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Implementation of Logistics and Transport Processes in an Enterprise Operating on Polish Territory in the Face of COVID-19

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ABSTRACT: Logistics managers are responsible for efficient functioning of transport companies. This article will allow logistics managers to better understand the essence of logistics projects and the implementation of alternative routes. The aim of this article is to show the process of implementation of new routing alternatives. The analysis was conducted for the period January ÷ April 2020, which marked the emergence of the first COVID-19 cases, as well as for the months January ÷ April 2021.
Alternative routes were proposed and implemented to improve the quality of services in a transport company operating in Poland. The impact of the pandemic on the selected transport company was evaluated. The results on new sections of transport corridors were presented together with an in-depth verification of how the introduced changes affected the provided transport services. In the end, the most important benefits connected with the analysis and the implemented project were presented.

1 INTRODUCTION

The Covid trend is characterized by an increase in the number of cases in 2021 compared to the parallel months in 2020. The first wave of Covid-19 in 2020 created great uncertainty and shattered the stable rhythm of people's lives not only in Poland but all over the world. Companies faced uncertain market conditions, sudden loss of customers and orders, resulting in drastically broken supply chains. Companies with more capital were better able to adapt to the situation. A large number of businesses had to declare bankruptcy due to a lack of funds for maintenance. Currently we are observing the process of rebuilding the Polish economy. Companies are trying to get back to functioning and making profits like before the pandemic. Covid has made a revolution in the transport industry due to the sudden increase in demand for courier services. Companies providing courier services enjoyed much higher revenues. Not all transportation sectors were so spectacularly successful. An important element was also looking for possibilities to improve the services provided. Some Polish companies implemented new projects in their businesses in order to best adapt to the new operating conditions during the pandemic. Companies in the transport industry have been analyzing and searching for improvements in many areas [6].

The specificity of each business forces to adjust to personalized areas for a given enterprise. For the examined enterprise the authors presented four key areas, which the transport company should pay attention to in order to analyze the provided services and search for potential bottlenecks (Fig. 1).

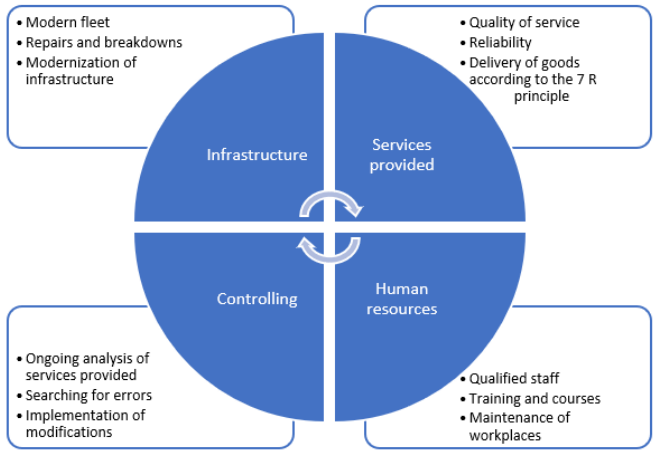

Figure 1. Key areas for improvement for a company operating in Poland (own elaboration)

2 LITERATURE REVIEW

Implementing logistics projects involves large-scale risk taking. It is important to apply activities that are designed to maximize the use of the available capital. Four main activities that increase the efficiency of capital can be singled out [1]. The groups identified include value engineering, asset portfolio, life cycle costing, and quality assurance. Abeysekara emphasizes that quality assurance reduces the risk of errors. Value engineering ensures proper implementation and know-how. The research conducted by Zubkov demonstrates the essence of the importance of the customer and its impact on the transportation process. The quality of customer service management is extremely important for the efficiency of a transport company [19]. In any transport or logistic process, it is important to collect, analyze, and rank data. Modern transportation and logistics systems should be intellectualized [20]. Processes should be designed holistically by providing a conducive environment for retrieving data and information, comparing problem situations, and finding solutions based on the knowledge gained. Many factors of both linear and node infrastructure are considered when routing and simulating trips. In a study by Smarsly K. and Mirboland M., a conceptual model for intelligent transportation system simulation platforms was proposed [17]. The concept considers routing based on increasing traffic safety while reducing congestion. An important point concerning modeling transit routes was presented by Qiang X. In his research, Qiang X used a search method with an increasing number of customers based on the concept of comovement and minimizing transportation cost at the same time. Using the critical path method, he presented the most efficient results and identified the most efficient routes [15]. The simulation is prepared for one truck that delivers goods to all customers. To achieve a set of routes for each truck, permutations and combinations are used. Optimization of travel routes is an important issue for transportation industries because it affects the quality of processes in these companies. Evangelista D.G.D. proposes the use of a genetic algorithm to determine alternative routes. The research investigated the creation of an optimization model by means of an algorithm that will offer an optimal route sequence for trucks [4]. Routing may involve the problem of assigning the vehicle location and selecting the order of unloading, as well as selecting appropriate travel routes in the transportation network. Feed J. provides a solution in the form of a developed optimization algorithm using a linear programming model [14]. The reason for doing so is to minimize the total cost. The research shows that the metaheuristic algorithms used and the evolutionary model included in it are applied to a large number of optimization problems. Another equally important aspect of routing is presented by Monti C.A.U. [12], who addresses the problem of multi-criteria truck movement. Monti C.A.U used a mixed integer linear programming algorithm considering truck scheduling, fleet reduction, and half load transport reduction among others. Technical constraints were also implemented to reflect the accuracy of the model. The results of the measures taken were: 72.92% fleet reduction, reduction in unnecessary hours. There was a reduction in trips with half loads to a result of 3.17%. A separate method of research and route selection was presented by Memon M.A., who bases his research on the calculation of time and quantity parameters. He presents methods for consolidating loads and assigning appropriate activities and actions to be performed to groups. Vehicles that can perform a given task are assigned to the next group. The assigned tasks take into account the time of their execution, and if a particular vehicle cannot perform the task, then the task is assigned to another vehicle [11]. Additionally, only if two conditions are met, i.e., execution time and payload, then the task can be completed. The aspect of cost and consolidation is also presented in the research by Kong Y., which includes a number of costs that affect transportation. It then identifies what constraints are present. The constraints illustrated indicate that the total shipment time does not exceed the time required by the customer. Another constraint is the guarantee of a complete path from the origin point to the end point. It also mentions a constraint that results from the continuity of the entire transport means, i.e., only one mode of transport can be used between nodes [9]. Idri A. devoted his research to the problem of the shortest path. As a result, he implemented a monolithic system for solving the problem related to the time dependence of multimodal transport taking into account the calculation of the shortest path from the source node to the destination source [7]. The specially constructed algorithm is focused on the search of virtual shortest path. It also considers the aspect of search space dimensions concerning time, mode, and constraints. The presented approach is used to reduce cost, travel time, and increase efficiency. A separate approach in general transportation process simulation is presented by Ebben M.J.R. Scheduling involves the geographical location and bottleneck problems that vary over time. The method created must be suitable for real-time scheduling [3]. The method includes serial scheduling and discrete simulation of dynamic events. A very broad and important aspect of optimization is addressed by Javadi A., whose research elaborates on the types of wastage associated with returning a vehicle empty and vehicle downtime while waiting for cargo. The objective of the research is to develop a transportation network model based on delay minimization for a balance between the number of vehicles and capacity. The algorithm is focused on minimizing vehicle dormancy. A differential evolutionary algorithm (MODE) was used to validate the performance of the proposed algorithm. A comparative study of Pareto and NSGA-II, which is determined by four metrics: quality, distance, diversity, and distance from the ideal point [8], was performed. It considered additional parameters: the cost of staying at a node, instantaneous demand, travel cost, and period. The solution in different aspects of the four-index transportation problem is included in the research of Skitsko V., who indicated a genetic algorithm that solves the four steps of the challenge using a special programming language [16]. When optimizing routes, the aspect of ecology and the environmental impact of the executed order is important. Operational parameters of speed, combustion, tonnage, and exhaust emissions translate into the quality of ecology. These topics are addressed in the research of Pamučar D. The TSDSM system [13] integrates multi-criteria weighted linear combination methods of WLC and GIS (spatial data). Using the developed model, it is possible to determine routes in the ecological aspect and maximize environmental impact. Ecological routing can also be performed using neural network adaptation [2]. It is used to evaluate the performance of the network. In the context of cost logistics and environmental protection, the input data and parameters to the neural network have been studied. The approach of environmentalism and route improvement has been included in the research of Liu Z. The adopted research methodology considers the determination of routes with environmentalism for transports containing hazardous waste and the impact of these transports [10]. Cargo consolidation also has an impact on increasing performance. Memon M.A. proposed a hybrid version of consolidation that takes into account the lead time and total order size [11]. The use of this methodology will translate into higher scheduling rates and consequently, increased customer satisfaction. Introducing alternative routes and making improvements requires adherence to the highest standards. Modern technologies facilitate improvement processes. The impact of information systems and technologies is of great importance. It is crucial to synchronize new technologies and the quality of implemented projects. Basic principles: the project must be well structured based on the understanding of future changes, and appropriate regulation of transport services, strengthening of transport infrastructure, efficiency must be carried out [18]. When looking for improvements in transportation processes, it is crucial to have a broad knowledge of the available solutions. It is also possible to combine different techniques such as neural networks, genetic algorithms, modern information, and telematics technologies, which will positively affect the whole process of improvement and translate into increased operational parameters. The final element of implementation is quality assurance and process standardization. Ensuring appropriate standards and adhering to them is a key factor in sustaining the effect. Maintaining standards leads to increased efficiency and facilitates process reengineering [5].

3 THE ESSENCE OF IMPLEMENTING LOGISTICS PROJECTS

An important aspect during the limited service market situation during a pandemic was the elimination of unnecessary costs. The selected transport company, after the modifications proposed by the authors, implemented a logistics project of route improvement.

Current management of logistics projects based on the implementation of improvements to a given process becomes more complex, susceptible to external factors in terms of ability to early capture and act on the changes taking place, and lead time. The implementation time of a logistics project plays a very important role, as it translates into achieving a competitive advantage if we implement the indicated solution early enough. The difficulty of coordinating a project is linked to unforeseen situations, to which one must react accordingly.

The procedure of implementing new route variants is a very sensitive activity. At each of the individual stages a check must be made regarding the impact of the change on the process. After a detailed analysis of the implemented routes and proposed variants, the authors supervised the implementation of new routes and verified and validated the collected data from the routes implemented in January ÷ April 2021.

The purpose of project implementation in the logistics context is to offer a unique product or service, an action aimed at improving a given process. In the transport process studied by the authors, the logistics project of alternative routes includes procedures for improving transport processes on the indicated routes. The implementation of logistics projects requires adherence to standards related to the proper conduct of such an activity.

Adherence to the mentioned elements is essential for the project to run properly. The steps shown in Figure 2 are closely interrelated. Correct execution of the next step is linked with the completion of work at an earlier stage and the summary of activities resulting from the step.

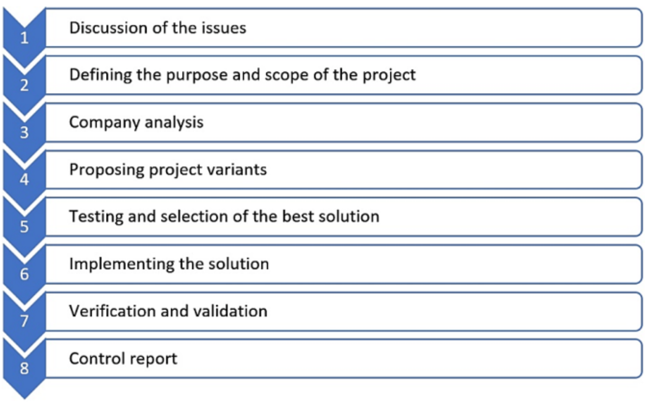

Figure 2. Sequence of procedures related to the logistic project implementation (own elaboration)

4 PROCEDURES TO BE FOLLOWED DURING IMPLEMENTATION OF THE LOGISTICS PROJECT

An algorithm for how a transportation company should proceed when implementing new travel routes is shown in Figure 3.

The different phases of supervising a logistic project which passes through different stages of the algorithm involve a check (Fig. 3.). The authors continuously checked the correct course of action, so that the company does not suffer losses associated with the determination of a new route.

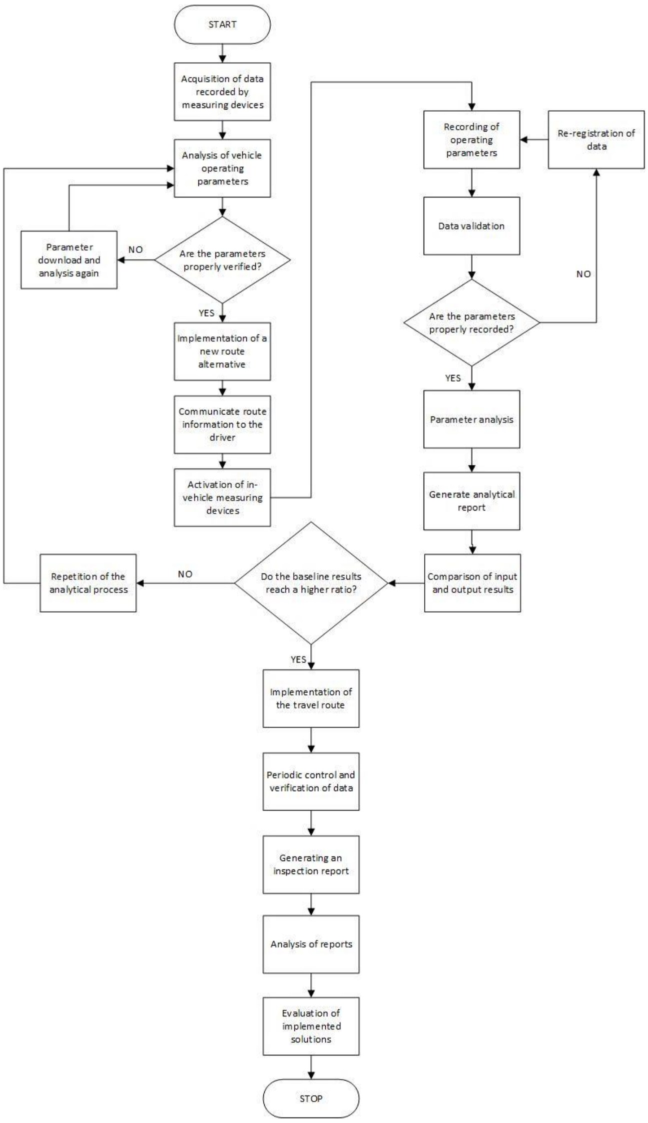

Figure 3. Route implementation algorithm (own elaboration)

At the beginning of the algorithm procedure, it is important to indicate which operational parameters are fundamental for the analysis and verification of progress. The element that is often checked is the correctness of the survey and data acquisition, so at each stage it is necessary to check whether the data obtained from the measuring devices are in accordance with the accepted standards. Next, it is important to introduce a new route and to train the driver. The driver is a very important factor that significantly affects the course of the route; each of his actions, positive or negative, is reflected in the results of the study. Another major element is the method of data collection. The data are collected directly from the telemetry devices mounted on the truck tractor. The use of recording devices in the vehicle allows for high data accuracy. For safety purposes, a verification of the data downloaded from the devices is performed to exclude possible faults or errors in the documentation. Activated measuring devices systematically record key parameters for the process related to fuel consumption, the exact route, the payload, and the time associated with the performance of individual activities. The next factor of the process is the selection of key data and its analysis. Finally, a comparison is made between the performance results that were realized before the alternative routes were introduced and after the logistics project was implemented with the new travel routes.

5 ANALYSIS OF ROUTE LENGTH REDUCTION IN A COMPANY OPERATING IN POLAND

After aggregating all the data from the completed routes in 2021, the authors made a comparison with the routes (baseline option) completed in 2020. Figure 4 shows the length of each section in the original version and after the improvements.

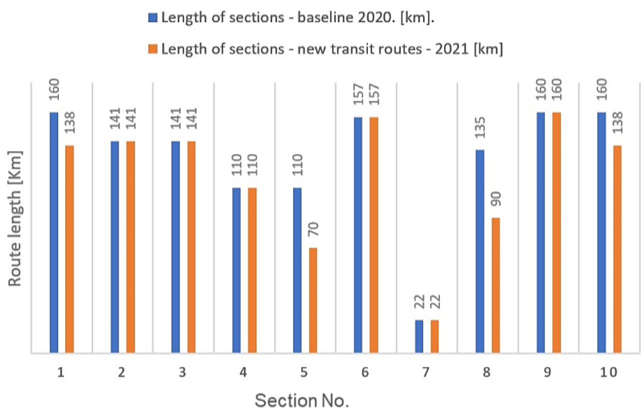

Figure 4. Reduction of the distance covered on the routes carried out in the studied company

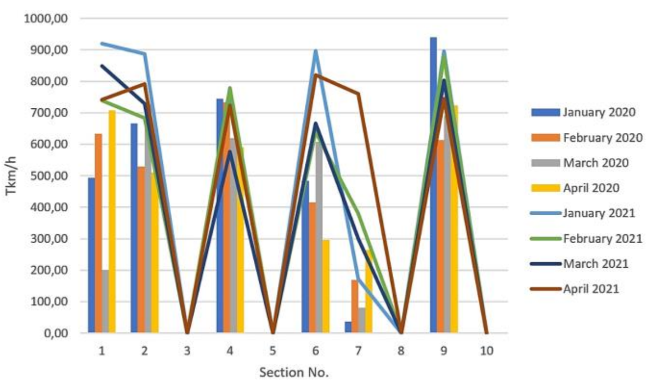

Figure 5. Vehicle performance

The authors indicate that the largest regression occurred in sections no. 8 – 45 km, and no. 5, where the difference is 40 km. Also, sections no. 1 and no. 10 exhibit a significant difference of the covered kilometers.

Another key aspect is to answer the question how significantly the introduced changes have affected the operational parameters: vehicle efficiency, payload utilization factor, and time utilization factor. (Figs. 5, 6, 7).

Figure 5 shows the vehicle performance. Sections No. 1, 2, 6, 7 achieve much higher performance in 2021, that is, after the implementation of the proposed alternative routes.

For example, in section no. 1, in March 2020 the number of tkm/h was 200. In 2021, the value increased to 849.23 tkm/h. There was also a high increase in section no. 7 in April, where there was an increase from 264 tkm/h to 760 tkm/h. The upward trend in vehicle performance is very good news for the company as it means that the vehicle has done more transport work per hour.

With the help of the data collected from the routes, the authors made calculations that indicate the coefficient of payload utilization (Fig. 6.) This is one of the key parameters, because it gives a clear picture of how much cargo space was used. This is followed by a detailed comparative analysis of each section in the base year 2020 and in 2021 (Tab. 1.).

A comparative analysis of individual sections was carried out in terms of the coefficient of vehicle capacity utilization (Fig. 6). Detailed characteristics are presented in Table 1. As it results from the analysis, the highest load capacity utilization took place on section no. 9. Section no. 4 is also characterized by a high level of results.

The authors analyzed the data in terms of working time utilization and prepared a graphic representation of the indicators of working time utilization on particular sections (Fig. 7).It is observed that the year 2021 achieves higher levels of working time utilization (Fig. 7). Sections no. 4 and no. 9 show the highest increase. In January there is an increase from 52% to 65% in 2021. Section no. 7 also shows a large increase. In February of 2020, the value is 33%. On the other hand, an increase of 24% is noted in 2021, which translates to a result of 57%. Maintaining an adequate time utilization rate is reflected in increasing the standard of driver work ethic. A high value of the time utilization rate means that the driver's work consisted mainly of driving. When the value of the indicator has a low volume, it may suggest that the driver used his working time mainly for activities:

- Technical - related to the operation and preparation of the vehicle for work;
- Supervision - related to the supervision of loading and unloading;
- Emergency - related to the use of time to solve unexpected activities that prevent further transport operations in a safe manner.

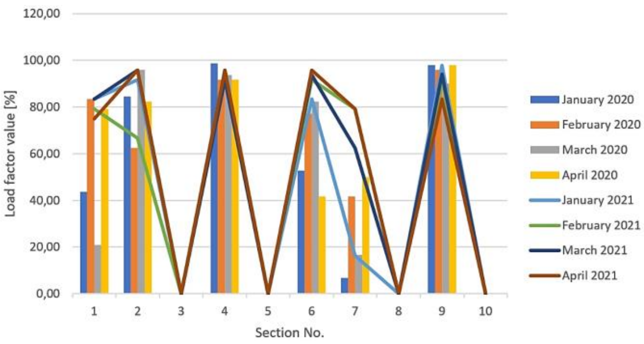

Figure 6. Coefficient of vehicle capacity utilization

Table 1. Analysis of individual route sections in the years 2020-2021 in the surveyed transport company

Section no.	Year 2020	Year 2021	Differences
1	Large coefficient fluctuations. January and March at low levels.	The ratio remains at a high level. April is at 75% while the other months are around 80%.	The section under study is more stable in 2021. More freight was transported making the indicator higher than in 2020.
2	January with the highest value of 96% while March with the lowest value of 63%.	The value reaches a high in January at 92%, March and April at an equal level of 96%.	February in both 2020 and 2021 is characterized by a decrease in productivity compared to the other months.
4	High performance in each month analyzed. Highest value of 99% in January.	Relatively low amplitude of index fluctuations, all routes above 90% with the highest value of 96% in February and April.	Section no. 4 is very effective as both 2020 and 2021 scores remain high.
6	Section no. 6 is characterized by high fluctuations. The variation from month to month is high.	The payload utilization rate is very satisfactory for 2020, with the rate at its highest level of 96% in April 2021.	2021 is definitely more stable and at a higher level. More cargo was transported during this period than in 2020.
7	Low payload utilization is prevalent in this section. In January, it is only 7%.	In 2021, the rate is at a much higher level. February and April have a value of 79% which is a big increase. January deviates from the other months with a score of 16%.	We have seen a significant increase in freight carried on the section indicated.
9	The section that reaches the highest values and is stable.	The value for this section is as high as in 2020. January will reach a very good value of 98%, while April will reach the lowest value at 83% which is also very good.	Section no. 9 is the most efficient, which means that on this route the payload of the semi-trailer was used almost 100%.
3, 5, 8, 10	No freight was transported on the indicated sections in both 2020 and 2021. The transport company decided not to consider the selection of transport orders. The transport company justifies its decision by taking care of the highest standard for the current supplier and ensuring the availability of sets of vehicles at a high level.		

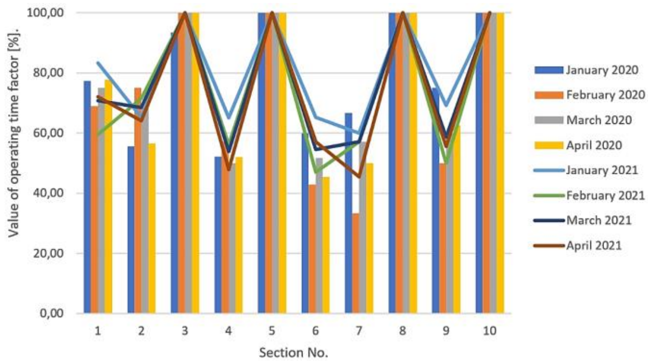

Figure 7. Time utilization ratio

6 THE IMPACT OF COVID-19 ON THE IMPLEMENTED PROCESSES IN THE TRANSPORT COMPANY

When considering the transport of cargo in Poland through 2019, the period since the beginning of the COVID-19 outbreak has resulted in a decline in tons of cargo transported. The biggest collapse for the transportation industry occurred in August 2020. The year 2021 also started at a very low level with 20,818 thousand tons (Fig. 8.). Since March, an improvement in the amount of cargo transported has been visible.

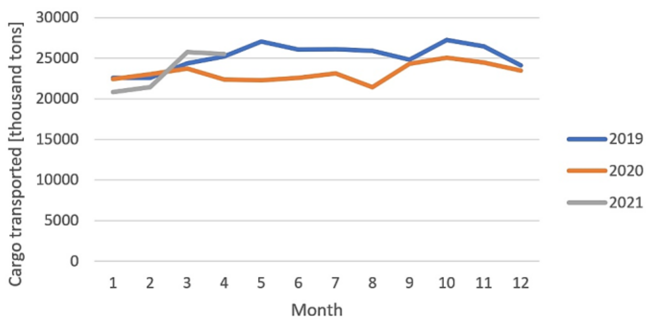

Figure 8. Cargo transport by road (own elaboration based on CSO data) [https://dashboard.stat.gov.pl]

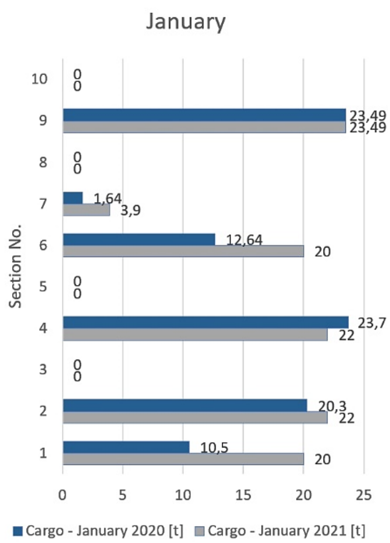

Figure 9. Quantity of cargo transported expressed in [t]

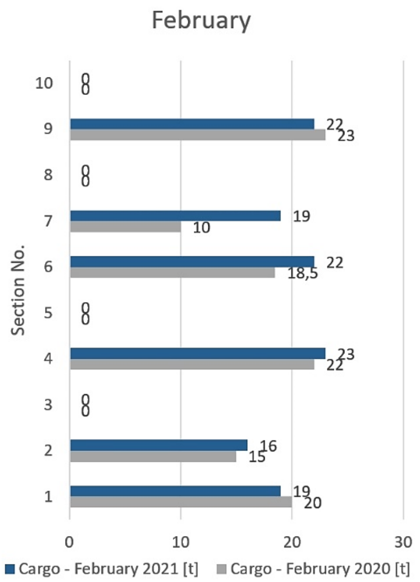

Figure 10. Quantity of cargo transported expressed in [t]

January and February 2020 represented the period before the first COVID-19 cases (Figs. 9, 10.). In the investigated company operating in Poland, the difference in transported loads expressed in tons in particular sections is relatively small. The value for January in section no. 9 remains at the same level. Also, sections no. 4 and no. 2 in February are characterized by a difference of merely 1 ton. The authors noticed the biggest deviation for January in sections no. 6 – 7.36 tons, and section no. 1 – 9.5 tons. In February 2020 and 2021, the biggest difference was noticed in section no. 7 – 9 tons.

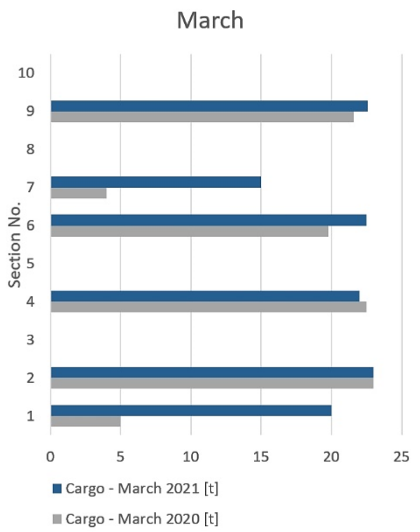

Figure 11. Quantity of cargo transported expressed in [t]

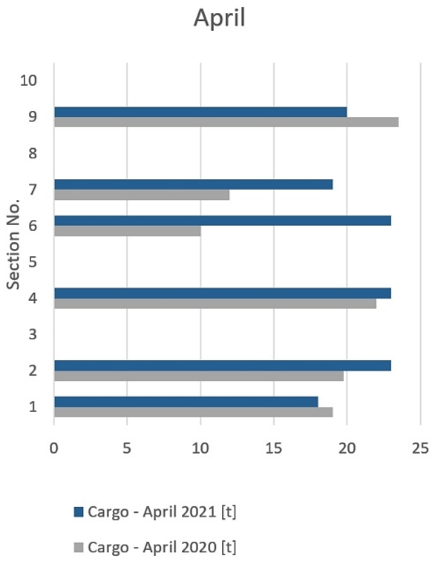

Figure 12. Quantity of cargo transported expressed in [t]

The next stage consisted in comparing March and April when the first cases of COVID-19 appeared in 2020 and March and April in 2021, when there were further increases in the incidence of Covid-19. In Figs. 11 and 12, the authors noticed significant disproportions in tons transported. In March, the biggest disparities are seen in section no. 1, where there was an increase from 5 to 20 tons in 2021, and in section no. 7, where starting with a result of 4 tons in 2020 there was an increase of 11 tons in the following year.

In April, significant fluctuations were observed in section no. 6, where the difference was 13 tons, i.e., the highest disparity recorded. Section no. 7 saw an increase from 12 tons to 19 tons in 2021.

7 CONCLUSIONS

The comparative analysis and data collection on the designated routes in the company operating in Poland required the authors to implement a project of modified routes. The authors emphasize the importance of the fundamental rules of project development, which determine the success of project realization. Subsequently moving through the eight stages of the procedure associated with the implementation of the logistic project allows to maintain the reliability and reality of the reproduced process. In order to maintain the transparency of procedures, the authors created an algorithm that presents the sequence of activities. Algorithmization in such a complex system as a transport company allows a quick and transparent understanding of the course of action during the implementation of routes.

The company followed the new routes proposed by the authors. The main benefit achieved by the implementation of the routes is the reduction of the distance covered on four sections, i.e., sections no. 1, 5, 8, and 10. The total number of reduced kilometers is 129 km, which is the value for one month. Converting the reduced kilometers into 12 months, the total value of reduced kilometers will reach 1548 km. On an annual basis this is a significant saving in kilometers travelled. The alternative routes had a stimulating effect on the transport performance defined as vehicle efficiency. The highest increase was observed in four sections, incidentally section no. 1 had an increase of 649.23 tkm/h in April 2021. The vehicle payload utilization on section no. 9 is 98% utilized. The highest increase in payload utilization was observed in section no. 7. The reduced distance also had a positive impact on the working time of the driver, who had fewer kilometers to cover.

In conclusion, the implementation of alternative routes brought a number of benefits, namely:

- reduction in distance travelled,
- reduced fuel consumption,
- time savings,
- increased vehicle efficiency,
- improved payload utilization,
- eliminating unnecessary activities,
- better use of the driver's working time.

The impact of COVID-19 was significant on the surveyed transport company during the first months of the pandemic outbreak, i.e., March - April 2020. During the onset of the pandemic, there was a significant decrease in transported cargo. It is also important that the months of January - April 2021 are characterized by a high volume of transported cargo. The reason for the sudden decline in 2020 was the emergence of an unexpected situation. There were huge fluctuations in the logistics industry. Restrictions were put in place that forced the logistics industry to reduce operations or stop work altogether. In 2021, industries got used to the situation and gained experience to operate more smoothly. This is reflected in the increase of cargo transported. To ensure the continuous development of the company, it is necessary to periodically inspect the implemented routes and analyze their progress. It is decisive to search for critical places and points that can be improved to streamline the entire transport process, bringing increased profits for the company. The analysis made by the authors allowed to save a large number of kilometers for the carrier. An algorithm was created for implementing new routes. The key factors that stimulate the implementation of routes were also identified.

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