EVALUATION OF THE USE OF TRANSPORT MEANS BASED ON TIME AND PERFORMANCE INDICATORS

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https://doi.org/10.37904/clc.2023.4823

Abstract

Transport efficiency is one of the fundamental goals of a transport company. Carriers can use several methods and indicators to evaluate the operation of means of transport, which create a database of data for evaluating processes and the means of transport. Several approaches can be used to evaluate transport performance. The goal of this paper is to evaluate the vehicle fleet of a small transport company. The fleet of five semi-trailer tractors was evaluated based on selected indicators for three months. Time (9 indicators) and performance indicators (8) were used to evaluate vehicles. Based on the results of performance indicators, it is possible to state that the use of vehicles is different for individual indicators, which is natural. Based on the obtained values, it can be concluded that not all vehicles were fully used during the monitored period. So, utilizing vehicles is one of the identified deficiencies that must be continuously addressed. Recommendations were proposed in the discussion.

Keywords: Metallurgy, steel, properties, applications, testing methods

1. INTRODUCTION

A good transport organization implies devising a fast and efficient transport plan for better use of transport resources and, if necessary, a fast and precise review of the plan. Quality transport plans can be made only through excellent knowledge of the user demands, the capacities of the transport resources and the conditions in which the transport will work [1]. One of the essential elements in the development of a transport plan is the means of transport, their capacity, the type of means of transport, its loading and carrying capacity, and especially availability in case of need. One of the tasks of the transport company is to monitor and evaluate the performance of the vehicle fleet. Carriers can use several methods and indicators to evaluate the operation of means of transport, which create a database of data for evaluating processes and the means of transport. Several approaches can be used to evaluate transport performance.

In her work, Rosová mentions the system of logistics indicators as one of the tools for controlling logistics. It divides the system of distribution logistics, transport logistics and material flow indicators into several categories (structural and framework indicators, productivity indicators, economic indicators, and quality indicators) [2]. Technical-economic indicators (indicators of technical parameters of transport, handling and storage equipment, indicators of operating conditions, indicators of capacity and utilization of equipment, indicators of workability, workforce and productivity, indicators of costs in handling and storing materials, indicators of efficiency) that are intended for evaluation manipulations but can also be used for traffic evaluation are presented in the authors' work [3]. The efficiency of transport subsystems in complex logistics structures should be assessed in terms of quantitative and valuable assessment. The quantitative assessment of its efficiency testifies such indicators as performed ton-kilometers, the number of items handled, the actual working time of transport, the number of goods carried, transport costs per ton-kilometre and consignment, utilization of working time and transport capacities owned means of transport [4]. Gnap et al., in their work,

state the technical-operational indicators of the evaluation of road freight transport and Surovec for mass passenger transport [5,6]. Equipment effectiveness models (OEE) and Key Performance Indicators models (KPI) are also used to evaluate equipment [7]. Authors [8] present the method of using artificial neural networks for the operational valuation of vehicles used in freight transport services.

From the point of view of ensuring the efficiency of operation when transporting different quantities of goods and operating vehicles with different capacities, it is necessary to use the useful weight of the vehicle or its loading space as much as possible. Use of one of these vehicle parameters depends on the volumetric weight of the transported goods.

The goal of this paper is to evaluate the vehicle fleet of a small transport company based on technical and operational indicators. The fleet of semi-trailer tractors was evaluated based on selected indicators for the selected period. Data was provided directly from the operation to calculate the indicators.

2. METHODOLOGY

The evaluation of the selected group of vehicles will be carried out by calculating selected technical and operational indicators, which are presented by the authors in the work of [5]. It is a set of indicators by which transport companies can evaluate vehicle fleet use. The information obtained can serve as a basis for the management, planning or analysis of the economic activity of the transport company.
The technical-operational indicators include:

1. Indicators of time use of means of transport,
2. Indicators of performance utilization of means of transport.

This chapter will only list the indicators used to evaluate vehicles [5]. Relations for individual indicators will be given, which are not in the methodology. The study will evaluate indicators of time utilization (9 indicators) and performance utilization (8 indicators) of means of transport. The list of indicators is in **Table 1**.

Table 1 Indicators of time and performance utilization

Indicators of time utilization	Indicators of performance utilization
Vehicle day in the register (VDR)	Driving performance DP (km)
Vehicle day in operation (VDO)	Driving performance with a loaded vehicle DP_{LOAD} (km)
Vehicle day in repair (VDR)	Driving performance with an empty vehicle DP_{EMP} (km)
Vehicle's idle day (VID)	Loading performance Q (tons)
Vehicle day in technical standby (VDTS)	Transport performance TP (tkm)
Coefficient of the use of the vehicle fleet (α)	Average shipping distance $\bar{d}$ (km)
Coefficient of the repaired condition of the vehicle fleet (α_{RC})	Average shipping quantity $\bar{q}$ (tons)
Coefficient of inactivity of the vehicle fleet (α_{IN})	Driving utilization factor β (%)
Coefficient of technical readiness of the vehicle fleet (α_{TR})	

The evaluation procedure consisted of two phases. The first phase represented data collection for the selected period, their registration and sorting. The second phase was the calculation of selected indicators, their evaluation, and the proposal of recommendations.

3. RESULTS

The analysis of indicators was carried out for semi-trailer tractors in a specific company. The analysis was performed for a quarter. Based on company documents, indicators were analysed for five tractors that

cooperated with several semi-trailers based on their availability and the nature of the material. All the company's tractors belong to the EURO 6 emission group. The vehicles are monitored using GPS and are equipped with standard equipment such as a mobile phone or a digital tachograph. The fleet consists of tractors of the following brands: MAN (TGX 18.480), VOLVO (FH 500), VOLVO (FH 500 6x4), MERCEDES BENZ (ACTROS 18.480), TATRA (PHOENIX 6x6). The semi-trailer tractors were designated as S1- S5 for evaluation purposes. The company has eight semi-trailers (5 tipping semi-trailers, a freezer semi-trailer, a canvas semi-trailer, and a semi-trailer for oversized transport).

Acceptance of orders occurs based on an agreement with customers by telephone, e-mail, or a framework contract. The company also uses the "Trans.eu", "Timocom" or "Raaltrans" portals. The company's website is mainly informative but can be used to create an online order. The company keeps essential records regarding vehicles. Using the MS Excel program, tables are created for each vehicle separately, where the driver's name, kilometres travelled, place of transport, what material was transported and in what quantity are recorded. The drivers write the kilometres travelled by hand in pre-prepared tables, based on which the owner's assistant registers them in a prepared template in the MS Excel program. There are no default functions in these files, so writing the necessary data takes an unnecessary amount of time.

3.1 Indicators of time utilization

First, the indicators of time utilization, vehicle days and the corresponding coefficients were determined. Graphic displays of vehicle days for evaluated vehicles S1- S5 are shown in **Figure 1**.

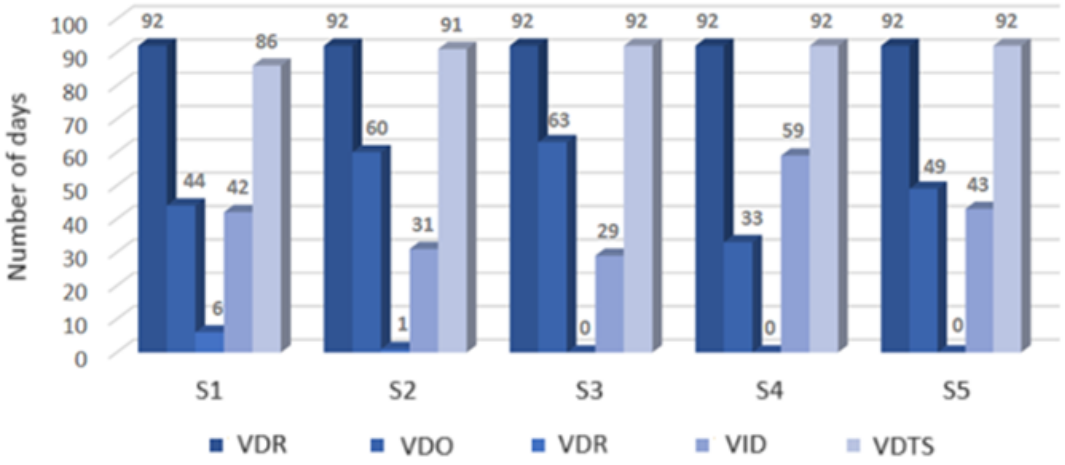

Figure 1 Vehicle Days (Table 1)

As shown in **Figure 1**, each vehicle was registered with the carrier for the entire observed period (92 days). Vehicle S3 was in service for 63 days and vehicle S2 for 60 days, compared to the other vehicles that were not in service for even 50 days. Vehicle S1 was in repair for six days. Vehicle S2 was in regular service maintenance for one day. The S4 vehicle spent the idlest days (59 days) due to the long-term absence of one of the drivers. **Table 2** shows the values of the corresponding coefficients.

Table 2 Coefficients of time utilization

	S1	S2	S3	S4	S5
α [%]	47.83	65.22	68.48	35.87	53.26
α_{RC} [%]	6.25	1.09	0	0	0
α_{I} [%]	45.65	33.7	31.52	64.13	46.74
α_{TR} [%]	93.48	98.91	100	100	100

Based on **Table 2**, the vehicles were used for dispositions almost throughout the monitored period. Their technical readiness was, on average, over 98%, which is highly positive.

3.2 Indicators of performance utilization

Driving performance, driving performance with a loaded vehicle, and driving performance with an empty vehicle were evaluated as the first indicators of performance utilization, and then loading performance and transport performance were evaluated. Based on **Figure 2**, it can be concluded that vehicle S3 had the highest driving performance. Vehicles S1 and S4 have the lowest transport performance compared to the others.

Table 3 shows the values of the indicators: loading performance and transport performance.

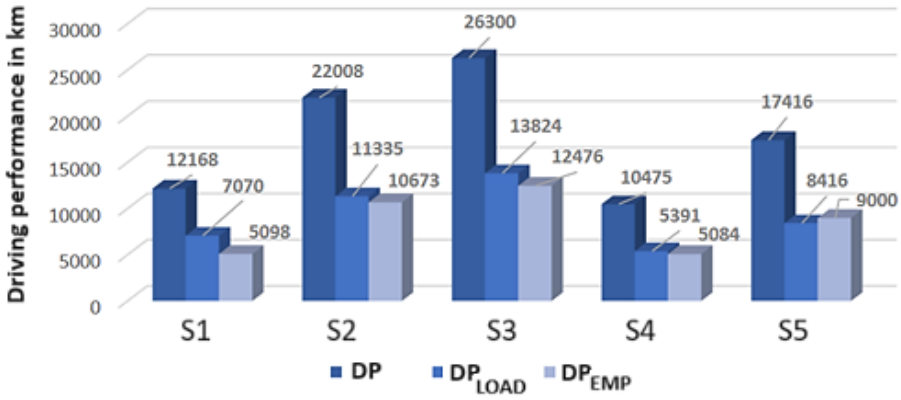

Figure 2 Driving performance

Table 3 Loading performance and transport performance

	S1	S2	S3	S4	S5
Q [tons]	3115.8	2817.2	3055.4	3200.5	3354.5
TP [km]	125,742.1	224,264.7	298,904.1	132,064.8	155,422.4

Table 3 shows that the highest load performance value was achieved by the S5 (3354.5 tons of material). The S2 vehicle had the lowest load performance value. Based on the values of individual performances (**Figure 2** and **Table 3**), other indicators were determined, which are in **Table 4**.

Table 4 Other indicators

	S1	S2	S3	S4	S5
$\bar{d}$ [km]	42.6	77	102.4	42	49.8
$\bar{q}$ [tons]	17.5	19.3	21.2	24.6	18.4
β [%]	60.66	51.64	52.68	51.67	48.57

3.3 Discussion

The indicators were monitored for three months with 92 calendar days. However, there were only 64 working days in the given monitored period. This number of days is not considered in the calculations. Based on this data, only the S5 vehicle worked all working days, so it had 100% utilization from a time point of view. Furthermore, the calculated coefficients of time use are determined based on the number of 92 days, which reduces the given values of the coefficients. However, this is how the formulas are set in the literature. In the future, consider the number of working days in the calculations, not only the vehicle days in the registers. For example, coefficient α for vehicle S1 would reach a value of 68.75% compared to the original value of 47.83%.

Based on the results of performance indicators, it is possible to state that the use of vehicles is different for individual indicators, which is natural. The nature of transport orders also caused the performance difference – the type of transported material and the transport distance. As it follows from the analysis of the indicators, the S3 vehicle achieved the best performance driving indicators. This vehicle was used every weekday, averaging 198 km/day. However, the Q parameter's value was only in fourth place in the ranking. The most significant cargo was transported by vehicle S5 (3354.5t), which is 68 tons/day, and travelled an average of 184 km/day. **Figure 3** shows the parameters: $\overline{DP}$ - average driving performance (km/day) and $\bar{Q}$ - average loading performance (ton).

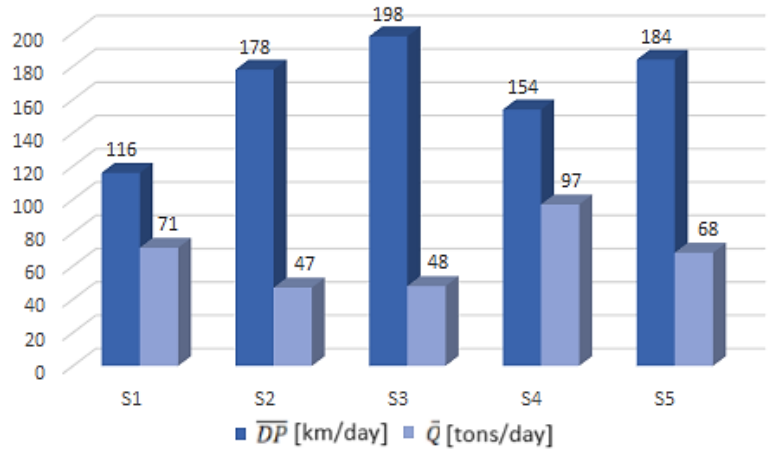

Figure 3 The average values of parameter $\overline{DP}$ and $\bar{Q}$

The indicators should also be supplemented with the parameter number of vehicle turnover per day, and then more detailed performance indicators could be calculated.

Based on the obtained values, it can be concluded that not all vehicles were fully used during the monitored period. Lack of utilization is one of the identified deficiencies, which needs to be continuously addressed in various ways. Another disadvantage is that the information from the drivers needs to be shared with the Excel file, and they must enter it manually.

One of the recommendations for the company is either to expand the existing MS Excel file or to design a transparent database that would contain all the necessary information for the operation of the vehicle fleet and the company, where data such as, e.g. driver's names, vehicle type (tractor type and semi-trailer type), customer's name, name of transported material and its quantity, number of kilometers travelled with and without load, transport route, date and time of transport journey, waiting time for loading and unloading and others. The purpose of the database is the generation of forms, for example, an employee's time sheet, a summary of trips, an overview of customers, and others. Another benefit of such a database would be the generation of graphs that can help the owner evaluate the company's activity.

4. CONCLUSION

Evaluating the use of the company's vehicle fleet is a critical task. To obtain qualitatively comparable results, records about each vehicle are essential. The company's evidence should include the summary parameters listed above and partial ones corresponding to, e.g. one drive (turn of the vehicle). In addition to time and performance parameters, parameters related to fuel consumption are also monitored in practice (these parameters were not addressed in the paper). Also, the number of drivers who drive a given vehicle and their skills significantly affect the performance and consumption of vehicles. Each company monitors selected parameters according to its priorities and possibilities. Some companies use an MS Excel file to register

parameters, and others use sophisticated software tools. With increasing technical and technological progress, carriers, even at the corporate level, could evaluate accurate operating data from vehicle computers and other technical recording devices, which they can also use when planning several services, e.g., in connection with the determination of the technical speed of the means of transport or the coefficients of their power utilization. When renewing and expanding the vehicle fleet, the carrier should emphasize using statistical data on the operation efficiency of specific categories of vehicles from the past.

ACKNOWLEDGEMENTS

This paper was created within the VEGA grant project No. 1/0430/22.

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