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AN ANALYSIS OF THE SERVICES PROVIDED BY A TRANSPORT ENTERPRISE

Summary. The escalating globalization of the market, increased competitiveness and the necessity to intensify actions directed at an appropriate level of logistics customer service, as well as the growth in provided services, are the most important strategic decisions made by transport enterprises. The tendency of transport enterprises to ensure fluidity of supplies and reduce the costs of transport processes requires the use of innovative technologies, which allow companies to improve the control of transport services. Enterprises plan transport services to minimize the costs. Therefore, looking for and implementing new solutions, which have an impact on increasing the efficiency of transport processes, are driving forces for every transport company. In this article, the authors conducted an analysis of the process of providing transport services in a specific enterprise. The authors also show that transport processes may be improved through the implementation of innovative monitoring system.
Keywords: transport; monitoring system.

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1. INTRODUCTION

The potential of transport enterprises has led to a trend in modern logistics, which is focused mainly on the performance of transport services that are adjusted to the individual needs of clients. A significant factor in planning the transport process is shortening the time of execution for a transport task, while providing high-quality customer service [10]. Moreover, the market success of a transport enterprise largely depends on providing services of appropriate quality. Therefore, transport enterprises try to execute transport orders in the best way possible using a vehicle fleet [4,7].

The organization of the processes is complex and includes the following actions: acceptance of an order from a client, planning the transport route, determining the value of transport, both in terms of income and costs, as well as preparing transport documents and monitoring transport execution in real time [9,14]. This process is very time-consuming and also cost-intensive [2,12,13]. Therefore, the execution of the above tasks in modern logistics processes, particularly transport processes, requires the application of modern solutions and concepts, above all, innovative technological solutions that facilitate transport management [1,3,5-6,8,11,15-22].

2. ANALYSIS OF THE TRANSPORT PROCESS IN A SPECIFIC ENTERPRISE

The authors analysed Route 1 and Route 2, in which return cargos are loaded at Szczecin Port. These routes consist of the transport of three cargos:

Route 1:

- the first cargo on the route Jasło - Odense in Denmark
- the second cargo on the route Odense - Szczecin
- and the third cargo on the route Szczecin - Jasło

Route 2:

- the first cargo on the route Jasło - Berlin in Germany
- the second cargo on the route Berlin - Szczecin
- and the third cargo on the route Szczecin - Jasło

Source data were listed in a five-sectional system and contain such information as: the number of the route, make, date, hour and place of departure, distance of a ride, cargo weight, date, hour and place of arrival, pauses on the route, time of loading operations, time of daily rest (Tables 1-2).

Based on the collected source data, the values of the averages and sums, maximal and minimum values and their standard deviation, whenever possible, the value of standard deviation was compared with the average value in the percentages. Directly from monthly data, the sums of distances, times of loading, unloading, pauses, daily rest and fuel consumption were calculated [23]. Apart from monthly sums, the average values of these parameters were calculated, while their maximal and minimum values and standard deviation were determined and compared with the average value.

The analysis was conducted by calculating such rates as: transport work, time of transport, journey time, time of work, operational speed, technical speed and combustion (Tables 3-4).

Data from Table 4, for Route 2, were integrated using a pivot table (Table 5), because two sections were performed within one shift in this run. In this way, daily rates (it was assumed that the results of the analyses would be in a daily system) were obtained.

Table 1

Source data of the route Jasło - Odense - Szczecin - Jasło

ROUTE	SECTION NUMBER	DEPARTURE DATE	START OF WORK	LOADING TIME [H]	HOUR OF DEPARTURE [HH:MM]	ROUTE	DISTANCE [KM]	LOAD [T]	PAUSE TIME AT THE ROUTE [H]	ARRIVAL DATE	HOUR OF ARRIVAL [HH:MM]	TIME OF UNLOADING [H]	TIME OF LOADING [H]	END OF WORK	TOTAL TIME OF LOADING OPERATIONS [H]	DAILY REST [H]	TOTAL FUEL CONSUMPTION [LITRE]
1	**1**	31-07-2017	6:00	1:00	07:00	JASŁO - OLSZYNA	605	24	00:50	31-07-2017	16:45			16:55	01:00	11:05	176
	2	01-08-2017	4:00		04:10	OLSZYNA - ODENSE (DN)	734	24	01:40	01-08-2017	15:40	01:10	01:00	17:50	02:10	12:10	211
	3	02-08-2017	6:00	1:30	07:30	ODENSE (DN) - SZCZECIN	675	24	00:50	02-08-2017	17:15	01:00		19:30	02:30	11:10	199
	4	03-08-2017	6:40		06:50	SZCZECIN - CRACOW	640	24	01:40	03-08-2017	18:20			18:30	00:00	11:10	188
	5	04-08-2017	5:40		05:50	CRACOW - JASŁO	150	24		04-08-2017	08:30	04:00		13:00	04:00		43
				2:30		**TOTAL**	**2,804**		**5:00**			**6:10**	**1:00**		**9:40:00**	**45:35:00**	**817**
				1:15		AVERAGE	560.8		1:15			2:03	1:00		1:56	11:23	163.4
				1:30		MAXIMUM	734		1:40			4:00	1:00		4:00	12:10	211
				1:00		MINIMUM	150		0:50			1:00	1:00		0:00	11:05	43
				0:21		STANDARD DEVIATION	235		0:28			1:41	-		1:31	0:30	69
				28.3		STANDARD DEVIATION/AVERAGE [%]	41.8		38.5			82.0	-		78.7	4.5	41.9

Table 2

Source data for the route Jasło - Berlin - Szczecin - Jasło

ROUTE	SECTION NUMBER	DEPARTURE DATE	START OF WORK	LOADING TIME [H]	HOUR OF DEPARTURE [HH:MM]	ROUTE	DISTANCE [KM]	LOAD [T]	PAUSE TIME AT THE ROUTE [H]	ARRIVAL DATE	HOUR OF ARRIVAL [HH:MM]	TIME OF UNLOADING [H]	TIME OF LOADING [H]	END OF WORK	TOTAL TIME OF LOADING OPERATIONS [H]	DAILY REST [H]	TOTAL FUEL CONSUMPTION [LITRE]
2	**1**	07-08-2017	6:00	1:20	07:20	JASŁO - OLSZYNA	605	18	00:55	07-08-2017	17:10			17:10	01:20	11:05	180
	2	08-08-2017	4:15		04:20	OLSZYNA - BERLIN (D)	180	18	00:50	08-08-2017	07:50	01:05		08:55	01:05		55
	3	08-08-2017	8:55		09:00	BERLIN (D) - SZCZECIN	151	0	00:50	08-08-2017	12:10		01:10	13:20	01:10	16:40	35
	4	09-08-2017	6:00		06:10	SZCZECIN – CRACOW	650	24	01:40	09-08-2017	17:30			17:30		11:30	195
	5	10-08-2017	5:00		05:10	CRACOW - JASŁO	150	24	00:15	10-08-2017	08:00	01:00		09:00	01:00		45
				1:20		**TOTAL**	**1,736**		**4:30**			**2:05**	**1:10**		**4:35:00**	**39:15:00**	**510**
				1:20		AVERAGE	347.2		0:54			1:02	1:10		1:08	13:05	102
				1:20		MAXIMUM	650		1:40			1:05	1:10		1:20	16:40	195
				1:20		MINIMUM	150		0:15			1:00	1:10		1:00	11:05	35
						STANDARD DEVIATION	257		0:30			0:03			0:08	3:06	79
						STANDARD DEVIATION/AVERAGE [%]	73.9		56.1			5.7			12.4	23.8	77.0

Table 3

Analysis results of Route 1

SECTION NUMBER	DATE OF DEPARTURE	DISTANCE [KM]	TRANSPORT WORK [TKM]	TIME OF TRANSPORT [H]	JOURNEY TIME [H]	TIME OF WORK [H]	OPERATIONAL SPEED [KM/H]	TECHNICAL SPEED [KM/H]	USE FACTOR OF TIME OF WORK [1]	FUEL CONSUMPTION [L]	COMBUSTION [L/100KM]		TRACTION WITH LOAD [KM]	TRACTION WITHOUT LOAD [KM]	COMBUSTION WITH LOAD [L/KM]	COMBUSTION WITHOUT LOAD [L/KM]
1	31-07-2017	605	14,520	09:45	08:55	10:55	55.4	67.9	0.82	176	29.1		605	0	29.1	-
2	01-08-2017	734	17,616	11:30	09:50	13:50	53.1	74.6	0.71	211	28.7		734	0	28.7	-
3	02-08-2017	675	16,200	09:45	08:55	13:30	50.0	75.7	0.66	199	29.5		675	0	29.5	-
4	03-08-2017	640	15,360	11:30	09:50	11:50	54.1	65.1	0.83	188	29.4		640	0	29.4	-
5	04-08-2017	150	3,600	02:40	02:40	07:20	20.5	56.3	0.36	43	28.7		150	0	28.7	-
	TOTAL	**2,804**	**67,296**	**45:10:00**	**40:10:00**	**57:25:00**	**48.8**	**69.8**	**0.70**	**817**	**29.1**	**TOTAL**	**2,804**	**0**	**29.1**	
												[%]	100.0	0.0		

Table 4

Analysis results for Route 2

SECTION NUMBER	DATE OF DEPARTURE	DISTANCE [KM]	TRANSPORT WORK [TKM]	TIME OF TRANSPORT [[H]	JOURNEY TIME [H]	TIME OF WORK [[H]	OPERATIONAL SPEED [KM/H]	TECHNICAL SPEED [KM/H]	USE FACTOR OF TIME OF WORK [1]	FUEL CONSUMPTION [L]	COMBUSTION [L/100KM]		TRACTION WITH LOAD [KM]	TRACTION WITHOUT LOAD [KM]	COMBUSTION WITH LOAD [L/KM]	COMBUSTION WITHOUT LOAD [L/KM]
1	07-08-2017	605	10,890	09:50	08:55	11:10	54.2	67.9	0.80	180	29.8		605	0	29.8	
2	08-08-2017	180	3,240	03:30	02:40	04:40	38.6	67.5	0.57	55	30.6		180	0	30.6	
3	08-08-2017	151	0	03:10	02:20	04:25	34.2	64.7	0.53	35	23.2		0	151		23.2
4	09-08-2017	650	15,600	11:20	09:40	11:30	56.5	67.2	0.84	195	30.0		650	0	30.0	
5	10-08-2017	150	3,600	02:50	02:35	04:00	37.5	58.1	0.65	45	30.0		150	0	30.0	
	TOTAL	**1,736**	**33,330**	**30:40:00**	**26:10:00**	**35:45:00**	**48.6**	**66.3**	**0.73**	**510**	**29.1**	**TOTAL**	**1,585**	**151**	**29.1**	**23.2**
												[%]	91.3	8.7		

Table 5

Pivot table for Route 2 containing all daily values of the parameters

LABEL LINES	SUM OF DISTANCE[KM]	SUM OF TRANSPORT WORK [TKM]	SUM OF TIME OF TRANSPORT [H]	SUM OF TIME OF RIDE [H]	SUM OF TIME OF WORK [H]	SUM OF FUEL CONSUMPTION [L]
07-08-2017	605	10,890	9:50:00	8:55	11:10:00	180
08-08-2017	331	3,240	6:40:00	5:00	9:05:00	90
09-08-2017	650	15,600	11:20:00	9:40	11:30:00	195
10-08-2017	150	3,600	2:50:00	2:35	4:00:00	45
TOTAL AMOUNT	**1,736**	**33,330**	**30:40:00**	**26:10:00**	**35:45:00**	**510**
AVERAGE	434	8,333	7:40:00	6:32:30	8:56:15	127.5

3. RESULTS OBTAINED FROM THE CONDUCTED ROUTE ANALYSIS

The results of the analysis of Route 1 and Route 2, in terms of daily distances, daily transport work, daily time of transport, ride and work, as well as daily fuel consumption, daily combustion and technical speed, are presented in Figures 1-12.

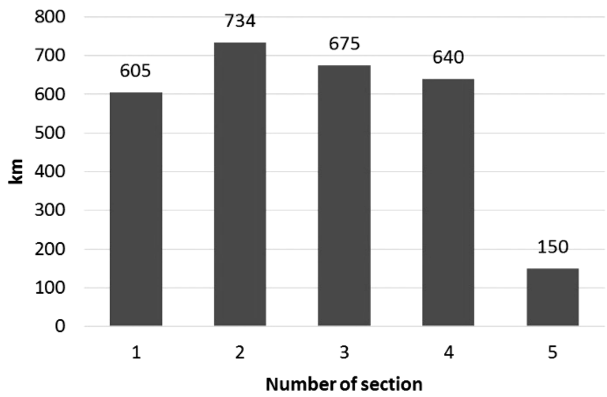

Fig. 1. Daily distances - Route 1

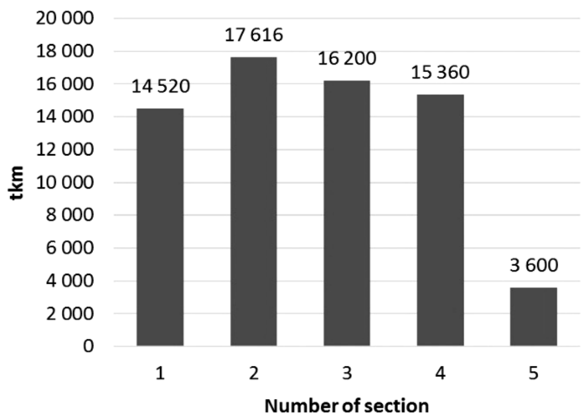

Fig. 2. Daily transport work - Route 1

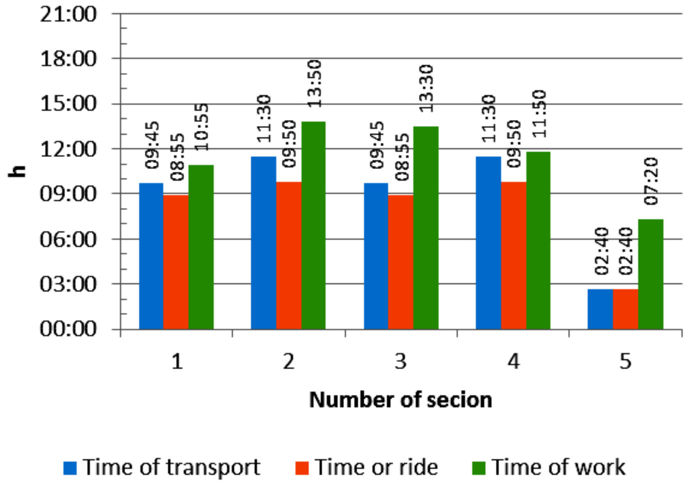

Fig. 3. Daily time of transport, ride and work - Route 1

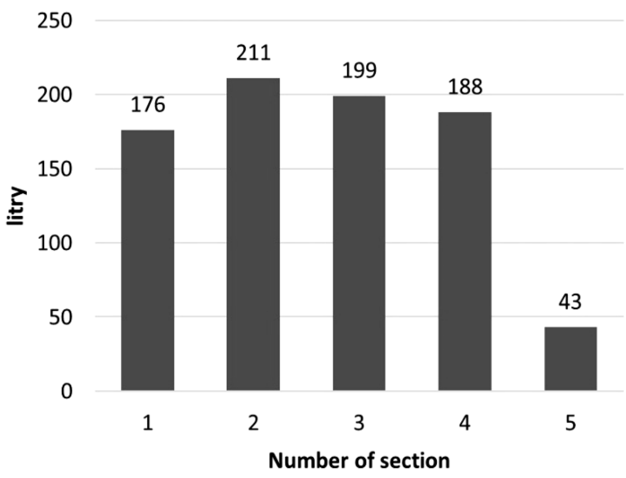

Fig. 4. Daily fuel consumption - Route 1

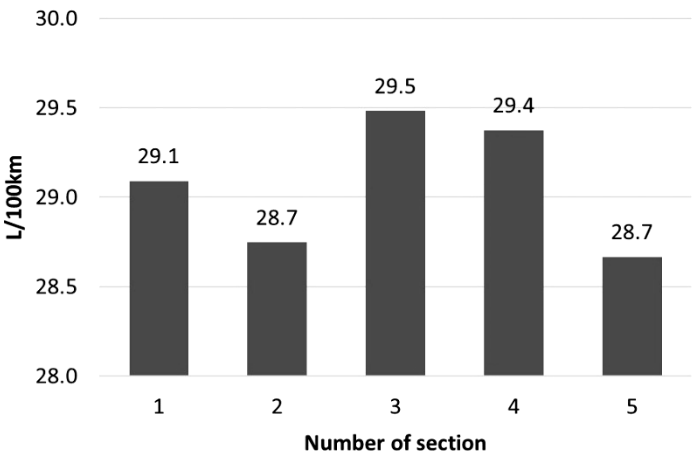

Fig. 5. Daily combustion - Route 1

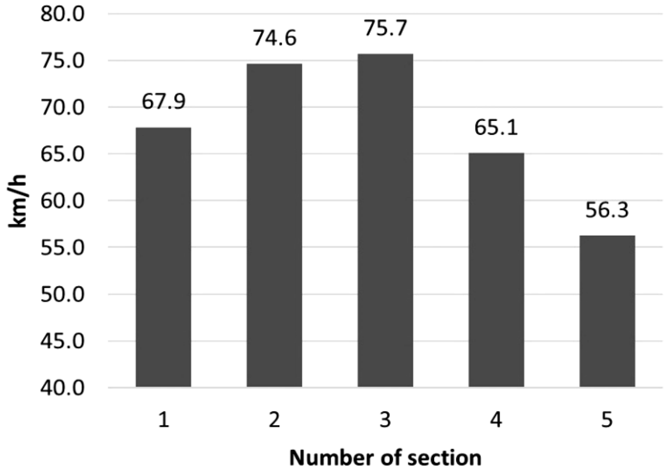

Fig. 6. Technical speed - Route 1

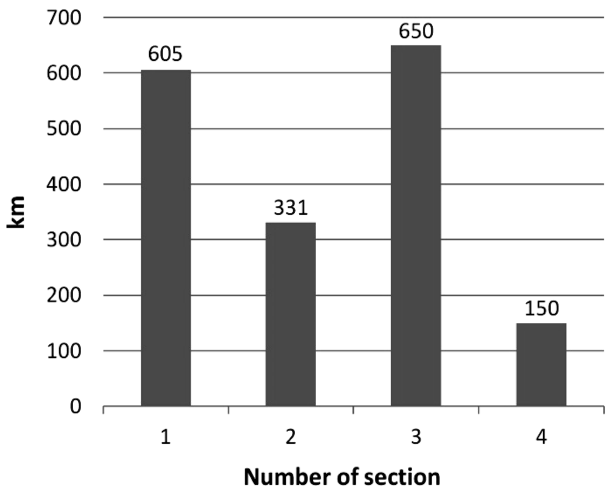

Fig. 7. Daily distances - Route 2

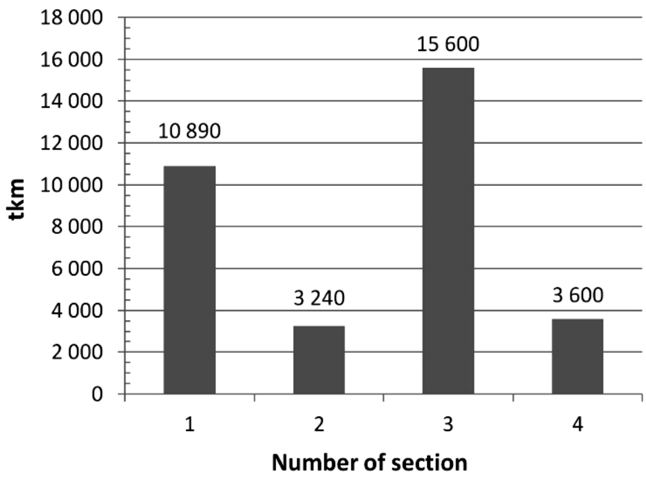

Fig. 8. Daily transport work - Route 2

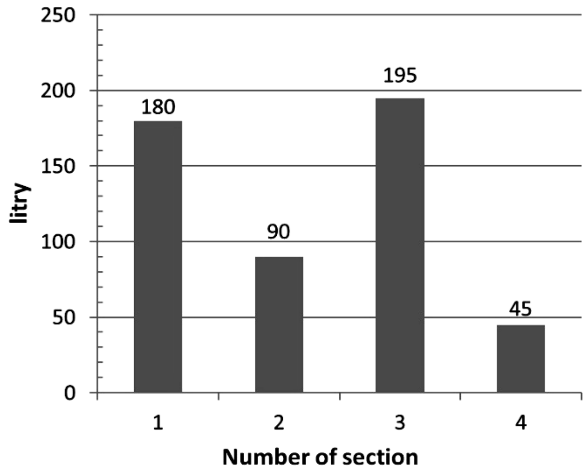

Fig. 9. Daily fuel consumption - Route 2

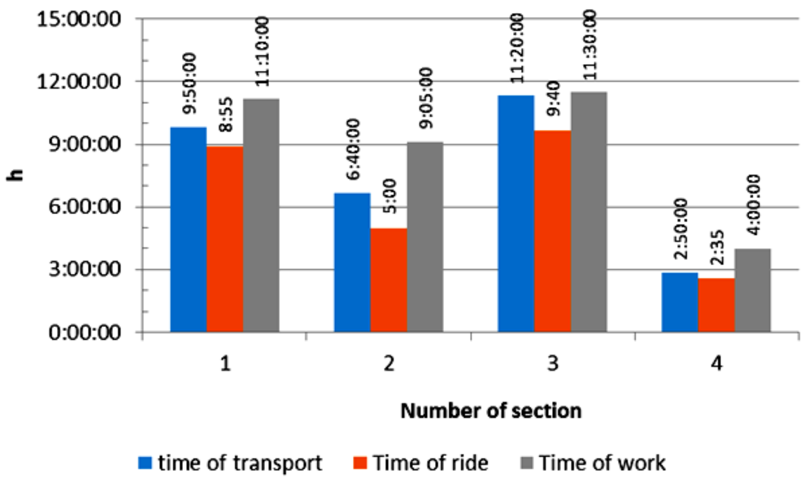

Fig. 10. Daily time of transport, ride and work - Route 2

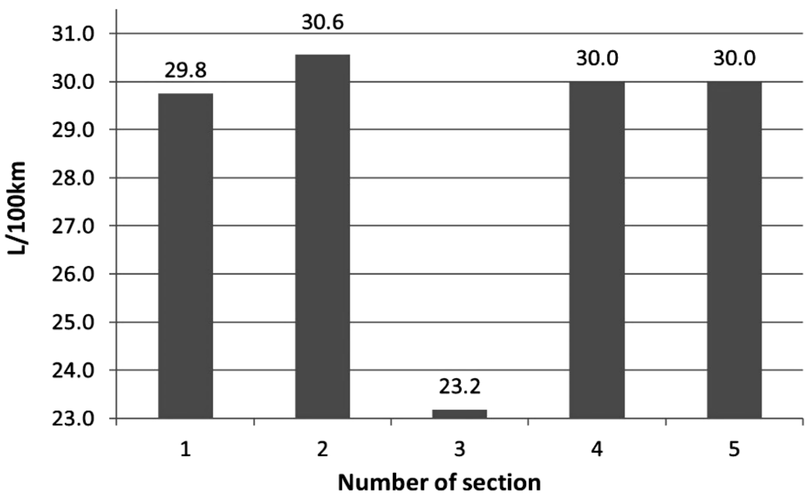

Fig. 11. Daily combustion - Route 2

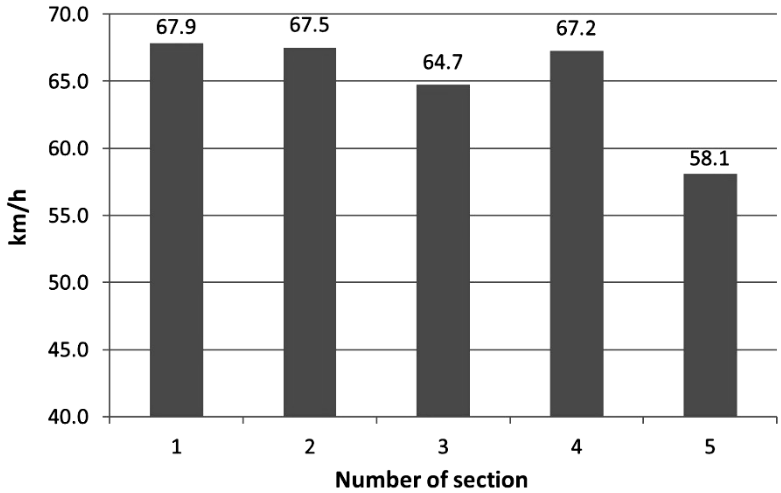

Fig. 12. Technical speed - Route 2

4. IMPLEMENTATION OF MONITORING SYSTEM

The journey time for Route 1 is 40 h and 10 min, divided into five working days. The journey time for Route 2 is 26 h and 10 min. We should check whether the application of a monitoring system would shorten the time of transport. Table 6 was created to check Route 1 and Table 7 to check Route 2. To simplify the process, it was assumed that departure starts at midnight, but it could be changed in the table. The data sets were also changed and include loading and unloading, journey time and pauses. Data were entered into the fields and marked in purple, whereas the remaining fields, such as hour of departure and arrival, the end of the shift, and time of work and day, were not changed (Table 6).

With reference to Route 1, it is possible to shorten the time of execution of this transport to four days in five shifts by maintaining the norms of time of work and driver’s rest. In the case of Route 2, it is possible to shorten the execution of this transport process by one day. However, the necessary conditions are the change in the place of daily rest from Cracow to Zielona Góra. In addition, unloading in Jasło must be improved. According to the source data, this unloading lasted 4 h, which is too long. To sum up, it is possible to shorten the journey time by one day. It allows for a vehicle and driver to be used for an additional run.

5. CONCLUSION

The conducted analysis showed that the selection of transport routes for both runs is optimal. Alternative routes are longer, while the roads are of low categories and require longer journey times. Changes in the route may be considered only in a run to Odense, that is, driving “there” through Szczecin, which would shorten the journey time through Germany and decrease the amount of remuneration for the driver in this section, because the number of hours payable in accordance with German minimal rates would be lower. As a result of conducted research, the authors claim that, on Route 1, the place of daily rest can be changed, on the return path, from Cracow to a town situated about 100 km earlier. This would avoid a 10-h shift on the route Szczecin - Cracow, decreasing it to about 8 h and 30 min, whereas this distance would be covered during the short shift to Jasło. Analogically, on Route 2, we can add to the section Olszyna - Berlin - Szczecin part of the return ride on the section Szczecin - Zielona Góra, which would allow for a better use for the permissible journey time during the day. Unloading in Jasło on Route 1 was too long, because it lasted 4 h. The obtained data showed that unloading usually lasts about 2 hours; therefore, we can assume that some disturbances occurred, for example, waiting for unloading.

The present study showed that this innovative system offers transport enterprises notable benefits, that is, savings in the execution of a transport task and improvements in the quality of offered services. Therefore, the research conducted by the authors highlighted the importance of logistics management, where we observe particular costs, which constitute a decision-making base for the appropriate management of a transport process in a transport enterprise.

Table 6

Monitoring system - data for Route 1
(purple fields refer to data obtained from the monitoring system)

DEPARTURE DAY	START OF WORK [HHMM]	TIME OF LOADING [H]	HOUR OF DEPARTURE [HH:MM]	ROUTE	DISTANCE [KM]	TIME OF RIDE [H]	PAUSE TIME AT THE ROUTE [H]	ARRIVAL DAY	HOUR OF ARRIVAL [HH:MM]	TIME OF UNLOADING [H]	TIME OF LOADING [H]	END OF WORK [HH:MM]	TIME OF WORK [H]	DAILY REST [H]	TOTAL FUEL CONSUMPTION [LITRE]	JOURNEY TIME ON THE SECTION [H]	OPERATIONAL SPEED [KM/H]	TECHNICAL SPEED [KM/H]
1	0:00	1:00	01:00	JASŁO - OLSZYNA	605	08:55	00:45	1	10:40			10:40	10:40	11:00	176	10:40	56.7	67.9
1	21:40		21:40	OLSZYNA - ODENSE (DN)	734	09:50	01:30	2	9:00	01:10	01:00	11:10	13:30	09:00	211	12:30	58.7	74.6
2	20:10		20:10	ODENSE (DN) - SZCZECIN	675	08:50	00:45	3	5:45	01:00		6:45	10:35	11:00	199	10:35	63.8	76.4
3	17:45	1:30	19:15	SZCZECIN - CRACOW	640	09:50	01:30	4	6:35			6:35	12:50	09:00	188	12:50	49.9	65.1
4	15:35		15:35	CRACOW - JASŁO	150	02:45		4	18:20	02:00		20:20	4:45		43	04:45	31.6	54.5
		2:30		**TOTAL**	**2,804**	**40:10:00**	**4:30**			**4:10**	**1:00**		**52:20:00**	**40:00:00**	**817**			
		1:15		AVERAGE	560.8	8:02	1:07			1:23	1:00		10:28	10:00	163.4			
		1:30		MAXIMUM	734	9:50	1:30			2:00	1:00		13:30	11:00	211			
		1:00		MINIMUM	150	2:45	0:45			1:00	1:00		4:45	9:00	43			
		-		STANDARD DEVIATION	235	2:59	0:25			0:32	-		3:26	1:09	69			
		-		STANDARD DEVIATION/AVERAGE [%]	41.8	37.2	38.5			38.6	-		32.9	11.5	41.9			

Table 7

Monitoring System - data for Route 2
(purple fields refer to data obtained from the monitoring system)

DEPARTURE DAY	START OF WORK [HH:MM]	TIME OF LOADING [H]	HOUR OF DEPARTURE [HH:MM]	ROUTE	DISTANCE [KM]	TIME OF RIDE [H]	PAUSE TIME AT THE ROUTE [H]	ARRIVAL DAY	HOUR OF ARRIVAL [HH:MM]	TIME OF UNLOADING [H]	TIME OF LOADING [H]	END OF WORK [HH:MM]	TIME OF WORK [H]	DAILY REST [H]	TOTAL FUEL CONSUMPTION [LITRE]	JOURNEY TIME ON THE SECTION [H]	OPERATIONAL SPEED [KM/H]	TECHNICAL SPEED [KM/H]	DEPARTURE DAY	START OF WORK [HH:MM]
1	0:00	1:20	01:20	JASŁO - OLSZYNA	605	18	08:55	00:45	1	11:00			11:00	11:00	01:20	11:00	176	11:00	55.0	67.9
1	22:00		22:00	OLSZYNA - BERLIN (D)	180	18	02:40	00:15	2	0:55	01:10		2:05	4:05	01:10		211	04:05	44.1	67.5
2	2:05	1:00	03:05	BERLIN (D) - SZCZECIN	151	0	02:20	00:30	2	5:55	01:00		6:55	4:50	02:00		199	04:50	31.2	64.7
2	6:55	1:30	08:25	SZCZECIN - ZIELONA GÓRA	200	24	03:00		2	11:25			11:25	4:30		11:00	188	04:30	44.4	66.7
2	22:25		22:25	ZIELONA GÓRA - JASŁO	600	24	09:15	01:30	3	9:10	04:00		13:10	14:45	04:00		43	14:45	40.7	64.9
		3:50		**TOTAL**	**1,736**		**26:10:00**	**3:00**			**6:10**	**0:00**		**39:10:00**	**8:30:00**	**22:00:00**	**817**			
		1:16		AVERAGE	347.2		5:14	0:45			2:03			7:50	2:07	11:00	163.4			
		1:30		MAXIMUM	605		9:15	1:30			4:00	0:00		14:45	4:00	11:00	211			
		1:00		MINIMUM	151		2:20	0:15			1:00	0:00		4:05	1:10	11:00	43			
		0:15		STANDARD DEVIATION	234		3:31	0:32			1:41			4:47	1:18	0:00	69			
		19,9		STANDARD DEVIATION/AVERAGE [%]	67.3		67.3	72.0			82.0			61.2	61.2	0.0	41.9			

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