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Road Transport Outsourcing for a Metallurgical Company and Its Alternatives

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Abstract

The purpose of the work is to develop methodological tools for determining the potentialities of alternative options for efficient organization of road transport for a metallurgical company. Research methods include review of specialized scientific literature, systematic analysis of production processes, economic and mathematical modeling, SWOT analysis, technical and economic analysis. Based on the research, following results were obtained: - the options for organizing the transport support of metallurgical company in modern economic conditions, including the conduct of motor transport activities by the forces of its own motor vehicle workshop, internal and external outsourcing of motor transport services were identified; -the features of organization of road transport for metallurgical company were identified due to the presence of organizational and technological interconnection of customers and contractors of motor transport services; - the essence of the concept and the mechanism for ensuring the balance of interests of metallurgical company, customers of motor transport services, and road carriers, performers of these services, are mathematically interpreted; - the results of comparative analysis of potentialities of outsourcing and its alternatives for organizing transportation activities in metallurgical industry are presented. The results obtained are highly relevant. The use of recommendations proposed in the work will allow balancing the interests of customers and contractors of motor transportation services, making profitable motor transport activities effective for metallurgical production.

Keywords: Outsourcing; Road Transport; Metallurgical Company.

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1. Introduction

The chosen research topic is relevant due to the desire of owners of metallurgy enterprises to increase the efficiency of their business by optimizing the costs of internal, inter-workshop and external transport. This desire is due to the large transport component (up to 30%) in the cost structure of metallurgical products.

Transport is an integral part of any metallurgical processing, including extraction of ore raw materials and energy resources, their enrichment and preparation, smelting of iron and steel, production of sheet and long products, and application of polymer coatings. For transportation of raw materials between redistributions, transportation of finished products and waste from metallurgical production, both railway and automobile, as well as special vehicles are used. The main role is assigned to road transport in the supporting and auxiliary technological processes for delivery of varieties of material and technical resources, small-scale shipments of finished products, as well as for transportation of personnel.

At present, companies of various sectors of economy, including metallurgy, are coming to the need to choose between two options for motor transport support of production process: 1) creation and development of their own motor transport facilities (insourcing); 2) outsourcing of motor transport services. Insourcing is based on the use of internal resources of the company. Insourcing allows reducing resource intensity of transportation only if there are unclaimed reserves of technical and labor resources in other production processes of the enterprise, for example, production and technical base. This option of organizing road transport is characteristic primarily for large metallurgical corporations.

Outsourcing of motor transport services is used when a company seeks to get rid of non-core business processes. In this case, metallurgical company makes contracts with one or more trucking companies for carrying out transportation and related activities. If the contract is concluded with a third-party carrier, then external outsourcing takes place. The use of outsourcing leads to a decrease in the number of personnel of metallurgical company, eliminates the need to maintain a fleet of vehicles, thereby theoretically should ensure a reduction in transport costs.

Internal outsourcing takes place when a metallurgical company allocates its own motor transport workshop to a legally independent organization, which is its subsidiary. In addition to all the advantages of outsourcing, this option of road transport service provides the customer with more options for operational control of transport process and quality of road transport services.

In practice, there are examples of successful implementation of both insourcing of transport and logistics activities, as well as internal and external outsourcing of transport services in various sectors of economy. Therefore, it is impossible to unambiguously judge the advantages of this or that option of organizing road transport services for large industrial enterprises, since the success or failure of its practical implementation is primarily determined by the organizational and technological specifics of customer's production system.

Specificity of production system of metallurgical company, which determines rational option for organizing road transport, is organizational and technological relationship between customers and contractors of road transport services, which is expressed in following:

- most of the fleet consists of specialized or converted equipment for the needs of metallurgical shops;
- rolling stock is an element of continuous technology of metallurgical units;
- carrier's production and technical base is part of the customer's production infrastructure;
- rolling stock rolling out and shift schedules for drivers are planned based on the rhythm of the main production.

The integration of transport process into production system of metallurgical company, as well as the need for constant monitoring of transport process by the customer, caused by the high reliability of transport services, makes it difficult to choose the option of organizing road transport in direction of external outsourcing. At the same time, internal outsourcing of road transport increases the risk of lower transportation costs by reducing the revenue side of carriers. When insourcing, when the carrier is practically deprived of revenue, reduction of transport costs is usually made by reducing investment programs to modernize the fleet and transport infrastructure. Therefore, the option of organizing road transport should be optimal to ensure a balance of interests in desire of customers to reduce costs for road transport services and in desire of carriers to avoid reducing profitability of their business and the loss of funds for their development.

The mechanism proposed in this work to ensure the balance of interests of customers and contractors of motor transport services is based on the identification of reserves of production resources hidden in the transport process. In modern research, this approach is called lean transportation. Recommendations for determining the reserves of production resources in transport process using lean production methods are proposed, for example, in the works of Iyer et al., 2019, Cherrafi et al., 2018, Garza-Reyes et al., 2017, Jakhar et al., 2018, Huo et al., 2019, Villarreal et al., 2017. In modern studies of this scientific direction, resource-saving approaches to the formation of supply chains are proposed, specific examples of successful implementation of proposed resource-saving technologies are described, positive influence of lean concept is proved sustainability of environmental, social and economic indicators of transport processes. However, as further studies have shown, including studies by the authors of this work (Kurganov et al., 2018; Kurganov et al., 2019; Sai et al., 2020), proposed lean transportation recommendations do not fully take into account specifics of metallurgical production.

It is advisable to carry out optimization of managerial decisions on organization of automobile transportation, guided, along with the lean concept, by the methods of situational management of production processes (Kurganov et al., 2019). The peculiarity of this scientific approach is that the environment in which the managerial decision is made is characterized by high dynamism and instability of influencing factors of a random nature, which is typical for the course of production processes in metallurgy. As applied to the organization of road transport, the situational approach has been developed in terms of mathematical support and general algorithms for making managerial decisions to increase the efficiency of road transport.

However, approaches proposed by modern scientific literature to reduce the cost of road transport in the metallurgical industry are not exhaustive for adjusting the balance of interests of customers and contractors of motor transport services. At present, there is no mathematical model for balancing the interests of metallurgical company and automobile carrier; in fact, there is no tool to justify the choice of options for efficient organization of transportation activities in the area under consideration. Development of such methodological tools is the purpose of this work. Development of research in the chosen direction contributes to the solution of currently relevant scientific and practical problem of reducing the cost of road transport in metallurgical production.

2. Methods

The results of the study were obtained using a set of standard methods, including review of specialized scientific literature, systematic analysis of production processes, economic and mathematical modeling, SWOT analysis, technical and economic analysis.

Formation of proposed methodological tools was preceded by a review of scientific literature and other sources of information, which resulted in the identification of successful implementation and outsourcing of motor transport services in the domestic industry, established methods for identifying the reserves of production resources hidden in the transport process, and selected the scientific approach for managerial solutions to the organization and management of road transport in metallurgical industry. At this stage of the study, work was carried out to establish theoretical foundations for ensuring a balance of interests between metallurgical company and automobile carrier.

Systematic analysis of production processes was used in this study to identify the features of organization of road transport in metallurgical production, due to the presence of organizational and technological relationship of customers and contractors of motor transport services. At the same time, transport process was detailed for technological operations in relation to the work of the main metallurgical shops. This made it possible to determine structural and functional relationship between the elements of basic technology of metallurgical production and the elements of transport process, which makes the transport process an integral part of production system of customers of transport services.

Mathematical interpretation of the essence of concept and mechanism for ensuring the balance of interests of metallurgical company and automobile carrier was carried out using economic and mathematical modeling. An economic-mathematical model was developed to ensure a balance of interests, including the objective function, system of restrictions, description of the elements of proposed economic-mathematical model, as well as sources of non-required reserves of production resources in the transport process necessary to adjust the balance of interests.

Potentialities of outsourcing and its alternatives for organizing transportation activities in metallurgical industry were determined using SWOT analysis. According to its results, strengths and weaknesses of implementation of

insourcing, internal and external outsourcing of motor transport services were identified, potentialities and threats in using these options for metallurgical company and carriers are indicated.

By means of a feasibility study involving a comparison of actual and forecast indicators of insourcing and outsourcing of transport process, a preferred option for organizing the transportation activity of one of the largest steelmaking companies in the Ural region of Russia has been established.

3. Results

The essence of the concept of balance of interests proceeds from the definition of market relations where the customer and the contractor of transport service are composed. In a general sense, market relations are understood as relations between market participants, including exchange of information, goods and services, aimed at achieving their goals by each of the market participants. The commercial nature of relationships of road transport market participants makes the goals pursued. The goal of the customer is to obtain a transport service of required quality at the lowest price. The goal of the carrier is to maximize the benefits of its activities. Multidirectional goals cause a conflict of interests between the customer and the executor of motor transport services.

In case the motor transportation service is road transportation, and its customer is a large enterprise with a continuous metallurgical cycle, the conflict of interest is aggravated by the strengthening of organizational and technological influence of the customer's production system on the carrier's activities. In fact, a road carrier must provide transport services to the customer, organizing its work in conditions of fluctuations in requests for transport, the need to maintain a large number of specialized and unclaimed equipment on the market, and great variability in the operating conditions of the fleet.

Both metallurgical company and transportation customer are guided by the potentiality of maximizing budget savings on transport services for its workshops (S). Being an equal participant in the market, but organizationally, technologically and financially dependent on the customer, the carrier is not interested in this approach, since this leads to the loss of income by a value (k), and carrier makes every effort to minimize such losses. Mathematically, it looks like this:

- transportation customer's goal:

$$S = b_{planned} - b_{actual} \rightarrow max, \quad (1)$$

where $b_{planned}$, b_{actual}– planned and actual budget of metallurgical company for transportation services of its workshops, thousand rubles.

- carrier's goal:

$$k = S \rightarrow min, \quad (2)$$

To adjust the balance of interests in this situation, it is necessary to establish the fundamental ways of saving the budget of metallurgical company for transport services of its workshops, as well as determine their positive and negative impact on the economic activities of interacting parties. All these methods are aimed at reducing the cost of transportation or resource consumption of transport process (Table 1).

Table 1. Fundamental ways to save the budget of metallurgical companies for transport service of their workshops.

Method	Metallurgical company		Transport carrier	
	Interest	Infringement of interest	Interest	Infringement of interest
Reduction in transportation costs	Reducing the costs of transport services of structural units.	Decrease in the quality of transport services of structural units.	Absent	Loss of profitability and lack of funds for development.
Reducing resource intensity of transport process		Increased likelihood of disruptions to the main production due to a possible shortage of transport	Reducing transport deficit to serve other customers.	Decrease in income caused by reduction in demand for transport services by the main customer.

As follows from table 1, the first group of ways to save the budget for transport services damages to a greater degree the economic interests of carrier, since it leads to a reduction in revenue, as well as to a loss of funds for development. Therefore, the balance of interests of both metallurgical company and carrier must be ensured by focusing on the technologically and economically viable reduction of resource intensity of transport process, which is indicated in the form of a matrix (Table 2).

Table 2. Matrix of interests of a metallurgical company and a carrier in saving the budget for transport services.

The way to achieve the optimization goal	Interest	
	Customer	Carrier
1. 1. Reduction in transportation costs	+	-
2. 2. Reducing resource intensity of transport process	+	+

- balance of interests in achieving the goal of optimization.

It is proposed to establish a balance of interests by planning by the customer an indicator of reducing transport costs for the reporting period of time, due to the development of measures aimed at reducing the carrier's consumption of production resources in the transport process. The planned reduction in resource intensity is mandatory for the carrier. This allows to use as a criterion of optimization the maximum savings of the budget of the metallurgical company for transport services of its workshops (formula (1)). A prerequisite for implementation of proposed mechanism for ensuring a balance of interests is the availability of reserves of number or time of use of rolling stock for the carrier, as well as absence of failures in the customer's main technology due to the implementation of optimization measures.

The presence of an optimization criterion, as well as stipulated conditions for its achievement, allows one to mathematically interpret the essence and mechanism of ensuring a balance of interests of a metallurgical company and a carrier in form of an economic and mathematical model:

target function:

$$S \to max, \tag{3}$$

restriction system:

$$\begin{cases} Q(t) \to 0 \\ 0 \prec \frac{S}{b_{planned}} \leq P \\ r_{actual} \geq r_{planned} \end{cases}, \tag{4}$$

where Q(t) – probability of failures in the customer's main technology due to the implementation of optimization measures, %; P – profitability level ensuring economically sustainable activity of carrier; r_{actual} – reserves of the number or time of use of rolling stock held by carrier, vehicle-hour; $r_{planned}$ – the number of vehicle- hours planned by customer for optimization, vehicle-hour.

The condition stipulated by the system of restrictions ($r_{actual} \geqslant r_{planned}$) ensures the operability of the economic-mathematical model. The measures taken should not lead to damage to the carrier's business activities, i.e., the profitability of its activities should not be lower than the value (P). In addition, the (P) value in the system of restrictions is only the upper limit of planned reduction of transport costs. Maximization of (S) will be welcomed by the customer; therefore, the proposed economic-mathematical model is an optimization one.

Sources of production resources unclaimed in the transport process that are necessary to adjust the balance of interests are:

- unregulated downtime of vehicles in the shops of customer;
- mismatch of operational parameters of vehicle weight and size characteristics of the transported cargo;
- inconsistency of interaction between dispatching services of transportation management and technological processes of metallurgical production;

- unsatisfactory reliability of customers planning of their needs in motor vehicles.

Identification and reduction of unauthorized by the main technology of workshop of vehicle downtime allows one to perform declared transport service with fewer vehicles. Assignment to a car route, the operational parameters of which correspond to the weight and size characteristics of the transported cargo, excludes payment by the customer of the transport work performed by a vehicle of a more expensive price group. Coordination of interaction between carrier and customer dispatching services ensures distribution of transport costs between several workshops, due to the formation of a schedule for securing the car during the shift across workshops, rational routing of transportation, including ring and pick-up routes, return routes loading. Improving the reliability of customers planning of their needs in road transport by rejecting applications for vehicles "with a margin", minimizing one-time and episodes transportation, by sorting, accumulating and consolidating shipments of cargo in workshops, directly reduces the budget for transport services. The methods of situational management associated with the designated sources of unclaimed reserves to reduce the resource intensity of transport process are systematized in table 3.

Table 3. Ways of situational management to reduce the resource intensity of transport process.

Source of Unclaimed Reserves	Situational Management method	Principle of reducing the resource intensity of transport process
The presence of unregulated vehicle downtime	Reducing the number of cars in the customer's workshop	Payment by the customer of transport services provided by less transport.
	Adjustment of the customer work schedule	Payment by the customer of a smaller volume of transport services.
	Customer's refusal of transport service of its workshop, through its transition to non-transport technology.	Reducing the cost of transportation provided to the customer's workshop, before its transition to non-transport technology.
Inconsistency of operational parameters of vehicle with overall dimensions of transported cargo	Use of transport of lower carrying capacity and cargo capacity, of lower price group	Payment by the customer of transport services performed by a car of a lower price group.
The inconsistency of interaction between dispatch services of transportation management and technological processes of metallurgical production	Formation of a schedule for securing a car during a shift in workshops	Cost reduction due to the distribution of costs for payment of transport services between several workshops.
	Organization of ring and pick-up routes	
	Providing a car with reverse loading	
Poor reliability of customers' planning of their needs for vehicles	Rationing the needs of workshops in vehicles	Reducing the budget for transport services by the amount of excess demand for transportation.

The effect in reducing the resource consumption of transport process will not be achieved if there is no automated monitoring of the use of vehicles in customer's workshops, based on the use of information and software tools for planning and organizing the interaction of participants in the transport process, normalizing and controlling excess vehicle downtime and customer needs for transport service, centralization of dispatch traffic control.

Achieving the goal set in this work requires a discussion of potential threats and potentialities for outsourcing and its alternatives for organizing efficient transportation activities in metallurgical industry. Using this or that transportation organization option, metallurgical company simultaneously acquires certain development opportunities and faces threats from the external business environment, i.e., difficulties that are independent of decisions made by the company's management. In addition, the company in each case has strengths and weaknesses, which are its advantages or "internal brake" in the competition, respectively. The presence of strengths and acquired capabilities of metallurgical company is an argument in favor of considered option for efficient organization of transportation.

One of the tools for choosing business strategies offered by economic theory is the SWOT analysis, which is often used in modern studies of various topics. For example, Lian Zhikang (2017) assesses the opportunities, threats, strengths and weaknesses of problem of reverse logistics of automotive industry in China. Luis Quesada and his colleagues in article (Luis et al., 2019) combine SWOT analysis with a balanced scorecard (BSC) to evaluate company performance. Peter Rauch (2015) uses SWOT analysis to assess strengths and weaknesses of primary

forest fuel supply chains in countries of southeastern Europe. This research method is the simplest and most accessible, despite the fact that it does not provide any numerical justification, especially since this is not the task of this study. Figure 1 shows the results of a SWOT analysis of a metallurgical company choosing an option for organizing transportation activities.

Outsourcing (third party company)

	Internal environment	External environment
Advantages	***S**trengths:* - reduction of transport costs in the cost structure of finished products; - disposal of non-core business processes and assets in full.	***O**pportunities:* - development of the main production at the expense of savings from transport costs.
Disadvantages	***W**eaknesses:* - limitation of the operational impact on the course of the transport process and quality control of transport services; - a balance of interests is achievable only if: $\frac{S}{b_{planned}} = const,$ This is fixed in the contract.	***T**hreats:* - increased risk of ongoing failures in the work of workshops, due to loss of controllability of the transport process; - increased risk of system failure of the main technology in the event of the carrier breaking the contractual relationship.

Outsourcing (affiliated undertaking)

	Internal environment	External environment
Advantages	***S**trengths:* - reduction of transport costs in the cost structure of finished products, if there are unclaimed reserves of production resources in the transport process; - getting rid of non-core business processes while retaining full or partial control over fixed assets; - strengthening the quality control of transport services and an almost complete impact on the course of the transport process; - a balance of interests is achievable provided: $0 < \frac{S}{b_{planned}} \leq P,$ Possible optimization.	***O**pportunities:* - development of the main production at the expense of savings from transport costs.
Disadvantages	***W**eaknesses:* - reduction of the positive impact of competition in the work of the carrier, as a priority provider of motor transport services.	***T**hreats:* - increased likelihood of loss of interest for investors due to increased capital intensity of production.

Insourcing

	Internal environment	External environment
Advantages	***S**trengths:* - reduction of transport costs in the cost structure of finished products, if there are unclaimed reserves of production resources in the transport process; - full control over all assets and the progress of the transport process.	***O**pportunities:* - development of the main production at the expense of savings from transport costs.
Disadvantages	***W**eaknesses:* - the practical lack of market tools for regulating the economic activity of the carrier; - running out of carrier reserves and residual investment in development; - no need for balance of interests.	***T**hreats:* - investing own funds of a metallurgical company; - inability to manage internal costs.

Fig. 1. SWOT analysis of choice of organization of transportation activity by the metallurgical company.

The results of SWOT analysis are the basis for further determining the potentialities of outsourcing and its alternatives for organizing transportation activities in the metallurgical industry.

4. Discussion

According to the results of the SWOT analysis, it follows that in all cases, metallurgical company reduces transportation costs due to savings, acquiring opportunities for development of production. With external and internal outsourcing of transportation activities, metallurgical company gets rid of non-core business processes, in the second case, retaining full or partial control over the fixed assets involved in the transport process. In case of transport services insourcing, metallurgical company retains full control over both business processes and its own assets. Undoubtedly, the presence or absence of control over assets, regardless of whether the company carries out business processes on its own or outsources them, is its strong side if such measures lead to a reduction in transport costs in the ready-made cost structure products. The implementing a mechanism to ensure a balance of interests will only be possible in case of outsourcing of transportation. Insourcing does not require such a setting, which is a weakness of metallurgical company, since it is practically deprived of market-based instruments for regulating the carrier's economic activity.

Separately, we should dwell on the threats faced by metallurgical company, realizing one or another variant of organizing transportation activities. External outsourcing increases the risk of ongoing disruptions to workshops. This is due to restrictions on the operational influence of customers on the course of transport process and quality control of transport services provided by an outsourcing company. Moreover, when an outsourcer leaves the market and breaks contractual relations, which in modern economic conditions occurs for several reasons, metallurgical company risks a systemic failure in the main technology associated with the risk of shutdown of metallurgical units due to lack of transport, which is unacceptable for continuous technological cycle.

The preservation of asset control, which is characteristic of internal outsourcing and transportation services, leads to an increase in the capital intensity of metallurgical production and a loss of interest from outside investors. In addition, when transporting insourcing, a metallurgical company needs to find its own funds to develop the rolling stock and the production and technical base of the carrier. Experience shows that funds are allocated for the development of a non-core structural unit according to the residual principle.

This procedure for development of investment programs in large companies deprives the carrier of available reserves of the number and time of use of rolling stock, which negatively affects the reliability of transport service shops. In addition, during in-sourcing, the carrier is the motor transport department of a metallurgical company. The latter, in this case, loses flexibility in managing internal costs in case of a decline in demand for finished products, for example, having to pay severance pay to drivers and repair personnel to be reduced.

Strengths and acquired opportunities form the “pluses” of the chosen business strategy, weaknesses and threats - its “disadvantages”. Based on the results obtained, it can be concluded that metallurgical company acquires the maximum number of strengths and opportunities when organizing transportation activities on the basis of internal outsourcing. The use of this option provides the greatest reliability of transport services, saving customer from the costs of conducting non-core business processes.

This is confirmed by a comparative analysis of outsourcing opportunities and its alternatives for organizing transportation activities in metallurgical industry. A comparative analysis was carried out for the working conditions of one of the largest steelmaking companies in the Ural region of Russia. The results of motor transport activities carried out at the enterprise in the format of a motor vehicle workshop and a subsidiary at different time periods were compared, as well as the projected performance of a third-party carrier received as part of a commercial offer (Table 4).

Table 4. Results of comparative analysis of potentialities of outsourcing and its alternatives on organization of transportation activities in metallurgical industry.

Indicator	Insourcing	internal outsourcing	external outsourcing
Reliability of transport services, %	95%	95%	93%*
Average cost of transport services, rubles / vehicle hour	300-800**	800-1300	1200-3100
Coefficient of technical readiness of the fleet, %	No more than 90%	92%	95%
Average age of the fleet, years	More than 10	5-7	3-5
Property of fixed assets involved in the transport process	Customer property	Customer property - 20%; Carrier property - 80%	Carrier Property
Sources of investment to upgrade the fleet and the production and technical base of the carrier	Customer funds	Consolidated: - customer - 40%; - carrier - 60%.	Carrier funds
Staff	In the customer's staff	In the structure of the carrier staff	In the structure of the carrier staff
Availability of associated income	Absent	From leasing to the carrier rolling stock and production and technical base.	From sale at the residual value of the fleet to the carrier. From leasing to the carrier a production and technical base.
Participation of subcontractors in the transport process	Excluded	Allowed	Allowed

Note: * - taking into account the probability of system failures;
** - at prices reduced to one time period.

The results of the comparative analysis confirm that the maintenance of our own motor transport workshop is the least economically justified for metallurgical company, which is associated with the need for investment in development of transport process. An external outsourcing company provides fleet renewal in the short term. However, in this case, investor funds spent quickly and profitably return, due to the higher cost of transport services. At the same time, the metallurgical company, deprived of a fleet of vehicles, is developing a stable dependence on a third-party transport organization.

5. Conclusions

Currently, for enterprises of metallurgical complex, the option with internal outsourcing of transportation activity is the most attractive. This option of organizing transportation at an affordable cost provides high reliability of transport services for metallurgical production, saving customers from non-core business processes.

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