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ANALYSIS AND EVALUATION OF THE PLANNING PROCESS IN A TRANSPORT COMPANY

Summary. Today, route planning requires freight forwarders to make a conscious effort to identify unloading points such that the transport process is both cost- and time-efficient. At the same time, operational parameters that help to determine the validity of the chosen route must also be considered. This article aims to present the key metrics and ways of attaining them to provide a reliable determination of a transport company's performance. Based on a selected transport company, the authors collected data on the transport routes implemented in 2020. Interpretation and analysis of the extracted information of the concerned sections were carried out and followed by alternatives. We present in this article the results of research concerning the exploitation parameters of the vehicle set. The evaluation of a given

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route section was indicated using selected indicators adapted to the specificity of the enterprise. The results are aimed at locating the components that have a destructive impact on the entire process. The proposed solutions serve to introduce factors that will pave way for improving the services provided. An in-depth analysis of all sections and key parameters was performed. Because of the conducted studies, abnormal parameters were identified, efficient sections were distinguished and new routes were developed in the case of previous routes that were not highly efficient and which had a possible alternative corridor. The obtained results of the research can comprise, for logistics managers, vital elements in the transport process, to which attention should be given in the course of overseeing these processes.

Keywords: transport, planning, organization and quality of processes, management

1. INTRODUCTION

The movement of goods using cars currently represents an outstanding mode of transport among such means as rail, air, water, inland waterway, maritime and industrial transport because it can deliver directly to the customer's doorstep in good time. The movement of freight must be carried out in a safe and precise manner, as stressed by the authors in their publication [1]. Cargo delivery is carried out using appropriate means of transport, which are adapted to the movement of the specific type of goods [2, 8]. Zubkow et al. state that cargo transportation services play a vital role in the functioning of the world economy; this is due to the core role of the transport service, that is, to ensure the smooth functioning of the entire national economy [3]. The volume and quality of performed services contribute to the socio-economic development of individual countries or regions. This has been the subject of consideration by several authors, including in publications [4-6]. Transport stimulates the development of economic areas, as elaborated in these papers [7-8].

The advantages of road transport are undoubtedly:

- a large number of transport companies, resulting in relatively low transport costs;
- just-in-time and door-to-door delivery possible;
- a high rate of on-time delivery;
- the possibility of adapting transport conditions to specific requirements imposed by the forwarding order;
- well-developed line and point infrastructure.

The advantages listed above represent the attractiveness of this mode of transport. This attractiveness resulted in the dynamic growth in services in the European market.

On the other hand, the main disadvantages of road transport include:

- high accident rate;
- longer transport times, particularly significant over long distances;
- low capacity of the transport fleet.

Osińska et al. claim that Polish transport companies are growing in strength and becoming major competitors in the forwarding market in the whole of Europe and the Middle East [9]. Along with efficient company management, it is crucial to carefully analyze the capacity of transport execution by cost per kilometer, as demonstrated in the papers [10-11]. Efficient competition between haulers is mainly based on the adjustment of the appropriate price of service. Incidentally, nowadays, the quality of services connected with timeliness and safe transport of goods is essential. In the publications [12-13], the authors believe that presently, of key significance is also the quality of services associated with timeliness and safe movement of cargo. A similar line of thought is pursued by Jachimowski et al. and Umberto who believe that guaranteeing the above components impacts growth in the cost of performing the service [14-15]. In this aspect, Pandelis et al. posit that a consensus must be reached between offering an attractive price and the quality of these services [16]. When increasing the profit for companies from the transport process, it is important to use the cargo area of the trailer [17]. Furthermore, it is important to employ solutions for monitoring the position of the means of transport, as this enhances the route efficiency by improved planning of the transport corridor; these matters were considered and solved in various papers [18-21]. Moreover, Ocalir - Akunal et al. and Mu et al. state that similarly, performing process mapping is key, as it reveals potential errors during service execution [22-23]. Implementation of a given solution should be preceded by an analysis of key operational parameters, which include [24-25]:

- duration of the course;
- operating speed;
- technical speed of the vehicle;
- time utilization factor;
- transport work;
- load factor;
- vehicle performance.

According to the authors of [26-27], analyzing the above parameters in a company allows for a better understanding of the effectiveness of executed transports. Therefore, as stressed in several works, an appropriate clarification in this aspect is a proper interpretation of the obtained results, which may translate into a more efficient performance of cargo transportation in the future [28-29].

In the literature, many authors have considered the efficiency of processes, for example, in the research conducted by S. Kokoszka [30], the payload, payload utilization factor, technical speed, transport time, and actual distance were considered. In this article, the scope of the studies was extended to include the following parameters: operating speed, driving time, time utilization factor, and freight work. The research conducted on a real object considers the extended scope of calculations, which affects the wider visualization of the quality of services provided. On the other hand, the authors' evaluation of the operating parameters is more detailed; this is reflected in the analysis of the improvement of individual sections. Research concerning an "Analysis of the use of drivers' working time" was considered in the formula for the use of working time also empty returns, or commuting to the loading or unloading site [31]. This was due to the specification of the services provided in the studied company, while the transport process was based on eight work phases related to forest transport. The correct research method in the transport company requires the separation of empty runs into separate sections on individual routes. Such an application of calculations will be more accurate and the results of the research will present a more precise coefficient of work time utilization. The method used by the authors showed the possible bottlenecks and areas where operational and technical speed should be increased by eliminating unnecessary activities. Moreover, transport system efficiency evaluation indicators can be divided into two basic groups: quantitative indicators and qualitative indicators. In the research conducted by J. Twaróg, both transport cost patterns and the use of, for example, working time or payload were considered in assessing the logistic subsystem [32]. However, the authors of this article proposed more detailed calculations of exploitation parameters, which will be the basis for further research related to cost parameters. The research method has been enriched with parameters such as transport work or vehicle efficiency. Efficiency can be separated into individual components, for example, the efficiency of transport, the efficiency of loading work, and the efficiency of employees [33]. The authors examined the efficiency of the vehicle as a whole and carried out a comparative analysis of the efficiency on individual routes. The presented data allows for more precise supervision of the transport process and consequently increases its efficiency.

2. CHARACTERISTICS OF THE ANALYZED COMPANY

The authors conducted a study on a transport company that has been providing services since 1998. The company is run as a sole proprietorship under Polish law. It is characterized by a stable position in the market with many years of experience. The registered office is located in the Małopolskie Voivodship. The company provides domestic services, which means carriage of goods only in Poland. The company has three functional truck sets. Each set consists of a tractor unit with a semi-trailer. One of the sets was included in this study. The data obtained by the authors concern a SCANIA R420 tractor unit from 2008. The admissible total weight is 40,000 kg, payload 18,000 kg (maximum rear axle load), unladen weight 7350 kg with a 420 km engine and 309 kW. A KRONE semi-trailer from 2014 with a capacity of 24 tons, and a permissible total weight of 40,000 kg. The vehicle and semi-trailer are in good visual and technical condition. The driver is a 27-year-old professional male driver with four years of experience.

The transport company provides services for a regular contractor. The transported cargo is food assortment. Goods are placed on EUR 1 pallets.

The company operates based on the DAP (Delivered at Place) principle, in which the seller bears the responsibility and costs pending the delivery of the goods to the destination indicated by the recipient. The company receives information on the loading and unloading sites. Then it determines the route in its own scope, considering linear and node infrastructure. This ensures a safe passage on roads, which are suitable for transporting heavy loads, including passing under overpasses without risk to other road users. The authors analyzed data from four months: January - April 2020. Four fixed routes were selected for analysis in all months:

- ROUTE 1- TYCHY→ TYMBARK→ LISIA GÓRA→ TYMBARK
- ROUTE 2- TYMBARK→ WOJNICZ → TYMBARK
- ROUTE 3- TYCHY→ WOJNICZ→ TARNÓW→ TYMBARK
- ROUTE 4- TYMBARK→ TYCHY→ TYMBARK

The course of the transport process on routes 1 and 3 is based on the principles of the circuit model (Figure 1), which consists in loading the cargo at the initial point with the possibility of loading or unloading at subsequent points. This is one of the most efficient models as it allows for making optimum use of loading space. The implementation of such a model aims to reduce the total transport costs.

Routes 2 and 4 are implemented according to the shuttle model (Figure 2), which is characterized by the fact that the external means of transport run between two loading and unloading points.

When carrying out this type of transport, the vehicle usually returns "empty", reducing the efficiency of this transport model. For the shuttle model, it is easier to plan all operations related to the transport process, as these are usually regular routes. The forwarder knows the peculiarities of the route and the necessary documentation of the regular sections [34].

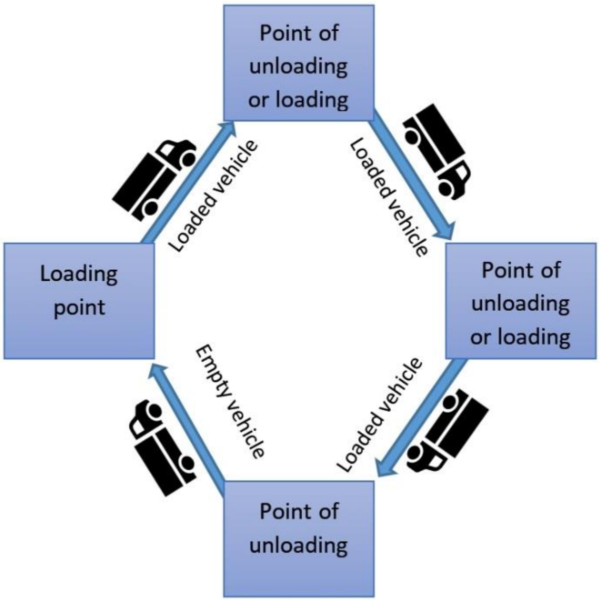

Fig. 1. Circuit model (prepared by authors)

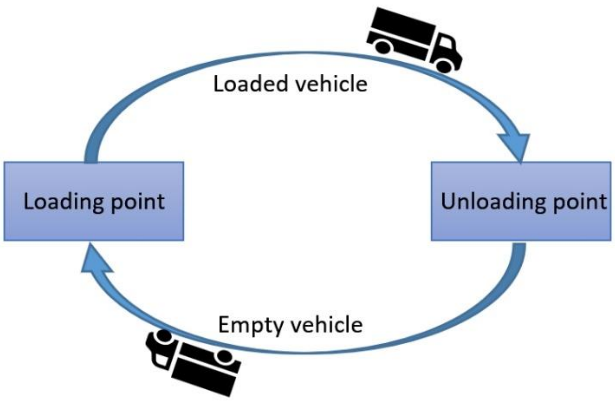

Fig. 2. The pendulum model (prepared by authors)

3. INDICATORS FOR ASSESSMENT OF OPERATIONAL PARAMETERS

Efficiency is measured when we want to check how effectively our services are delivered [24]. Transport companies set measurable performance indicators to identify substitutes when defining transport corridors from suppliers to customers. Determination of new solutions should be based on producing the highest efficiency at the lowest cost. When considering a transport issue, the following indicators should be calculated [24]:

– Duration of the course from the time of departure to the arrival of the means of transport at the end point (1):

$$t_h = t_{jh} + t_{wh} \text{ [hrs, min]} \tag{1}$$

where:
t_{jh} - driving time,
t_{wh} - waiting time for operational activities.

– Operating speed means the ratio of the distance traveled to its operating time per unit of time (2):

$$v_h^e = \frac{L_h}{T_{ph}} \text{ [km/h]} \tag{2}$$

where:
L_h - distance traveled on line h,
T_{ph} - vehicle operating time and all accompanying activities.

– Technical speed of the vehicle meaning the ratio between the distance traveled and the driving time per unit of time (3):

$$v_h^t = \frac{L_h}{T_{jh}} \text{ [km/h]} \tag{3}$$

where:
L_h - distance traveled on line h,
T_{jh} - vehicle travel time on route h.

– Time utilization ratio, which means driving time to working time (4):

$$K_h^p = \frac{T_{jh}}{T_{ph}} \tag{4}$$

where:
$K_h^p \in < 0,1 >$

– Transport workload, which is the product of the cargo transported on a given route and the length of that route (5):

$$Q_h = \sum_{i=1}^{n} Q_i \times L_i \text{ [tkm]} \tag{5}$$

where:
Q_i - cargo volume expressed in tons,
L_i - length of route.

– Capacity utilization rate, which is the ratio of the transport work actually done by a vehicle per unit of time to the transport work that could be done if the vehicle was operating at full capacity (6):

$$K_h^Q = \frac{Q_h}{Q_h^{poj} \times L_h} \tag{6}$$

where:
$K_h^Q \in < 0,1 >$,
Q_h- Transport work,
Q_h^{poj}- the maximum authorized capacity of the vehicle expressed in tons.

– Vehicle efficiency is the ratio of transport work to vehicle operating time (7):

$$w_h = \frac{Q_h}{T_h^p} \text{ [tkm/h]} \tag{7}$$

An early enough assessment of indicators allows for the identification of stimulating or destructive factors influencing the process. Further, it allows for rational process management.

4. TESTING ON A REAL OBJECT

On the analyzed routes, the loading warehouses are located in points: Tychy and Tymbark. The remaining points are unloading warehouses.

Because of the conducted research, the authors have presented the outcomes of the taken data on the studied routes in Table 1.

The data presented in Table 1 have been systematized in the sectional system. The travel route has been divided into an appropriate number of sections depending on the loading or unloading points. Each section contains data on fuel consumption, payload and time data connected with loading and unloading, among other things.

The information in Table 1 served as a source for the authors to calculate the operational parameters in Table 2. The tonnage of the transported load and the maximum allowed load capacity were used to calculate the load capacity factor. The performance of the vehicle was derived from the number of tons transported, the distance traveled, and the operating time.

Fuel consumption (Table 1) in particular sections in a given month was analyzed and presented in Figure 3. Thus, lower fuel consumption was observed in section 6 compared with 1, 9, and 10, which have a similar distance to cover.

Further, a detailed analysis of technical speed, operating speed, payload and fuel consumption was performed. The results are presented on a monthly basis (Figures 4 - 7). The authors presented the data and indicated the sections with low parameters in particular months. Sections 2, 4, 6, 7, and 9, in each of the analyzed months, achieved low parameters of operational speed. The technical speed is particularly low in section 5 in March.

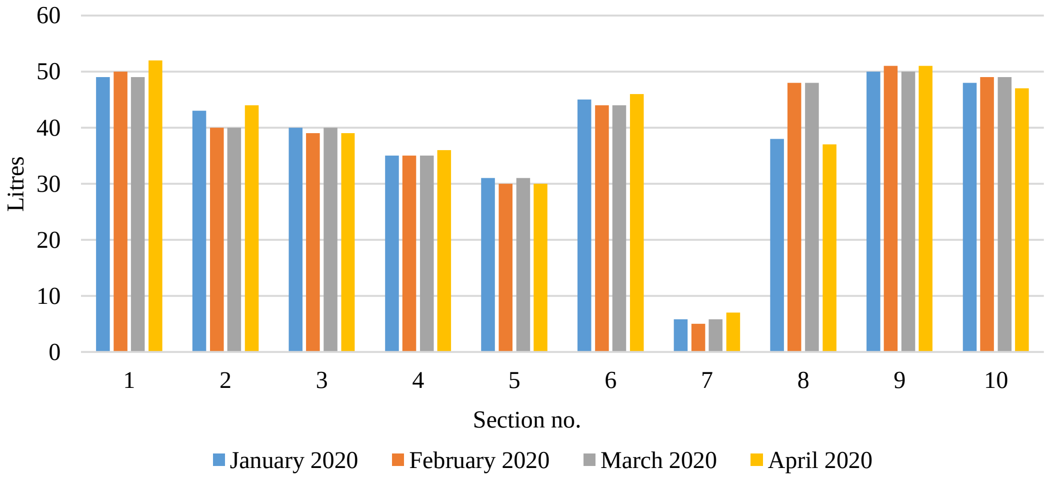

Fig. 3. Fuel consumption by section

Tab. 1

List of transport operations carried out

	ROUTE	SECTION NO.	DATE OF DEPARTURE	DEPARTURE TIME [h]	PLACE OF DEPARTURE	DISTANCE [km]	LOAD [t]	ARRIVAL DATE	ARRIVAL TIME [h]	LOADING TIME [h]	UNLOADING TIME [h]	PAUSE TIME ON ROUTE SECTION [h]	DAILY REST [h]	TOTAL FUEL CONSUMPTION [l]
January		1	02.01.2020	14:50	Tychy - Tymbark	160	10.5	02.01.2020	17:40	00:50				49
	1	2	02.01.2020	18:30	Tymbark - Lisia Góra	141	20.3	02.01.2020	21:00	01:00	01:00	00:45		43
		3	02.01.2020	23:40	Lisia Góra - Tymbark	141	0	03.01.2020	02:10				11	40
	2	4	03.01.2020	13:20	Tymbark - Wojnicz	110	23.7	03.01.2020	15:20	00:50	01:00			35
		5	03.01.2020	17:30	Wojnicz - Tymbark	110	0	03.01.2020	19:30				11	31
		6	14.01.2020	14:00	Tychy - Wojnicz	157	12.64	14.01.2020	16:30	00:30	01:10			45
	3	7	14.01.2020	18:20	Wojnicz - Tarnów	22	1.64	14.01.2020	19:00		00:20			5.8
		8	14.01.2020	19:30	Tarnów - Tymbark	135	0	14.01.2020	21:50				11	38
	4	9	16.01.2020	14:00	Tymbark - Tychy	160	23.49	16.01.2020	17:00	01:00				50
		10	16.01.2020	18:00	Tychy - Tymbark	160	0	16.01.2020	21:00			00:45		48
February	1	1	12.02.2020	17:00	Tychy - Tymbark	160	20	12.02.2020	20:30	01:15	00:20			50
		2	12.02.2020	22:30	Tymbark - Lisia Góra	141	15	13.02.2020	01:30		01:00	00:45		40
		3	13.02.2020	03:30	Lisia Góra - Tymbark	141	0	13.02.2020	05:30				11	39
	2	4	10.02.2020	14:00	Tymbark - Wojnicz	110	22	10.02.2020	16:00	01:00	00:30			35
		5	10.02.2020	17:30	Wojnicz - Tymbark	110	0	10.02.2020	19:30				11	30
	3	6	14.02.2020	04:30	Tychy - Wojnicz	157	18.5	14.02.2020	07:30	02:00	02:00			44
		7	14.02.2020	10:00	Wojnicz - Tarnów	22	10	14.02.2020	10:30		01:00			5
		8	14.02.2020	11:30	Tarnów - Tymbark	135	0	14.02.2020	14:30			00:45	11	48
	4	9	13.02.2020	14:00	Tymbark - Tychy	160	23	13.02.2020	17:00	02:00	01:00			51
		10	13.02.2020	18:30	Tychy - Tymbark	160	0	13.02.2020	21:15			00:45		49
March	1	1	11.03.2020	18:30	Tychy - Tymbark	160	5	11.03.2020	21:30	01:00				49
		2	11.03.2020	22:30	Tymbark - Lisia Góra	141	23	12.03.2020	01:45	00:30	01:00	00:45		40
		3	12.03.2020	03:00	Lisia Góra - Tymbark	141	0	12.03.2020	05:30				11	40
	2	4	20.03.2020	12:40	Tymbark - Wojnicz	110	22.5	20.03.2020	14:40	01:00	01:00			35
		5	20.03.2020	15:40	Wojnicz - Tymbark	110	0	20.03.2020	18:50			00:45		31
	3	6	12.03.2020	23:50	Tychy - Wojnicz	157	19.76	13.03.2020	02:30	01:30	01:00			44
		7	13.03.2020	03:30	Wojnicz - Tarnów	22	4	13.03.2020	04:10		00:30			5.8
		8	13.03.2020	05:00	Tarnów - Tymbark	135	0	13.03.2020	08:00				11	48
	4	9	26.03.2020	01:00	Tymbark - Tychy	160	21.6	26.03.2020	04:00	01:00	01:00			50
		10	26.03.2020	05:00	Tychy - Tymbark	160	0	26.03.2020	08:50			00:45		49
April	1	1	17.04.2020	03:00	Tychy - Tymbark	160	19	17.04.2020	06:30	01:00				52
		2	17.04.2020	07:30	Tymbark - Lisia Góra	141	19.77	17.04.2020	10:45	00:30	02:00	00:45		44
		3	17.04.2020	12:45	Lisia Góra - Tymbark	141	0	17.04.2020	15:00				11	39
	2	4	18.04.2020	05:20	Tymbark - Wojnicz	110	22	18.04.2020	07:30	01:00	01:00			36
		5	18.04.2020	08:30	Wojnicz - Tymbark	110	0	18.04.2020	10:20					30
	3	6	07.04.2020	19:00	Tychy - Wojnicz	157	10	07.04.2020	21:30	02:00	01:00			46
		7	07.04.2020	22:40	Wojnicz - Tarnów	22	12	07.04.2020	23:10		00:30			7
		8	07.04.2020	23:40	Tarnów - Tymbark	135	0	08.04.2020	02:45			00:45		37
	4	9	16.04.2020	22:50	Tymbark - Tychy	160	23.5	16.01.2020	02:10	01:00	01:00			51
		10	16.01.2020	03:10	Tychy - Tymbark	160	0	16.01.2020	06:55			00:45		47

The utilization factor, shown in Figure 8, indicates to what extent the car was used for driving relative to the driving time and all the accompanying stopping and loading activities. The observations show that section 7 has large variations in the coefficient relative to the different months. In February, the working time utilization in section 7 (Figure 8) is at its lowest level relative to the other months, with a value of 0.33. This result indicates that the means of transport was not used most of the time, and consequently, does not generate profits.

Tab. 2

Performance results

	SECTION NO.	COURSE DURATION [hrs, min]	OPERATING SPEED [km/h]	TECHNICAL SPEED [km/h]	DRIVING TIME [hours, minutes]	TIME FACTOR [∈< 0, 1 >]	TRANSPORT WORK [tkm]	CAPACITY UTILIZATION factor [∈< 0, 1 >]	VEHICLE PERFORMANCE [tkm/h]
January	1	03:40	47.06	64	02:50	0.77	1680.00	0.44	494.12
	2	04:30	32.79	61	02:30	0.56	2862.30	0.85	665.65
	3	02:30	61.30	61	02:20	0.93	0.00	0.00	0.00
	4	03:50	31.43	55	02:00	0.52	2607.00	0.99	744.86
	5	02:00	55.00	55	02:00	1.00	0.00	0.00	0.00
	6	04:10	38.29	68	02:30	0.60	1984.48	0.53	484.02
	7	01:00	22.00	55	00:40	0.67	36.08	0.07	36.08
	8	02:20	61.36	61	02:20	1.00	0.00	0.00	0.00
	9	04:00	40.00	53	03:00	0.75	3758.40	0.98	939.60
	10	03:00	53.33	53	03:00	1.00	0.00	0.00	0.00
February	1	05:05	31.68	48	03:30	0.69	3200.00	0.83	633.66
	2	04:00	35.25	47	03:00	0.75	2115.00	0.63	528.75
	3	02:00	70.50	71	02:00	1.00	0.00	0.00	0.00
	4	03:30	33.33	55	02:00	0.57	2420.00	0.92	733.33
	5	02:00	55.00	55	02:00	1.00	0.00	0.00	0.00
	6	07:00	22.43	52	03:00	0.43	2904.50	0.77	414.93
	7	01:30	16.92	73	00:30	0.33	220.00	0.42	169.23
	8	03:00	45.00	45	03:00	1.00	0.00	0.00	0.00
	9	06:00	26.67	53	03:00	0.50	3680.00	0.96	613.33
	10	02:45	65.31	65	02:45	1.00	0.00	0.00	0.00
March	1	04:00	40.00	53	03:00	0.75	800.00	0.21	200.00
	2	04:45	31.69	45	03:15	0.68	3243.00	0.96	728.76
	3	02:30	61.30	61	02:30	1.00	0.00	0.00	0.00
	4	04:00	27.50	55	02:00	0.50	2475.00	0.94	618.75
	5	03:10	35.48	35	03:10	1.00	0.00	0.00	0.00
	6	05:10	30.78	65	02:40	0.52	3102.32	0.82	608.30
	7	01:10	20.00	55	00:40	0.57	88.00	0.17	80.00
	8	03:00	45.00	45	03:00	1.00	0.00	0.00	0.00
	9	05:00	32.00	53	03:00	0.60	3456.00	0.90	691.20
	10	03:50	45.71	46	03:50	1.00	0.00	0.00	0.00
April	1	04:30	37.21	48	03:30	0.78	3040.00	0.79	706.98
	2	05:45	25.87	45	03:15	0.57	2787.57	0.82	511.48
	3	02:15	65.58	66	02:15	1.00	0.00	0.00	0.00
	4	04:10	26.83	52	02:10	0.52	2420.00	0.92	590.24
	5	01:50	73.33	73	01:50	1.00	0.00	0.00	0.00
	6	05:30	29.62	68	02:30	0.45	1570.00	0.42	296.23
	7	01:00	22.00	73	00:30	0.50	264.00	0.50	264.00
	8	03:05	44.26	44	03:05	1.00	0.00	0.00	0.00
	9	05:20	30.77	50	03:20	0.63	3760.00	0.98	723.08
	10	03:45	46.38	46	03:45	1.00	0.00	0.00	0.00

On each of the analyzed routes is observed in particular sections where the car does not carry cargo (Table 1). In Figures 9 - 10, Sections 3, 5, 8, and 10, show the value 0. The reason for this is passage without cargo. Consequently, the car has free cargo space that could be used. Data on the ton-kilometers transported given the time unit identify the efficiency of the vehicle in each analyzed month. A significant amplitude of efficiency can be observed in January (Figure 10). The research shows that section 7 is characterized by low efficiency. The consequence of low vehicle utilization is inefficient vehicle operation.

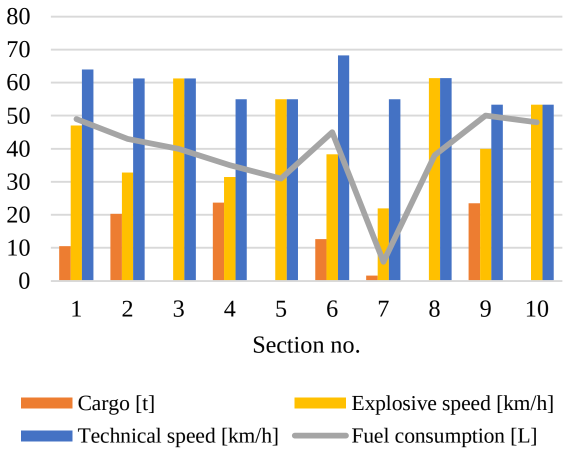

Fig. 4. Vehicle statistics for January 2020

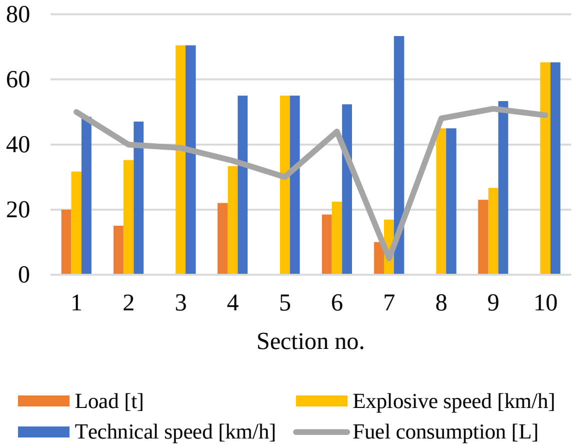

Fig. 5. Vehicle statistics for February 2020

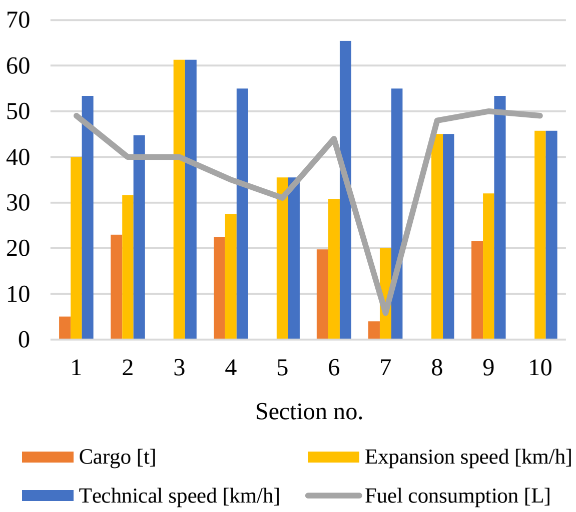

Fig. 6. Vehicle statistics for March 2020

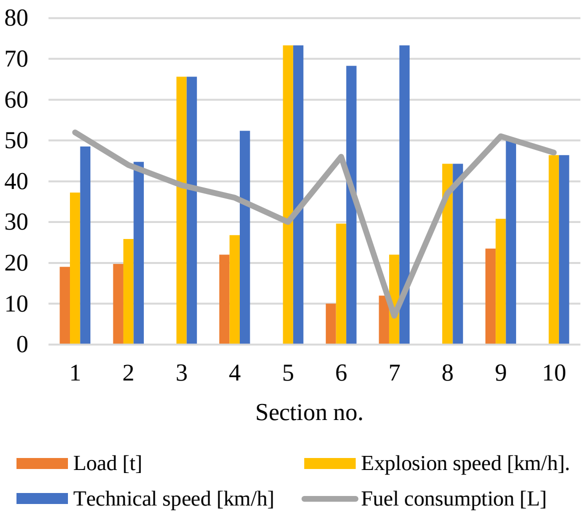

Fig. 7. Vehicle statistics for April 2020

5. ROUTES TO BE FOLLOWED

The authors observed the use of alternative transport corridors for the transport processes analyzed.

The authors propose an alternative solution for the realization of travel route 1 (Figure 11). The distance between the city of Tychy and Tymbark is 160 km on the route via the A4 motorway. Change of the A4 transport corridor to road no. 44 from Tychy to Zator and then by road no. 28 through Sucha Beskidzka will reduce the distance to 138 km. Therefore, choosing such a transport corridor shortens the route by 22 km. Fuel consumption is also a key aspect in this respect. Noticeably, fuel consumption increases between Wadowice and Tymbark as it is a mountainous area. When defining a new route, the linear infrastructure should be used to indicate whether it is suitable for a particular mode of transport. In this case, the key constraints are the tonnage capacity of the roads. These must be roads with a vehicle load of 10 tons per vehicle axle. In addition, viaducts must be 4.10 m high.

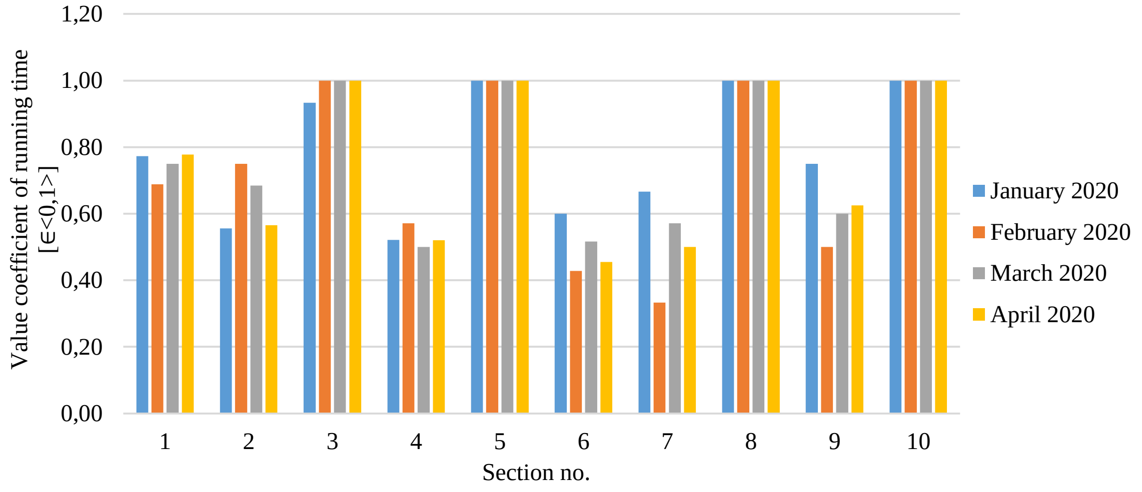

Fig. 8. Time utilization factor

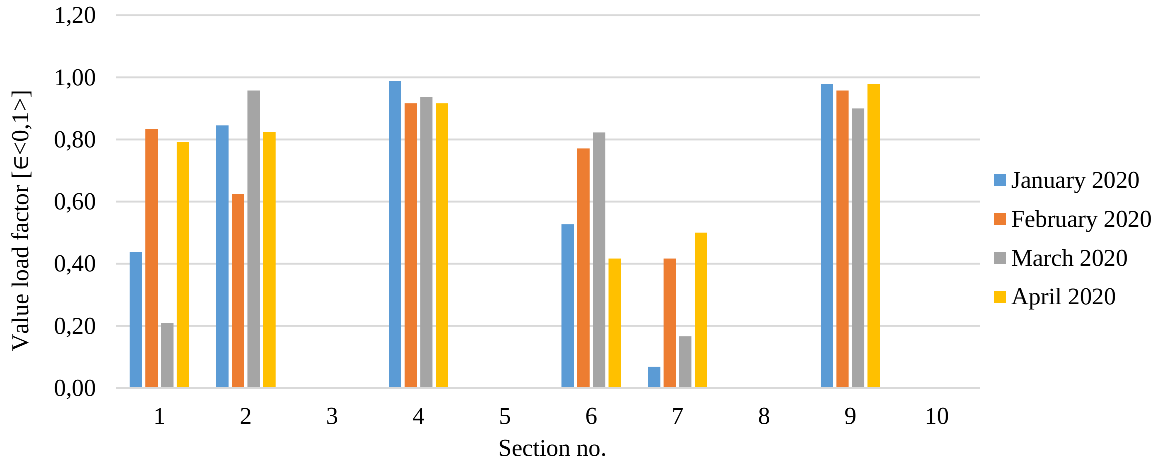

Fig. 9. Coefficient of utilization of vehicle capacity

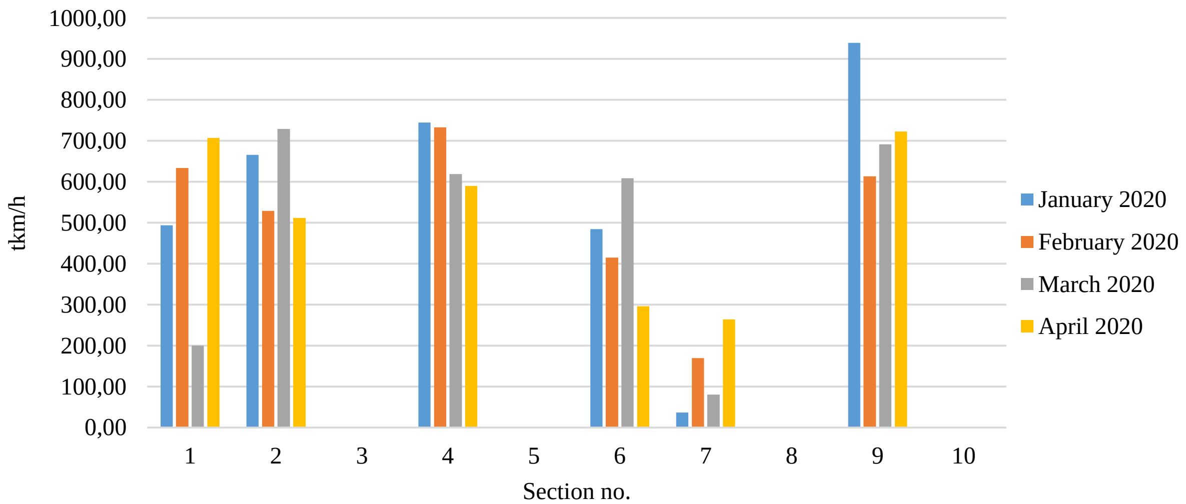

Fig. 10. Vehicle performance

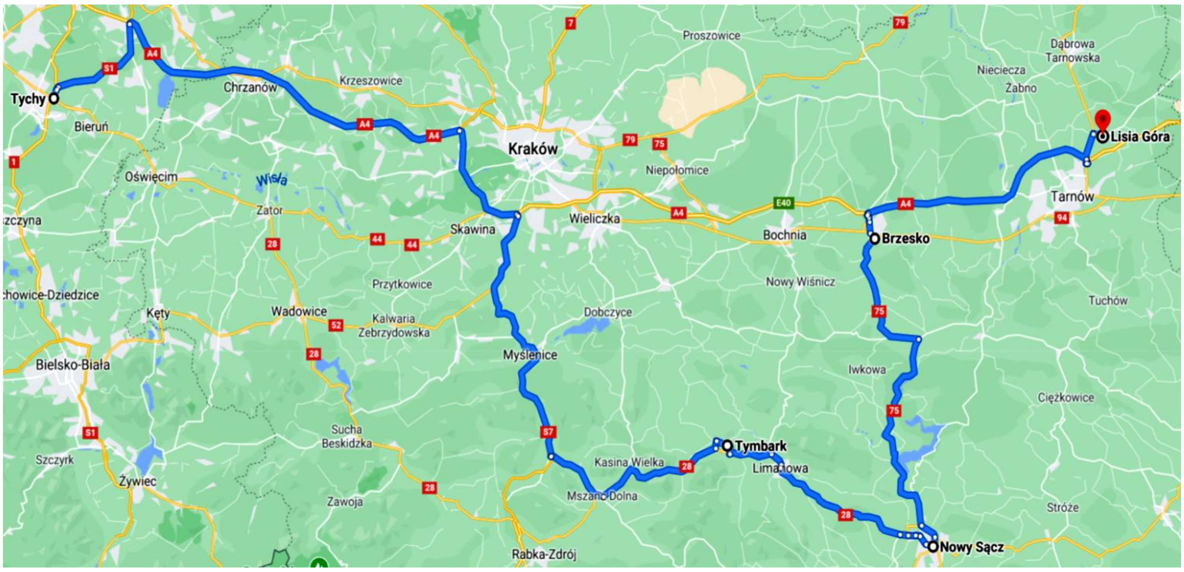

Fig. 11. Route 1

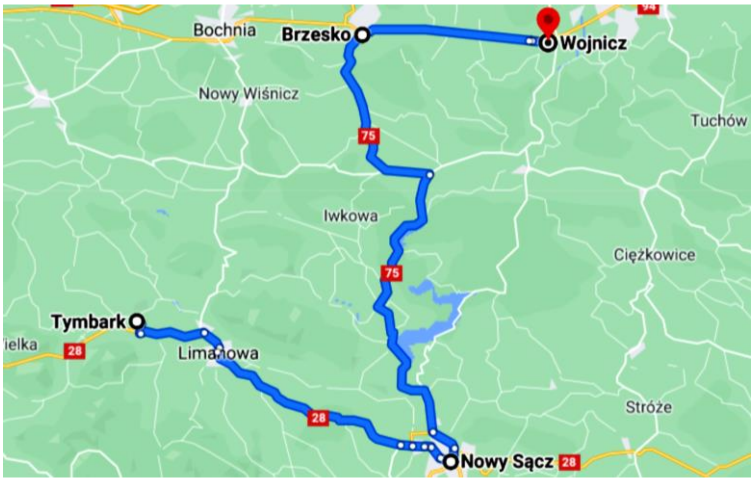

Fig. 12. Implementation of route 2 (Tymbark - Wojnicz - Tymbark)

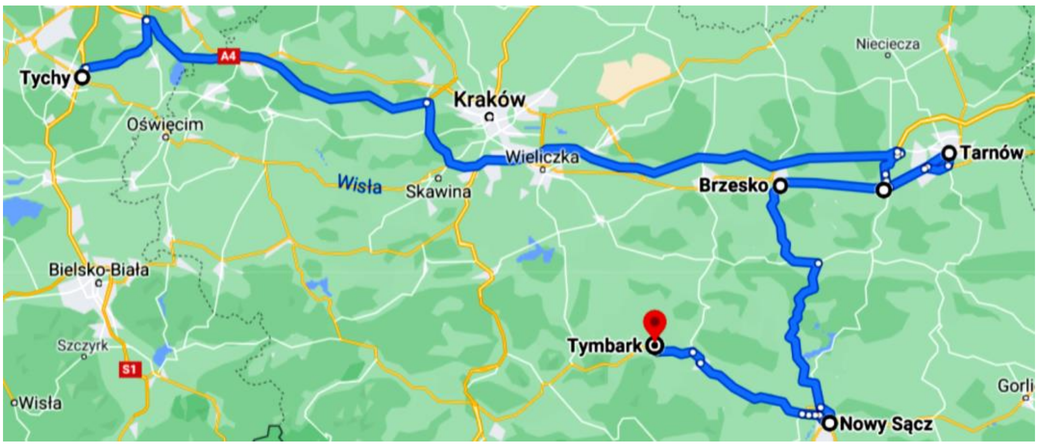

Fig. 13. Implementation of route 3 (Tychy - Wojnicz - Tarnów - Tymbark)

When carrying a load in section 4 (Figure 12) Tymbark-Wojnicz, the driver has to drive to Nowy Sącz and then to Brzesko as far as Wojnicz. Wojnicz is where the unloading is carried out. A car without cargo can return via an alternative route. It is possible to modify the route of section 5 from Wojnicz to Zakliczyn and then to Tymbark. The above solution will reduce the distance traveled, thus shortening it by 40 km, translating into lower fuel consumption.

Upon analysis of route 3 (Figure 13), it was found that it is possible to shorten section 8, that is, Tarnów-Tymbark, which is very close to section 5. Assigning an optional route via Zakliczyn will reduce the distance to be covered, translating into benefits such as lower fuel consumption, lower vehicle operating coefficient, and increasing efficiency of the driver's working time.

Analyzing route 4 (Figure 14), it should be noted that in section 9 (Table 1) of every month, the coefficient of capacity utilization is close to 100%, which disqualifies the cargo selection. The authors noticed that the coefficient of capacity utilization for section 10 is always 0 (Table 2). There are optional solutions available. The first solution consists of planning a new return route similarly to route 1 via Zator, Wadowice. It should be emphasized that this solution will significantly reduce the distance to be traveled by 22 km. The disadvantage is the unused potential of the means of transport and loss of potential benefits resulting from the additional course. Another option is to look for a new transport order on the original route. There is an industrial zone in Tychy, while Krakow has a Special Economic Zone, where logistics centers and warehouses of various manufacturers are located. Such zones increase the attractiveness of locations in terms of the number of transport orders. There is a large number of offers on transport exchanges in the Tychy - Krakow section. Acquiring additional transport orders can positively influence the transport work performed and increase company revenue. Matching loads also translates into minimizing empty mileage.

6. CONCLUSIONS

Given the analysis, the authors noticed that sections 1, 9, and 10 require the introduction of improvements to reduce fuel consumption to the level of section 6. The above sections have similar distances; however, fuel consumption varies widely. In sections 2, 4, 6, 7, and 9, measures should be considered to increase the operating speed. Thus, vehicle stops should be planned accordingly. The low index of technical speed in section 5 in March is a one-off result, which may indicate random events on the road beyond the driver's control. Furthermore, the reasons for large fluctuations in section 7 may be the waiting times for loading and unloading, inadequate planning of the driver's stops and unnecessary accompanying activities such as unjustified stops, which should be eliminated. The authors suggest introducing an alternative transport corridor for route 1, reducing the distance to be covered by 22 km. The next proposed solution is the transformation of section 5, where the authors showed a reduction in the distance to be traveled by 40 km. In route 3, the introduction of an alternative route in section 8 should be considered. Another proposal is the selection of forwarding orders in section 10 when the vehicle returns without a load. By introducing the improvements, there will be an increased degree of efficiency in the executed processes. This research identified physical locations that could have destructive effects on the performed service. With the help of the presented solutions, the authors have highlighted the number of introduced modifications that occur in enterprises when processes are not subjected to efficiency assessment. Adequate assessment of indicators made it possible to indicate the factors that will act as stimulants in the functioning of a given process.

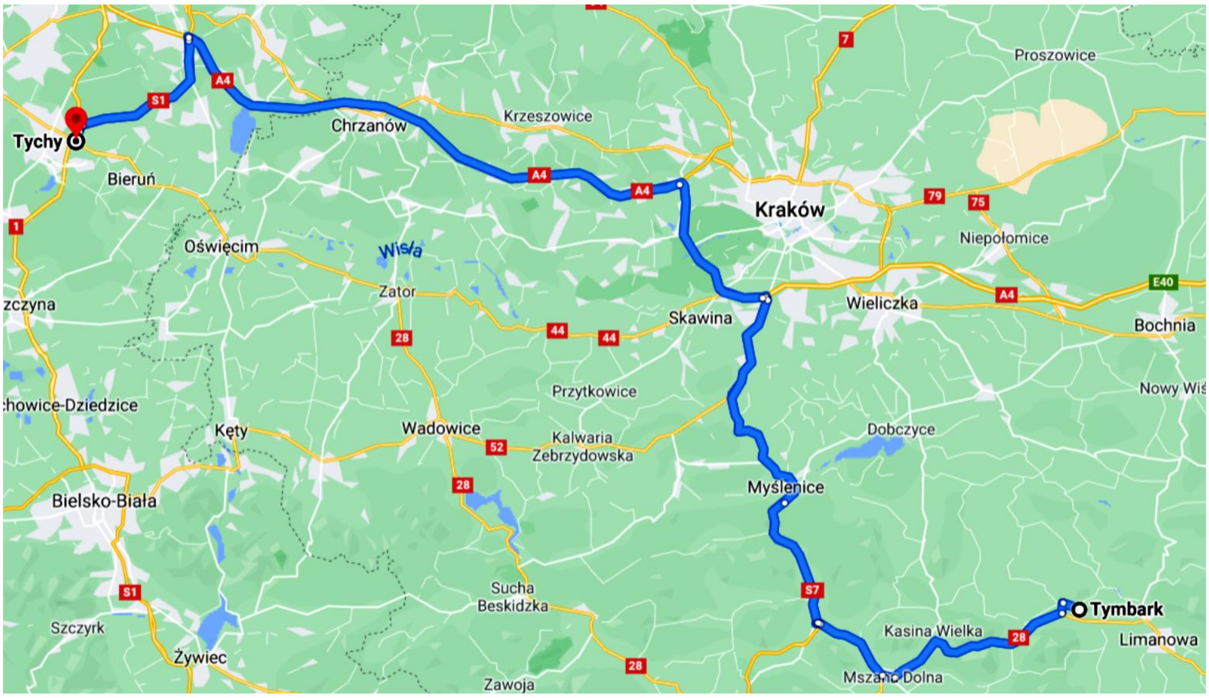

Fig. 14. Implementation of route 4 (Tymbark - Tychy - Tymbark)

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