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ANALYSIS OF THE EFFECTIVENESS OF MONITORING VEHICLE FLEETS USING THE EXAMPLE OF A SELECTED REAL-TIME TRANSPORT MANAGEMENT SYSTEM

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Abstract – The paper presents an analysis of the effectiveness of the MyCar system in monitoring vehicle fleets in road transport and identifies its development prospects. Key functionalities of the MyCar system are discussed and its effectiveness is analyzed based on a selected case study. Methods for measuring effectiveness are presented, as well as how to calculate the benefits of implementing the described solution. Based on a case study describing the implementation of the MyCar system at a transport and construction company, and using real-world data, the author demonstrates that implementing the monitoring system brings measurable financial benefits.

Key words – road transport, vehicle fleet monitoring, real-time systems, GPS system, RFID reader, GSM network

JEL Classification – A19, D29, K39

INTRODUCTION

Vehicle fleet monitoring is a system that enables accurate, real-time determination of an object's location on Earth and its control. Technologies such as Global Navigation Satellite Systems (GNSS) and the Global System for Mobile Communications (GSM) network are used for this purpose [1-5]. Devices installed in vehicles and machines, using the aforementioned technologies, can receive signals from satellites, process them, and then transmit them via the cellular network to a server, providing system users with data such as location, speed, and direction of movement. This is the basic information available from GPS modules [6-7]. In addition to the parameters mentioned above, many devices offer a wide range of other functionalities, such as monitoring data from the vehicle's CAN bus, monitoring conditions in cargo spaces (temperature, humidity), and many others [8].

GPS monitoring contributes to the optimization of costs related to fleet management, increases road safety, and helps more efficiently utilize company resources. GPS vehicle monitoring also provides a source of data for systems such as e-TOLL or SentGeo, products of Polish government institutions used to collect tolls on toll road sections, or their foreign equivalents, such as the Romanian RO e-transport or the German Toll Collect [9-10].

Modern transport and logistics companies increasingly use advanced fleet monitoring systems that allow for route optimization, reduction of operating costs and increased safety.

One of the solutions on the Polish market is the MyCar system from the Radom-based company Tekom Technologia Sp. z o.o., offering comprehensive tools for real-time fleet management [11-12].

The MyCar system allows online tracking of the current location of vehicles and machinery, checking their condition and current speed on a map, and monitoring refueling and fuel levels. The application provides real-time fuel consumption information and alerts about uncontrolled fuel leaks. It also monitors and analyzes driver driving style, checking acceleration and braking dynamics, and providing idle alerts.

The MyCar system offers full fleet integration with the e-TOLL system, and allows the application to be linked to accounting, warehousing, or billing systems. MyCar helps distinguish between private and business trips and monitors the position of vehicles transporting sensitive goods (oil, fuel, medicines, etc.). It also monitors fuel card usage and manages company fuel expenses [13].

This paper presents the architecture and effectiveness analysis of the MyCar tool for monitoring vehicle fleets, based on the example of a selected company [4]. The functionalities of the MyCar system are discussed and its effectiveness is analyzed.

1. DESCRIPTION OF THE ARCHITECTURE OF THE MYCAR SYSTEM

The window of the MyCar vehicle fleet monitoring system is shown in Figure 1. It includes, among other things, a list of measured vehicles, a map on which, after selecting an object of interest, its location and the shape of the last route will be displayed, and a preview of selected telemetry data in real time.

The MyCar system, like any vehicle monitoring system, consists of three basic components: hardware (GPS devices) [1], [3], [5], a server platform, and client software [13]. Vehicle-mounted trackers receive satellite signals and collect data from optional sensors and modules, then transmit it to servers via data transmission via cellular networks. The server platform receives and stores this data, but also analyzes and processes it using algorithms, allowing for things like identifying driver behavior patterns and detecting potential failures. This component also integrates with external platforms at the API level, such as fuel systems such as ORLEN Flota or freight forwarding companies. Access to the collected and processed data is available for viewing and further action in the client software. It includes applications such as the MyCar Desktop installed on a PC, the mobile MyCar GPS, and the web-based version available in a browser. Each of them has specific functionalities, such as generating reports, sending event notifications or remotely locking the ignition in vehicles.

The MyCar system hardware consists primarily of GPS trackers from our own and commercial manufacturers, operating in both second- and fourth-generation networks. The MyCar system is based primarily on two types of devices: the proprietary, versatile iTEK 2.0 tracker and the simpler commercial FMC/FMM920 module. Where fuel level information is not available via the CAN bus, for example, in older trucks, or the system user wants to have continuous visibility of the tank's status, a common solution is the installation of fuel level sensors. Aplisens (Fig. 2) supplies these components. They offer a variety of sensor types, and the MyCar system utilizes both analog and digital sensors [13].

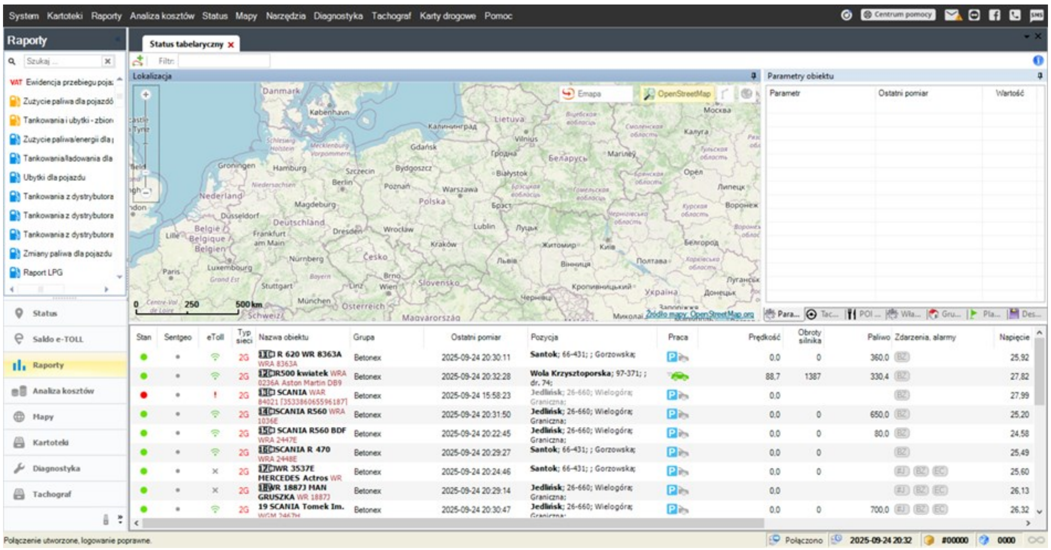

Fig. 1. View of the main window of the MyCar Business application in the desktop version [own work]

Fig. 2. Digital probe manufactured by Aplisens [13]

Fig. 3. Aplisens filler cap type BAK-Q80 [13]

After installing the fuel sensor in the tank, the installer drains the fuel tank and then begins calibration by pouring in a measured amount of fuel, recording the output voltage (or number of bits in the case of a digital sensor) and the amount of liquid poured in for each refill. After completing these steps, the installer sends a report with the measurement results to the service office, where the responsible person enters the calibration into the system.

To respond early to fuel theft or loss, tank filler caps are used. These devices, primarily installed in trucks and construction machinery, replace the original tank caps. They have in-cab alarms that warn the driver of unintentional tank opening, and a voltage signal connected to a GPS tracker to record such an event and generate an alarm for the user specified in the system. The filler cap used in the MyCar system is shown in Figure 3.

ID readers are components that allow for the identification of drivers using company cars. Mounted on the dashboards of vehicles or machines, they come in two main types: iButton (popularly called Dallas, after the company that introduced them) and RFID, which operate at frequencies of 125 kHz or 13.56 MHz [16-18]. This allows them to be used as extensions, for example, in corporate access systems. All of these types of readers transmit data using the 1-Wire standard and are additionally equipped with LEDs and audible buzzers, reminding the user to log in with their ID.

Fig. 4. Dallas (left) and Drexia 125 kHz (right) ID readers [own work]

An important component installed with GPS trackers in car and construction equipment rental companies are relays and devices that enable remote vehicle immobilization. The installer installing the tracking system in the vehicle locates an electrical circuit that, when cut, will immobilize the vehicle. According to legal regulations, cutoffs must be implemented safely, so activating the cutoff with the ignition on is unacceptable and will cause the vehicle to stall. Therefore, the starter circuits are most often cut. In hybrid or electronically advanced combustion vehicles, modules from commercial companies such as SEO Electronics or Igla are used for safety reasons. After appropriate configuration, they immobilize the vehicle via the CAN bus [8]. The components used for vehicle immobilization are shown in Figure 5.

Fig. 5. Components used to implement vehicle immobilizers. On the left, a classic relay used in the automotive industry; on the right, an SEO CANi immobilizer [**own work**]

Data recorded by telemetry devices installed in monitored vehicles is transmitted via the GSM network to the MyCar system's data processing center. The processed data is stored in a database and simultaneously sent to client applications, where it is presented in a readable format. The distributed architecture of the MyCar system enables various data operations, including export for customer needs. Figure 6 presents a schematic diagram.

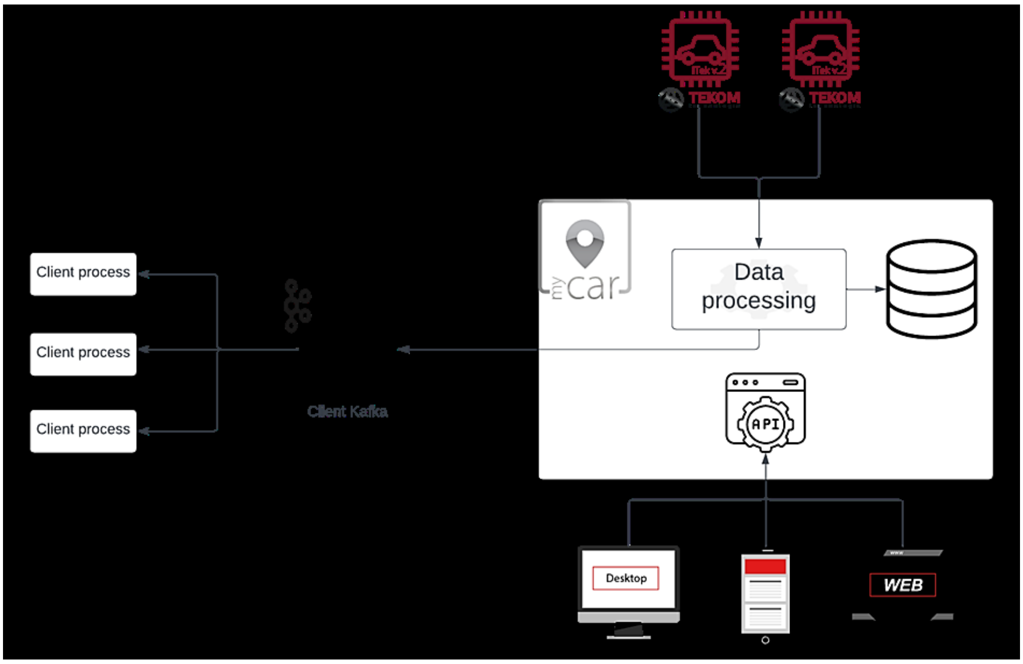

Fig. 6. MyCar system architecture diagram [**own work**]

Data export to other systems is implemented using the Kafka service [12-13]. This streaming data processing platform is similar to a message broker, with the difference that Kafka places a strong emphasis on performance and scalability, and messages are not immediately deleted after being read. The software included in the MyCar system sends messages containing data to Kafka servers, categorized by topic – this software is called a message Producer. On the other side, other programs or systems can read and process these messages; we call them Consumers. There can be multiple Producers and Consumers of the same message type. Kafka ensures that messages are read sequentially and in the order they were placed. In the case of multiple Consumers, it ensures even distribution of messages to increase the efficiency and reliability of the processing process. Data can also be retrieved from other servers via the API (application programming interface). An example of importing data into the MyCar system is the so-called ORLEN Integration. This feature allows ORLEN fleet card users to automate the download of fuel transactions to the GPS system. This allows for faster verification of GPS-registered fuel fills against fuel card fills in fuel reports.

The GPS monitoring system consists of three main types of applications: MyCar Desktop, which is installed on a PC; the MyCar GPS mobile application available for Android and iOS mobile phones; and a web application available in a browser at mycar.tekom.pl. The most advanced product is the first one, intended for Business plan customers, which offers the ability to generate the largest number of reports. It also allows users to control file downloads from digital tachographs, create access for other users, edit data on monitored vehicles, analyze telemetry parameters, and manage [12] electronic road cards.

The type of application most frequently chosen by customers primarily using e-TOLL is a mobile app. Nowadays, a mobile phone with internet access is essential for everyday life, especially for business owners, so MyCar GPS is the ideal solution. It allows for quick and easy access to vehicle location tracking and allows monitoring of the vehicle's device's proper operation. The mobile app also provides a clear and concise alarm history, providing information on the status of trackers, and is a source of push notifications. It is constantly being developed with new functionalities, one of the latest being the ability to remotely lock vehicles and a window with parameter analysis for a selected fleet vehicle. Individual screenshots from the MyCar GPS app are presented in Figure 7.

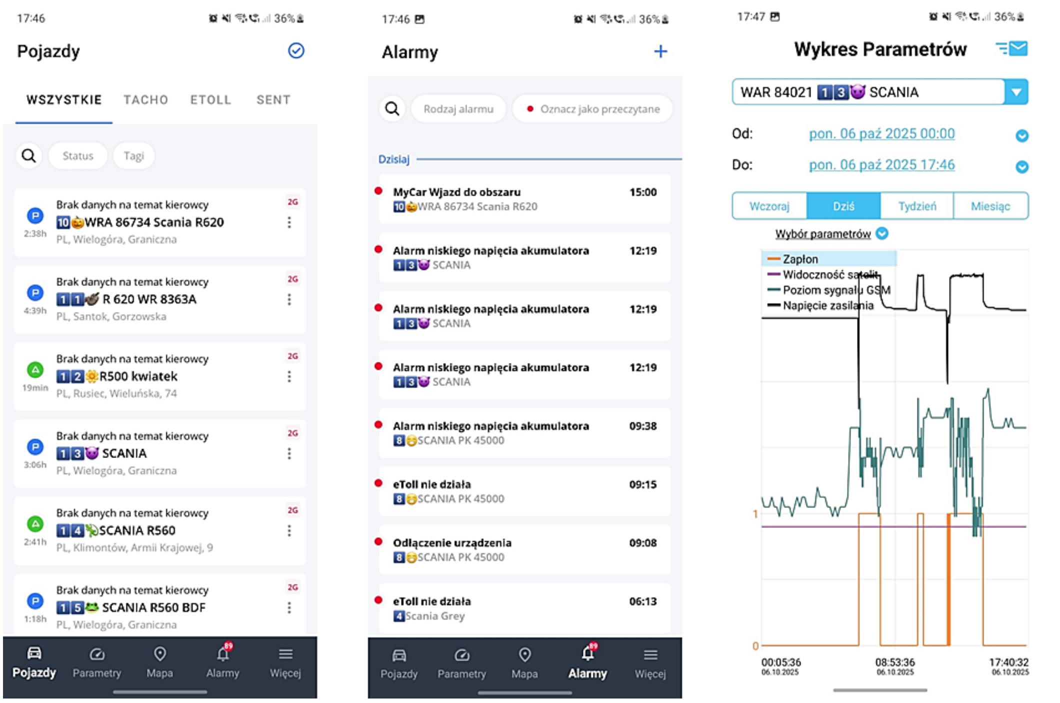

Fig. 7. Screenshots from the MyCar GPS application, showing selected functions [own work]

The final type of application, currently under the most intense development, is the web version. Accessible through a web browser, it resembles a mobile app in terms of appearance and the number of supported functions. It offers several additional features, including the ability to download files from tachographs installed in monitored vehicles, and its capabilities are constantly growing. In response to competitive growth, the web version will ultimately incorporate all the features available in MyCar Desktop and become the primary tool for operating Tekom's vehicle monitoring system. The main application view, which appears after logging in, is shown in Figure 8.

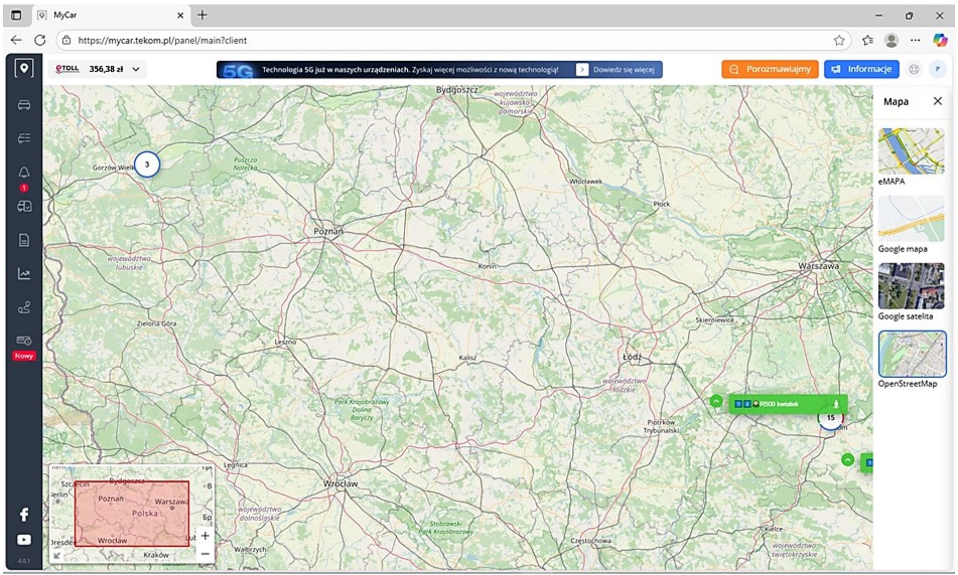

Fig. 8. View of the main window of the MyCar application in the browser version [**own work**]

2. ASSESSMENT OF THE MYCAR SYSTEM'S EFFECTIVENESS BASED ON DATA ANALYSIS. CASE STUDY

To analyze the effectiveness of implementing the MyCar system, a company was selected with a fleet of as many vehicle types as possible, ranging from passenger cars and trucks to various types of construction machinery. An example of such a company is Włodan, headquartered in Porszewice, Łódź Voivodeship [14]. Founded in 1989, the company initially offered road freight transport services, later expanding its scope to include comprehensive construction solutions, primarily in the road construction sector. The implementation of the MyCar monitoring system began with test installations involving two passenger cars, eight trucks with various body types, and three agricultural tractors. After a month of familiarization with Tekom Technologia's monitoring system, the company decided to purchase the comprehensive service. From November 2024 to early April 2025, installation teams measured 216 different types of vehicles. A prerequisite for each installation was to extract as much data as possible from the vehicle's CAN bus and install a driver identification reader. In the absence of a CAN bus in selected vehicle groups (primarily machinery, but also some older trucks), analog connections for engine speed and fuel level signals were required. The first was obtained if the vehicle's alternator had a W output, a signal whose frequency changes with the crankshaft speed. After finding the signal, the installer verified whether it met the assumed conditions, i.e., constant amplitude and variable frequency. In the initial implementation phases, due to the client's contract to supply a 4G-based system, commercial FMx 130 devices were primarily used, which lacked a frequency input. While the iTEK 2.0 was already available on the market and did have one, since the device had only just been officially released, it could have resulted in significant servicing and troubleshooting costs. Therefore, a proven solution was chosen: a frequency-to-voltage converter, which was connected between the alternator and the analog input of the FMx 130 device. After completing this installation, the installer could calibrate the engine speed and record it on an electronic assembly protocol. This procedure was performed during the measurement of the 11005 BOMAG BF800C asphalt paver.

Fuel level measurement in the tank, in the absence of this information on the CAN bus, was primarily achieved by connecting to a voltage signal from the factory float located in the tank. Using a fuel sensor would provide continuous, ignition-independent measurement of the fluid level in the tank, but the customer wasn't concerned about immediate detection of fuel loss. If a theft attempt occurred, the user would immediately receive an alarm on their mobile phone and could catch the thief in the act. Furthermore, installing a sensor and calibrating it would be significantly more expensive, so it was only performed in situations where the signal from the float was different from the one expressed in volts or was absent altogether. In exceptional situations, fuel monitoring was completely omitted, and such situations occurred when access to the tank was difficult or even impossible, for example, when the top of the tank was completely enclosed. Regarding driver or operator identification, the assumptions were simple. Drexia readers had to be installed in every type of vehicle, while where a digital tachograph capable of remote reading was installed, such as in the case of trucks, installers were required to connect to the CAN and K lines. These buses contain information about the driver's card number and the current activities (work, driving, or resting), and they allow remote downloading of ddd files. Installers responsible for the installation in a given vehicle had to verify the tachograph model on board. Remote operation is available for Continental recording devices from version 2.0 and selected older ones, as well as Stoneridge from version 7.1. Since trucks were measured next after construction machinery, and the iTEK 2.0 was already a stable device and easily capable of reading data from the CAN bus, both from the vehicle and the tachograph, this type of locator was chosen for this type of installation. The conditions for remote file reading were met by 49 devices recording working time, so the number of locators with this function was installed.

At Włodan, trucks have various purposes, and therefore different bodies. These include tractor units, dump trucks, concrete mixers, concrete pumps, and vehicles equipped with self-loading and unloading cranes (HDS). The main monitored parameter for each of these trucks is the power take-off (PTO). This is a mechanical device designed to transfer power generated by the vehicle's combustion engine to an external system, such as a hydraulic pump powering the attached equipment. In newer vehicles, the PTO engagement signal can be read from the CAN bus. This significantly simplifies vehicle metering, as there is no need to search for an electrical signal in the vehicle's wiring or connect via transformers (in the case of vehicles equipped with pneumatic PTO engagement). Monitoring this parameter allows you to see when and for how long the vehicle is used for work other than driving. To check whether the displayed PTO signal is correct, analyze the vehicle's engine speed. When the power take-off is coupled to the engine crankshaft, the engine speed is increased relative to idle speed, and in the case of diesel engines, it is approximately 800 rpm. In dump trucks, commonly known as tippers, engaging the power take-off can be assumed to coincide with the operation of the tipper, a set of actuators responsible for lifting the vehicle's cargo space. In trucks equipped with a lifting crane, the power take-off also drives the hydraulic pump, but its engagement does not directly reflect the work performed by the superstructure. For example, the operator may have the power take-off running but not control the crane arms at the time, thus using time inefficiently and exposing the company to unnecessary costs resulting from wasted fuel consumption. The power take-off signal is monitored in 59 vehicles in the Włodan fleet.

Concrete transport vehicles were equipped with drum rotation sensors. These devices, installed on mixing drums, monitor the direction of the tank's rotation, allowing them to determine whether the concrete mixer is currently mixing the material or pumping it out. Nine vehicles at the analyzed company were measured with this type of equipment. For the machines, in addition to implementing the assumptions for each vehicle type, the client designated 11 agricultural tractors frequently used on construction sites for the installation of filler cap protection devices on their tanks to detect unauthorized opening attempts that could result in fuel theft. The measurement of vehicles with a gross vehicle weight of up to 3.5 tons, i.e., passenger cars and light commercial vehicles (vans), covered a total of 64 vehicles manufactured between 1999 and 2024. In the vast majority of these vehicles, we were able to extract the full set of basic data for monitoring systems from the CAN bus, such as speed, engine RPM, fuel level and consumption, mileage, accelerator pedal position, and in some of them, the cruise control engagement signal. The latter two parameters are essential for generating reports on so-called economical driving. In several of the oldest vehicles in the fleet, where the CAN bus is not available, only the simplest locators were installed, allowing for the connection of ID readers and manual synchronization of the vehicle's mileage. In such vehicles, an analog connection to signals from the alternator or float switch would be uneconomical, as the effort involved would be disproportionate to the expected results.

Due to the number of measured objects, the analysis was conducted using three selected vehicles from each group: trucks, passenger cars, and machinery. Since the system has been in its final form for less than a year, a monthly billing period will be considered, which will be September 2025.

The passenger car model is a SKODA Kamiq, manufactured in 2023. It is powered by a turbocharged gasoline engine with a displacement of 1.5 dm^3, generating 150 horsepower. It is equipped with a dual-clutch automatic transmission with 7 gears. Average fuel consumption per 100 km before the GPS tracker was installed was 7.1 liters per 100 km. In September 2024, the average price of 95 octane unleaded gasoline in the Łódź Voivodeship was 5.97 PLN per liter. During that period, the vehicle traveled a distance of 1,526 km. The cost of driving 100 km was PLN 42.38.

Insuring this particular vehicle cost the company PLN 580 annually, which translates to PLN 48 per month. The cost of a mandatory MOT in Poland for this type of vehicle is PLN 99, which translates to PLN 8.25 per month. The vehicle in question did not travel on toll roads and therefore did not generate such costs. Service costs for the entire year 2024 amounted to PLN 1,232, so the cost per month was PLN 102.67. Monthly maintenance costs for the vehicle in question, excluding the lease payment, amounted to PLN 805,745.

The truck in question is a two-axle Mercedes Actros MP5 tractor-trailer. It is equipped with a 12.8 dm^3 diesel engine and 421 hp. Power is transmitted via an automatic transmission. This vehicle meets the EURO 6 emissions standard. The fleet owner's declared fuel consumption before installing the GPS system was 33.8 liters per 100 kilometers in September 2024. During this period, the vehicle covered 6,312 kilometers, and the average diesel price at that time was PLN 5.99/liter. The cost of traveling 100 kilometers was PLN 202.46, and the total distance traveled by this vehicle was PLN 12,779.27. The cost of a technical inspection for a tractor-trailer with a gross vehicle weight exceeding 16 tons is PLN 269, which translates to PLN 22.41 per month. In this case, vehicle insurance was PLN 3,427, and dividing this amount by 12, the monthly cost is PLN 285.58. The Mercedes is subject to road tax, and the owner must pay PLN 2,189 for the entire year, as the vehicle has two axles. On a monthly basis, the tax is PLN 182.41.

Table 1. Summary of data and costs before implementing the monitoring system [own study]

Vehicle type	**passenger car**	**truck**	**machine**
Car model	SKODA Kamiq	Mercedes Actros	HITACHI Zaxis ZX 170 W
Amount per liter of fuel [PLN]	5.97	5.99	5.99
Number of kilometers traveled [km]	1526	6312	-
Average fuel consumption [l/100km]	7.1	33.8	-
Number of engine hours worked [mth]	-	-	151
Average fuel consumption [l/mth]	-	-	11.42
Cost of driving 100 km [PLN]	42.38	202.46	-
Cost of kilometers traveled [PLN]	646.82	12779.27	-
Cost of engine hours worked [PLN]	-	-	10332
Cost of working one engine hour [PLN]	-	-	68.42
Insurance cost [PLN]	48	285.58	-
Cost of technical inspection [PLN]	8.25	22.41	-
Number of kilometers covered by road toll [km]	-	5982	-
e-TOLL road toll [PLN]	-	1495.5	-
Road tax [PLN]	-	182.41	-
Cost of services [PLN]	102.67	730.41	182
Total cost [PLN]	**805.74**	**16386.54**	**10514**

Table 2. Summary of data and costs after the implementation of the monitoring system [own study]

Vehicle type	**passenger car**	**truck**	**machine**
Car model	SKODA Kamiq	Mercedes Actros	HITACHI Zaxis ZX 170 W
Amount per liter of fuel [PLN]	5.83	5.95	5.95
Number of kilometers traveled [km]	1742	6752.7	-
Average fuel consumption [l/100km]	5.8	31.6	-
Number of engine hours worked [mth]	-	-	142
Average fuel consumption [l/mth]	-	-	9.2
Cost of driving 100 km [PLN]	33.81	188.02	-
Cost of kilometers traveled [PLN]	646.82	12779.27	-
Cost of engine hours worked [PLN]	-	-	7773,08
Cost of working one engine hour [PLN]	-	-	54.74
Insurance cost [PLN]	40	266.37	12
Cost of technical inspection [PLN]	8.25	22.41	-
Number of kilometers covered by road toll [km]	-	6123	-
e-TOLL road toll [PLN]	-	1836.9	-
Road tax [PLN]	-	182.41	-
Cost of services [PLN]	102.67	730.41	182
Subscription fee for the monitoring system [PLN]	26.5	26.5	26.5
Total cost [**PLN**]	**784.24**	**15244.2**	**7993.58**

The vehicle in question used sections of GP and G class toll roads, so it had to be registered with the e-TOLL system. The toll rate for each kilometer traveled for the vehicle in question was PLN 0.25. According to data provided by a Włodan employee, the Actros had to pay PLN 1,495.50 for toll roads, as it traveled 5,982 kilometers. Service costs for the entire year 2024 amounted to PLN 8,765, so an average monthly cost of PLN 730.41 should be assumed.

The analysis for machines is performed under slightly different conditions. Here, fuel costs are calculated per hour. An example of a machine in the Włodan fleet is a HITACHI Zaxis ZX 170 W excavator. In September 2024, it had operated for 151 operating hours. During this period, it consumed 1,725 liters of diesel fuel, which, at PLN 5.99 per liter, amounted to PLN 10,332. The only additional costs associated with operating the machine were service and repair fees, which, according to the fleet accountant, totaled PLN 2,192 for the entire 2024, or PLN 182 per month. All data and costs, calculated monthly before the GPS system was implemented, were collected and recorded in Table 1.

After metering the entire fleet and implementing the system across the company, virtually all costs described and included in the table changed. Only the cost of vehicle inspections remained constant.

Referring to Table 1, it should be noted that each vehicle traveled or operated a similar number of kilometers or hours as during the same period last year. The Mercedes consumed an average of 31.6 liters, which, compared to 33.8 liters, represents a saving of 2.2 liters per 100 km. With diesel prices remaining at PLN 5.95/l in September this year, a difference of only 0.4 groszy compared to last year's rate, the company using this vehicle, after metering, paid PLN 188.02 for the same distance. This change translates to a savings of PLN 14.44. Also, using the example of a passenger car, a reduction in average gasoline consumption can be observed, which after implementing the system is now 5.8 liters per 100 kilometers. This result is close to the manufacturer's declared combined cycle fuel consumption of 5.5 liters per 100 km.

The diesel engine in the HITACHI excavator consumed 1,307 liters of diesel fuel. Converting the time given in the report (days, hours, minutes, and seconds) to full hours gives a result of 142 hours. Dividing the amount of fuel burned by this value yields an average consumption of 9.2 liters per operating hour, which, compared to last year's standard of 11.42 liters, translates to a saving of 2.22 dm^3 of oil per hour of operation.

Table 2 summarizes the results after the implementation of the monitoring system. It is worth noting that, due to the installation of GPS devices in the fleet vehicles, the insurer granted a discount resulting from the enhanced anti-theft protection.

Comparing the values in both tables, it is worth noting that despite the slightly longer distances traveled by passenger cars and trucks, the increase in toll road rates, and the requirement to insure construction equipment, the costs associated with operating vehicles and machinery decreased. Adding the costs for the three facilities described before implementation totals PLN 27,706.28. After implementing the fleet monitoring system, the monthly expenses for the three same vehicles, ignoring the variability of component costs and including subscription fees, amount to PLN 24,022.02, which is PLN 3,684.26 lower. In order to show the scale of savings achieved thanks to the implementation of monitoring, it would be necessary to multiply the individual differences in amounts for a given type of machine by the number of units in the fleet.

Analyzing the above data, we can conclude that metering is particularly effective for construction machinery, with measurable savings achieved in each of the groups described. The financial benefits presented in the case study are just some of many that MyCar system implementation brings. Other benefits of monitoring, not included in the above discussion, may include the benefits described earlier in the project, such as optimizing work time and improving safety.

3. PROSPECTS FOR THE DEVELOPMENT OF THE MYCAR SYSTEM

In recent years, the pace of global technological development has not slowed. The GPS monitoring industry is no exception, and companies providing such solutions are constantly working to make their offerings increasingly competitive and comprehensive, both in terms of hardware and software. At Tekom Technologia, the manufacturer of the MyCar system, development work is ongoing simultaneously on both these levels. The recently presented and launched iTEK 2.0 is still under constant development. An example is the modernization of this device's communication module. In the initial versions of the tracker, communication was handled by a module designated SARA R422, which can operate in LTE Cat M1, NB-IoT, and 2G networks [18]. To optimize production costs, it was decided to create a version of iTEK 2.0 that can only connect to 4th-generation networks using the LEXI R-10 module. This version of the device can be successfully used in countries without so-called "coverage gaps." Poland is an example of a market where there is no need to implement more expensive communication modules operating in both 2G and 4G networks in locators, as the entire territory is within the range of the newer of these two technologies.

The technological development of iTEK 2.0 also involves continuous work on its firmware. Updates bring improvements and fixes, but also new functionalities. An example of such innovations is support for new vehicle models in terms of reading data from the CAN bus. To meet customer expectations, Tekom Technologia is conducting a project to develop a proprietary CAN module implemented in its devices. The team involved in this work constantly monitors the automotive market and analyzes whether the debuting vehicle model will be compatible with existing programs or whether it requires interrogation. If work is required on a given vehicle or machine, the responsible individuals assess the priority of developing a given bus type. If there is a chance that the new vehicle will be a popular choice for customers, the process of organizing a vehicle for testing and development begins. The most common sources of vehicles for this type of work are rental companies or dealers of the given brand. However, if the forecasts for a specific model's popularity are low, the request for participation is forwarded to the logistics department, which is responsible for informing the project team if an order for assembly of the desired vehicle type is received. In such cases, the development of a new bus is carried out during the installation of the locator in the given vehicle. Once a vehicle has been selected for the work, the process of reviewing the connection diagrams of commercial companies, such as SEO Electronics, begins to locate the CAN bus, which will be analyzed for data availability. Once these steps are completed, work is carried out directly in the vehicle. While the bus is being monitored, a test drive is conducted, and as many on-board devices generating the desired signals as possible, such as all types of exterior lighting, are activated. An integral part of the vehicle development process also involves installing a reference CAN module from a commercial company to verify the accuracy of the data read from the bus. If external suppliers do not support a given bus, the time required to properly develop the program increases significantly. Once the complete set of devices is installed in the test vehicle, development begins, resulting in the release of test firmware, which is uploaded to the previously installed module. After a series of tests and analyses by the design team, the decision is made to release the official software version with support for the new bus type.

Tekom Technologia has recently placed increasing emphasis on the operation of electric vehicles. Data obtained from their on-board computers may prove to be an important element in creating tools for route planning that take into account battery charge levels and charger locations, as well as controlling charging processes to extend battery life. The MyCar system's potential for integration with modern telematics and AI systems [21] lies primarily in the analysis and interpretation of large data sets. Machine learning algorithms enable, among other things, route optimization based on current traffic volume, weather forecasts, and restrictions in environmental zones. AI also supports driver driving style analysis, identifying risky behaviors such as sudden braking, excessive speeds, or prolonged idling. This data can be used to create personalized reports and training programs in eco-driving and safety.

Another important development direction is the integration of telematics and AI systems with ERP (Enterprise Resource Planning) and TMS (Transport Management System) platforms. This enables comprehensive management of logistics processes – from transport planning and order monitoring to cost settlement. This integration provides companies with a tool that supports both daily operational decisions and strategic fleet management. In the coming years, we can expect increasingly widespread use of vehicle-to-everything (V2X) communication technology, which enables the exchange of information between vehicles, road infrastructure, and urban systems. The combination of telematics, AI, and V2X will pave the way for the full automation of transport processes, including the management of mixed fleets, including traditional and autonomous vehicles.

Integrating the monitoring system with the charging infrastructure is also crucial. Integrating charging stations with GPS allows for real-time information on the location, availability, and power of chargers. This allows the monitoring system to automatically plan the electric vehicle's route to accommodate charging breaks in optimal locations. This solution is particularly important in managing fleets of delivery vehicles, where route and stop scheduling directly impacts operational efficiency.

Modern systems also enable two-way communication between the vehicle, the fleet management system, and the charging station. This means that information on battery status is automatically transmitted to the monitoring system, which can remotely reserve a charger or designate the vehicle to the nearest charging point with the appropriate power. Furthermore, integration with the invoicing and billing system enables the automatic allocation of electricity costs to a specific vehicle or transport order. Another important aspect of this integration is the analysis of historical data. Based on information on charging times, energy consumption, and vehicle operating conditions, it is possible to create predictive models for battery degradation or plan service cycles. Combined with artificial intelligence (AI), the system can predict the energy needs of the entire fleet and optimize the charging process based on energy tariffs and infrastructure availability. In the case of the MyCar system, AI also includes device diagnostics and fault detection. To this end, advanced tools are being developed that will automatically detect operational issues in the tracker, such as the GNSS module.

CONCLUSIONS

Based on a case study describing the implementation of the MyCar system at a transport company, calculations were made and it was proven that implementing a monitoring system brings measurable financial benefits.

To thrive in the telemetry and telematics industry, system manufacturers must conduct continuous development work. To this end, Tekom Technologia is focusing on expanding the capabilities of its proprietary CAN data reading module.

In response to the dynamic development of solutions such as SmartCity and similar technologies, it is necessary to create the widest possible opportunities for integrating fleet management systems with other telematics systems available in this industry.

Forecasts and research suggest that the GPS monitoring market will continue to grow, thanks to the increasing demand for such solutions and the decreasing costs of the technology.

Work on fleet monitoring and management systems should continue, and trends and developments in the automotive and technology markets should be closely monitored. It is also necessary to monitor and respond to changes and regulations introduced by national governments, such as the recently introduced obligation to report fleet emissions or changes in the methods of controlling land traffic.

ABBREVIATIONS

1. **AI** - Artificial intelligence;
2. **CAN bus** - Controller Area Network bus;
3. **ERP** - Enterprise Resource Planning;
4. **TMS** -Transport Management System;
5. **GNSS** - Global Navigation Satellite Systems;
6. **GSM** - Global System for Mobile Communications.

__The authors of this paper DECLARE__ that by using the __MyCar__ trademark of __Tekom Technologia Sp. z o.o.__ in their work, they did so solely for the purpose of this publication and with the intention of benefiting the trademark owner, without any intention of infringing the trademark.

__Autorzy artykułu OŚWIADCZAJĄ__, że używając w pracy znaku towarowego __MyCar__ firmy __Tekom Technologia Sp. z o.o.__ zrobili to z myślą tylko o tej publikacji i z taką intencją, aby było to z korzyścią dla Właściciela znaku, bez zamiaru naruszania znaku towarowego.

ANALIZA SKUTECZNOŚCI MONITORINGU FLOT POJAZDÓW SAMOCHODOWYCH NA PRZYKŁADZIE WYBRANEGO SYSTEMU DO ZARZĄDZANIA W CZASIE RZECZYWISTYM W TRANSPORCIE

W artykule przedstawiono analizę skuteczności systemu MyCar w monitoringu flot pojazdów oraz określenie jego perspektyw rozwoju. Omówione zostały kluczowe funkcjonalności systemu MyCar oraz przeprowadzono analizę jego efektywności na podstawie wybranego studium przypadku. Przedstawiono jakie są sposoby badań skuteczności oraz jak można obliczyć korzyści płynące z wdrożenia opisywanego rozwiązania. Na podstawie studium przypadku, w którym opisano wdrożenie systemu MyCar w przedsiębiorstwie transportowo-budowlanym, pracując na rzeczywistych danych, dowiedziono, że implementacja systemu monitoringu niesie za sobą wymierne korzyści finansowe.

Słowa kluczowe: road transport, vehicle fleet monitoring, real-time systems, GPS system, ID reader, Radio Frequency Identification (RFID), sieć GSM.

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- conceptualization, P.T. (Piotr Turek) and M.L. (Mirosław Luft);
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