMPLIKACJE: Zastosowanie semantycznego modelowania różniczkowego opartego na zaangażowaniu ilościowych metod modelowania matematycznego pozwala na zwiększenie stopnia trafności decyzji zarządczych. Harmonizacja i równoważenie interesów w obszarze B2B uwzględnia wyniki modelowania w zarządzaniu. Proponowana metodologia składa się z głównych wskaźników transportu taboru oraz niektórych wskaźników ekonomicznych. Wskaźniki te uzyskano dzięki współpracy z ekspercką grupą uczestników procesu transportowego. Zastosowanie stworzonego modelu pozwala na określenie kierunków priorytetowych w zakresie obsługi właścicieli ładunków przez koleje ukraińskie według rodzajów ładunków i przewozów oraz uzasadnienie odpowiednich decyzji zarządczych przez przewoźników towarowych. ORYGINALNOŚĆ I WARTOŚĆ: Innowacja to kompleksowa interdyscyplinarna integracja metod badawczych opartych na filozofii semantycznego modelowania różniczkowego, pozwalająca na integrację podejść harmonizujących interesy firm transportowych i konsumentów ich usług z wynikami współpracy w zakresie przewozów towarowych. Dlatego opracowaną innowacyjną metodologię można wykorzystać nie tylko w transporcie kolejowym, ale także w innych rodzajach transportu i działalności.

Słowa kluczowe: *modelowanie, harmonizacja interesów, zróżnicowanie semantyczne, transport towarowy, właściciele ładunków, podejście innowacyjne, analiza skupień, analiza korelacji i regresji, zarządzanie transportem*

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Conflicts of interest

The authors declare no conflict of interest.

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