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Assessment of the logistics service provider PKP Cargo using indicator analysis

Ocena usługodawcy logistycznego PKP Cargo z wykorzystaniem analizy wskaźnikowej

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Abstract. The aim of this article is to select indicators that can be used to evaluate a logistics operator in the field of rail transport services. The article presents the characteristics of PKP Cargo and assesses this service provider. The research problem posed in this study is: How should a logistics operator be evaluated? The hypothesis put forward in the article is: The use of ratio analysis enables the construction of a model for assessing the logistics service provider, PKP Cargo. The publication presents results from an analysis of literature and legal acts, as well as findings from a diagnostic survey conducted using interviews with employees in the railway sector. The results presented in the article also rely on statistical data published by PKP Cargo S.A. The research fills a niche in exploring a new approach to ratio analysis. A substantive selection of available indicators and measures was undertaken to identify those most important for evaluating the effectiveness and efficiency of transport activities. A set of selected indicators and measures characterizes the company's operations. The research findings may be useful for comparative assessments of railway companies providing logistics services. This example also enables the detection of imperfections in the system of rail transport services operation and provision. As a result, the findings can be used to enhance the level of effectiveness and efficiency in PKP Cargo's transport service activities.

Keywords: rail transport, PKP Cargo, efficiency of the transport, transportation services, indicator studies

Abstrakt. Celem artykułu jest wybór wskaźników i mierników, które mogą zostać wykorzystane do oceny operatora logistycznego w zakresie usług realizowanych transportem kolejowym. Artykuł przedstawia charakterystykę przedsiębiorstwa PKP Cargo oraz ocenę usługodawcy. W pracy postawiono następujący problem badawczy: W jaki sposób dokonać oceny operatora logistycznego? Czy analiza wskaźnikowa może zostać wykorzystana do oceny PKP Cargo? W artykule postawiono następującą hipotezę: Wykorzystanie analizy wskaźnikowej pozwala na dokonanie oceny usługodawcy logistycznego PKP Cargo. W publikacji zaprezentowano wyniki analizy literatury i aktów prawnych oraz rezultaty sondażu diagnostycznego sporządzonego techniką wywiadu z pracownikami sektora kolejowego. Wyniki przedstawione w artykule są również oparte o dane statystyczne pochodzące ze źródeł opublikowanych przez przedsiębiorstwo PKP Cargo S.A. Badania prezentowane w artykule wypełniają niszę badawczą z zakresu nowego podejście do analizy wskaźnikowej. Dokonano selekcji merytorycznej dostępnych wskaźników i mierników celem wybrania takich, które są ważne z punktu widzenia efektywności oraz sprawności realizacji działań transportowych. Zbiór wybranych wskaźników i mierników charakteryzuje działalność spółki. Wypracowane wyniki badań mogą być przydatne do dokonania oceny porównawczej przedsiębiorstw świadczących usługi transportowe. Ponadto możliwe jest wykrycie niedoskonałości systemu funkcjonowania i realizacji usług transportem kolejowym. W efekcie czego uzyskane wyniki mogą posłużyć do podniesienia poziomu efektywności i sprawności realizacji działań w zakresie usług transportowych przez PKP Cargo.
Słowa kluczowe: transport kolejowy, PKP Cargo, efektywność usługodawcy transportowego, usługi przewozowe, analiza wskaźnikowa

Introduction

In 2001, PKP Cargo was established. This company, along with other independent railway companies, took over the primary responsibilities related to the bulk transport of goods. To assess the effectiveness of PKP Cargo, the indicator method was employed. This method facilitates a comprehensive analysis through the use of appropriately selected logistic measures and indicators. The collective set of available indicators and metrics was quite extensive. Considering the objectives of the study, a selection was made, choosing those indicators crucial for assessing the effectiveness of the company's operations. The aim of this article is to prepare an assessment of PKP Cargo as a transport service provider. The purpose of the article enabled the formulation of a research question: How can a logistics service provider be accurately evaluated using PKP Cargo as a case study? The choice of PKP Cargo was justified by the availability of quantitative data, collected from railway sector employees and published by PKP Cargo itself, and by the company's prominent position among Polish enterprises. Ratio analysis allows for the comparison of phenomena across different time periods, an important element of the assessment. However, accurate assessment requires the appropriate selection and combination of indicator groups. An incorrect selection can lead to imprecise and ineffective evaluations, posing a significant risk.

Solving the research problem required the use of several appropriately selected research methods. These methods include analysis of literature and documents, synthesis, deduction, induction and comparison.

Development and operation of PKP CARGO

One of the stages in the development of strategic means of communication, including rail transport, was the enactment of the Act of 8 September 2000 on the commercialization and restructuring of the state enterprise "Polish State Railways" (Journal of Laws of 2000, 84, item 948). As a result of the organizational restructuring, on 1 January 2001, PKP S.A. was established and railroad companies were spun off (Dylewski, 2012). Since July 1, 2001, among others, LHS (Zamość), PKP SKM (Gdynia), PKP WKD (Grodzisk Mazowiecki), CS (Warsaw) were created, while from September 1, PKP Intercity Sp. z o.o. began to function. This was followed by such companies as PKP Energetyka Sp. z o.o; PKP Informatyka Sp. z o.o; PKP PLK SA, PKP Cargo Sp. z o.o; PKP PR Sp. z o.o; and PKP Telekom Sp. z o.o. The aforementioned organizational arrangements fulfilled their tasks until the end of 2008, but in 2009 a number of restructuring measures were launched. The functioning and management of the company was streamlined. Numerous changes were made to the issue of reorganization of the company's plants, which consisted of reducing them from 42 to 16, and a reduction in employment by 16 thousand people was also carried out (rp.pl, 2023).

A key moment in PKP Cargo's development was the application for a safety certificate. This is a document consisting of two parts, A and B, which allows PKP Cargo to obtain permission to carry out its rail freight operations not only in Poland, but also in European Union member states. PKP Cargo received a Part A safety certificate in 2009, which certifies that the safety management system of a rail carrier complies with the standards set forth in national and EU regulations. On the other hand, in 2010 the railroad company received a Part B safety certificate, which is confirmation that it has been granted permission to operate within the territory of European Union countries (Piotrowska, 2016, pp. 69-72).

PKP Cargo has begun dynamic mutual cooperation with the far eastern country of China since 2013. Within the framework of the New Silk Road, the PKP Cargo Group and Zhengzhou International Hub in 2015 concluded an agreement that turned out to be a precursor to the establishment of a joint venture company responsible for the implementation of container transportation by rail between European countries and China.

An extremely important element in the operation of any enterprise or company is to define a strategy, which includes having a mission. PKP Cargo Group is Poland's largest and Europe's second largest provider of rail transportation. Its mission is „To realize a comprehensive logistics service in the market of rail freight and intermodal services giving the position of first choice supplier" (pkpcargo.pl, 2023). Currently, it can be seen that rail transport is one of the main sectors of the economy. Additionally, rail transport is one of the key types of military transport

(Piękoś, 2022, pp. 6). PKP Cargo provides a lot of services to the Armed Forces and must take this into account in its strategy.

In addition to the mission and vision, the company also specifies certain strategic goals and short-term objectives as part of the developed strategy. The former are a determinant of the direction of action over a properly adopted time horizon. All this is further supported by human factors, such as awareness, knowledge, intellect, determination in pursuit of the goal, ability to make accurate decisions, misses and innovations (Wiśniewski, 2022). For PKP Cargo, one of the goals set out in the company's strategy is to become a leader in terms of freight work performed and cargo mass transported in the EU zone. In its efforts, the company aims to increase its share measured by freight work to 65% in the domestic market in terms of rail freight by 2023. (pkpcargo.pl, 2023).

The company PKP Cargo focuses on the use of an extensive network of rail connections corresponding to the location of key distribution and supply markets, develops the speed and regularity of the currently offered connections, takes care of highly specialized rolling stock for the transportation of a variety of cargoes, and the compatibility of the implementation of operations during transport with containers (Kwaśnikowski, Gramza, Medwid, 2010, pp. 77-79).

Achieving properly set goals is possible by taking small steps toward certain objectives. Such a procedure effectively and efficiently brings the enterprise closer to the set goal. It is helpful to set short-term goals. For PKP Cargo, it is important to prepare a maximally competitive proposition for business associates, annual gains in operational efficiency balanced by key performance indicators (Smyk, 2023, pp. 43-46). The company aims to maintain an annual net profit of a minimum of 5% of revenue from 2019 and a minimum of 8% of revenue from 2023. PKP Cargo is also focusing on the issue of sustaining share price growth that would outpace that of the WIG30 (pkpcargo.pl, 2023).

Assumptions for the assessment of a logistics service provider

An assessment of PKP Cargo can be made using various methods. Noteworthy is the indicator method, which allows to evaluate a selected enterprise with the help of appropriately selected measures and logistic indicators. A measure, according to the proposal of J. Twaróg, is "an economic and logistic category reflecting the events and facts of management in the enterprise and its environment, expressed in appropriate units of measurement."(Twaróg, 2003, pp. 23). Considering the totality of the above factors and taking into account the aspects mentioned above, it can be said that a measure is a number that represents a certain phenomenon, which gives its measure and the possibility of comparing it with other phenomena (Twaróg, 2003,

pp. 23). The purpose of a measure in logistics services is to measure logistics events. The priority task of meters is that they meticulously reflect the actual transformations in logistics processes over a certain period of time, which show the locomotion of raw materials, semi-finished materials, finished products and information in the right quality, quantity, place and time (Krzysztofik et al., 2022, pp. 1-3).

An indicator, on the other hand, is an economic category depicting the events of material circulation in the logistics system of a given enterprise, as well as the supply chain. An indicator is called a relative number expressing the reciprocal ratio of certain statistical quantities, such as the product price index. The purpose of the indicator in logistics services is primarily to estimate the activities and received effects of the logistics systems of enterprises and to compare their elements. The key task of the indicator is to provide the necessary information on current and future tasks in the system and to study the efficiency of logistics services (Dmuchowski, 2019, pp. 91-92).

In order to present the scale of the studied problem, it is necessary to detail a more extensive list of indicators and measures that apply to the selected enterprise, which is PKP Cargo. Table 1. presents the analyzed type of subsystem, which is transport, and shows the definition of the measure.

Table 1. Selected measures on the transport subsystem

Economic measures of transport	Average transportation costs per 1 kg/ 1 T
	Transportation costs per 1 transport order
	Unit costs per to-kilometer
	The share of transportation costs in the cost of contract execution
	Share of transportation costs in total supply chain costs
	Value of means of transport
	Depreciation costs of means of transport
Measures of transport quality	Degree of handling of transport orders
	Timeliness of transports
	Frequency of accidents
	Frequency of damage to vehicles

cd. tab.1

Forwarding and transportation data and framework measures	Number/load/capacity of fleet
	Weight/volume of cargo carried
	Number of kilometers driven
	Average number of hours of operation of the means of transport
	Number of repairs
	Degree of mechanization and automation
	Number of transport workers
	Transport readiness of vehicles in the year
	Transport costs
Measures of productivity and efficiency of transport operations and the level of utilization of the transport fleet	Transport time per 1 transport order
	Degree of use of means of transport
	Efficiency of means of transport
	Number of kilometers per mode of transport
	Number of kilometers per 1 driver
	Number of customers served per route
	Average repair time

Source: Own study based on (Śliwczyński, 2007)

Table 2. illustrates the analyzed type of transport subsystem and shows the definition of the indicator.

Table 2. Selected indicators for the transport subsystem

Transport reliability indicator
Fleet load indicator
Failure indicator of transport means
Accident frequency indicator
Load planning indicator
Transport intensity indicator
Indicator of cargo damage during transport
Timeliness indicator of transport
Driver load indicator
Structure indicator

Source: Own study based on (Śliwczyński, 2007)

Table 3. illustrates a set of selected indicators and measures characterizing the activities of PKP Cargo.

Table 3. Selected measures and indicators for creating a logistic service provider assessment model

INDICATORS	MEASURES
Timeliness indicator of transport	Transport cost per ton-kilometer
Transport reliability indicator	Load on the transport fleet
Indicator of cargo damage during transport	The cost of maintenance and upkeep of the means of transport
	Fuel efficiency measure

Source: Own study

The available set of measures and indicators is quite extensive. After taking into account the purpose of the conducted considerations, a substantive selection of the given indicators and measures was made. Those that are important from the point of view of efficiency and effectiveness of activities by PKP Cargo were selected. The selected indicators and measures are described below.

The timeliness indicator of transport is the percentage of the number of transports performed on time in all completed transports , calculated according to the following formula:

$$T_p = \frac{P_t}{p} \times 100\% \ [\%] \tag{1}$$

Another indicator is transport reliability . This is the percentage of the number of transports that comply with the transport order and the order of a specific customer in all completed transports , calculated according to the following formula:

$$\eta_t = \frac{P_z}{p} \times 100\% \ [\%] \tag{2}$$

Indicator of cargo damage during transport is the percentage of the number of damaged transport units in all transported cargo units , calculated according to the following formula:

$$U_ł = \frac{U_{jt}}{L_{jt}} \times 100\% \ [\%] \tag{3}$$

The fuel efficiency measure is calculated as the quotient of the product - distance traveled in kilometers and cargo transported in tons – to the amount of fuel consumed in liters . The given measure is calculated according to the following formula:

$$W_p = (D \times Ł)/L_p \left[\frac{km \times t}{l}\right] \tag{4}$$

The transport cost per ton-kilometer is the average transportation cost incurred per ton-kilometer calculated according to the following formula:

$$C_t = \frac{C_{tr}}{S}\left[\frac{zł}{t \times km}\right] \quad (5)$$

The next measure considered is the load on the transport fleet , the average weight of freight carried by the number of means of transport calculated according to the formula:

$$O_t = 5{,}18\left[\frac{t}{vehicle}\right] \quad (6)$$

Another measure is the cost of maintenance and upkeep of the means of transport , that is, the average cost of maintenance and upkeep of one transportation asset over a given period of time.

$$k = 11764{,}7\left[\frac{zł}{vehicle}\right] \quad (7)$$

The main goal of the model is to create a structure that comprehensively illustrates the characteristics and functions of an enterprise (Lexicon of science and technology, 1998). In this case, the focus was on evaluating the service provider PKP Cargo. In order to achieve this goal, various indicators and measures were used to provide a thorough analysis of the company's performance and efficiency. The analysis of the described indicators and measures makes it possible to identify potential causes of performance decline. Such problems arise from improper use of resources, suboptimal management of logistics processes or improper allocation of resources. By carefully analyzing these factors, it is possible to introduce an appropriate change to the logistics process management model at PKP Cargo. The created list of indicators is intended to reflect the quality of the phenomena and processes. It takes into account various aspects, such as transport efficiency, on-time delivery, customer service quality, resource utilization, operating costs, etc. This provides a complete picture of the company's functioning, allowing it to focus on the most costly areas of operations that need improvement. Conducting such an assessment of logistics process efficiency allows you to identify areas where changes can be made to increase efficiency. This can include optimizing routes, planning and managing transportation assets, improving the loading and unloading process, or increasing the efficiency of internal and external communications. By improving these areas, the flow of materials and goods can be increased and operating costs reduced.

Assessment of the Logistics service provider – PKP Cargo

The extracted statistical data published by PKP Cargo made it possible to assess the logistics service provider. Each of the listed indicators and measures has a separate role, but together they make it possible to assess the selected enterprise. The indicators template can be used to make an assessment in comparison with

another enterprise. However, the author did not conduct a comparison with another enterprise due to the monopolistic nature of the service provider PKP Cargo. Table 4. shows the collected data and estimates the percentage of relevant indicators.

Table 4. Calculated values of indicators for PKP Cargo

No.	NAME OF INDICATOR	COMPANY DATA	INDICATOR LEVEL
	Timeliness indicator of transport	$P_t = 238{,}112$ $P = 255{,}511$	$T_p = 93.19\%$
	Transport reliability indicator	$P_z = 253{,}879$ $P = 255{,}511$	$\blacklozenge_t = 99.36\%$
	Indicator of cargo damage during transport	$U_{jt} = 135$ $L_{jt} = 397{,}786$	$U_s = 0.03\%$

Source: Own study based on data: https://www.pkpcargo.com/pl [accessed: 27 March 2023] and information obtained from railroad employees

The level of the transport timeliness indicator is 93.19%, which shows that the company has no problems meeting the transport deadline. Some deviations from the benchmark value of the indicator may be due to errors made by the employed personnel. As a consequence of this, attention should be paid to the issue concerning the planning and control of the transports carried out. Meticulous determination of the hours of unloading and loading will also eliminate unnecessary stops of transport vehicles. In order to increase the indicator of timeliness transport, it is also necessary to focus on activities related to the operation of transport units and the systematic and consistent implementation of diagnostic tests, in order to prevent unexpected damage to the rolling stock.

The level of the transport reliability indicator is 99.36%. Each company strives to achieve 100% of this indicator. Considering PKP Cargo, the number of transports compliant in all respects with the transport order and the order is very high, which proves the appropriate level of customer service and reliability of the means of transport.

The level of cargo damage indicator during transport is 0.03%, which proves a very low accident rate of rail transport and its high efficiency. When analyzing the causes of damage more deeply, it can be concluded that they are mainly generated by shocks and inattention of the personnel during the proper securing of the transported load.

Table 5. presents a list of selected measures related to the activity of PKP Cargo along with their estimated values.

Table 5. Calculated values of measures for PKP Cargo

No.	NAME OF MEASURE	COMPANY DATA	MEASURE LEVEL
	Transport cost per ton-kilometer	$D = 100\,km$ $£ = 1560\,t$ $L_p = 350\,l$	$W_p = 445.71\left[\frac{km*t}{l}\right]$
	Load on the transport fleet	$C_{tr} = 5.24\,mld\,z$ $S = 55.9\,mld\,tkm$	$C_t = 0.09\ \left[\frac{z}{t*km}\right]$
	The cost of maintenance and upkeep of the means of transport	$m_t = 331,506\,t$ $q = 64,000$	$O_t = 5.18\left[\frac{t}{vehicle}\right]$
	Fuel efficiency measure	$k_c = 780\,mld\,z$ $q = 64,000$	$k = 11,764.7\left[\frac{z}{vehicle}\right]$

Source: Own study based on data: https://www.pkpcargo.com/pl [data accessed: 27.03.2023], https://www.rynek-kolejowy.pl [accessed: 27 March 2023] and information obtained from railroad employees

The value of the fuel efficiency measure is 445.71 $\left[\frac{km*t}{l}\right]$ which shows that it is relatively lower and thus definitely more favorable than in the case of self-car transportation. In order to improve the level of this meter, it is necessary to consider using more modern locomotives and to purchase more ergonomic railcars. It is worth mentioning that Western European service providers identify themselves with a lower level of this measure.

The value of the measure - transport cost per ton-kilometer is 0.09 . This is an average value that only gives an idea of unit costs. The level of this measure is strictly dependent on the measure of fuel efficiency; however, it is not determined solely by this value.

Another measure is the load on the transport fleet. Its value is 5.18 and indicating relatively poor utilization of transportation means. This is evidenced, for example, by the characteristics of the goods transported and the values of permissible wagon loads. In addition, this measure is closely dependent on the planning process for the use of the transport fleet. Unfortunately, in this aspect, rail transport significantly deviates from the accepted norms and the loading of automobile means of transport. Disruptions in supply chains significantly impact business costs, especially opportunity costs. This cost is a measure of the value of lost benefits related to the inappropriate use of its resources (Gądek-Hawlena, 2023, pp. 183-184).

The other measure examined is the cost of maintenance and upkeep of the means of transport, and it is11,764.7 $\left[\frac{zł}{vehicle}\right]$. The level of this indicator may seem high. However, this is due to the variety of rolling stock used. The most capital-intensive rail vehicle is the locomotive. The operation of the towing vehicle is several times higher than that of the railcar itself. However, comparing the value of this measure with automobile means of transport, rail transportation has a value several times lower. Proper planning is necessary to maximize the availability of locomotives and cars for preventive maintenance. You need to use efficient heuristic and meta-heuristic algorithms that are able to find optimal solutions. Simulations based on real data show that appropriate timetables significantly improve the availability of railway vehicles, which translates into high potential financial benefits for railway companies (Rudek, Rudek, 2024, pp. 2-4)

PKP Cargo, wishing to carry out mass transport, should sustain relatively low prices for medium- and long-distance transport. Each of the indicators and measures mentioned has a different function, but together they make it possible to assess PKP Cargo and other transport companies. At this stage of the assessment, it can be concluded that the company has no problems in meeting the freight deadline. In order to increase the timeliness of transports, it is necessary to focus on activities related to the operation of transport units and the systematic and consistent implementation of diagnostic tests, in order to prevent unexpected damage to rolling stock. It is worth adding that the activities of PKP Cargo are reducing the accident rate in rail transportation. The load on the transport fleet indicates a relatively poor utilization of transport assets. This is evidenced, for example, by the characteristics of the goods transported and the values of permissible wagon loads. The load also depends on the planning process for the use of the transport fleet.

Conclusions

The results of the conducted research confirm the assumption that the assessment of a service provider - PKP Cargo can be carried out using various methods. Noteworthy is the indicator method, which allows you to evaluate a selected company with the help of appropriately selected logistic measures and indicators. The purpose of the article was to prepare a indicators template that can be used to assess the transport service provider PKP Cargo. The goal was achieved. Indicator analysis made it possible to compare phenomena in different time periods. Correct assessment requires using the right groups of indicators and combining them into a single whole. It was extremely important to combine theoretical research methods. The indicator method made it possible to evaluate the enterprise with the help of

appropriately selected measures and logistics indicators. The model prepared by the author can be used to assess the transport company PKP Cargo and any service provider. There are several reasons explaining why this example can be used more widely. The indicators template was developed to reflect the general characteristics and functions of transportation companies. It covers various aspects, such as operational efficiency, resource management, customer service quality, timely deliveries, operating costs, etc. As a result, it can be adapted to the assessment of various transport service providers, regardless of their size or specialization. The example is based on the use of indicators and measures that are commonly used in the transportation industry. They allow an objective assessment of the efficiency and effectiveness of a transport company. They make it possible to compare the performance of different service providers and identify areas where improvements are required. Effective management of logistics processes has a direct impact on customer satisfaction. By analyzing indicators related to the quality of service, timeliness of deliveries and effectiveness of communication, the model makes it possible to identify areas where the transport service provider can take action to improve customer service.

The elaborated template is universal, which makes it possible to assess various transport companies, including PKP Cargo. Its application makes it possible to identify areas for improvement, optimize logistics processes and increase customer satisfaction.

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