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## **The efficiency of vehicle fleet management using the example of a company transporting a T60 medium**

### **Abstract**

The transport of hazardous substances is an integral part of today's society. Nearly 90% of dangerous goods are transported by road in Poland. Due to the lack of a nationwide monitoring system, based on the electronic transmission of data related to the transport of this cargo, it is extremely important to comply with transport safety rules right from loading. In order to improve the efficiency of the fleet, it is important to implement monitoring at each stage of the transport of hazardous materials. In the case of the transport of dangerous goods, monitoring is one of the elements that minimise the consequences of accidents by, among other things, pinpointing the exact location of the vehicle, checking the vehicle's route and the driver's compliance with traffic regulations and working time limits. The aim of this study is to present the concept of effective truck fleet management. The hypothesis of the thesis identifies areas through which the efficiency of fleet management can be improved, using the example of a company transporting a medium T60.

**Keywords:** dangerous goods, transport, efficiency, vehicle fleet, medium T60.

## **Efektywność zarządzania flotą pojazdów na przykładzie firmy transportującej medium T60**

### **Streszczenie**

Transport substancji niebezpiecznych jest integralną częścią dzisiejszego społeczeństwa. Blisko 90% towarów niebezpiecznych przewożonych jest w Polsce transportem drogowym. Ze względu na brak ogólnokrajowego systemu monitoringu, opartego na elektronicznej transmisji danych związanych z przewozem tego ładunku, niezwykle istotne jest przestrzeganie zasad bezpieczeństwa transportu już od załadunku. W celu poprawy efektywności floty istotne jest wdrażanie monitoringu na każdym etapie przewozu materiałów niebezpiecznych. W przypadku transportu towarów niebezpiecznych, monitoring jest jednym z elementów minimalizujących skutki wypadków, m.in. poprzez dokładne określenie lokalizacji pojazdu, sprawdzenie trasy przejazdu pojazdu oraz przestrzegania przez kierowcę przepisów ruchu drogowego i czasu pracy. Celem pracy jest przedstawienie koncepcji efektywnego zarządzania flotą samochodów ciężarowych. Postawiona hipoteza w pracy określa obszary, w których można zwiększyć efektywność zarządzania flotą pojazdów na przykładzie firmy transportującej medium T60.

**Słowa kluczowe:** ładunki niebezpieczne, transport, efektywność, flota pojazdów, medium T60.

### **1. Introduction**

The selected transport company operates internationally and transports Class 3 and Class 9 hazardous materials. It uses high-class tankers for the transport of these materials (Janusz, 2017). In addition to transporting hazardous substances, it also provides transport services for tarpaulin combinations. Over the past 25 years, the company has also offered other forms of transport for the carriage of construction materials, right up to sensitive loads such as electronic devices (Ciula et al., 2023). Since 1998, the company has been fulfilling orders on the basis of the ADR convention, observing international

guidelines with regard to the marking of hazardous materials and their protection (Brodzik R. 2020). In addition, the company conducts training to minimise the likelihood of accidents involving tankers that transport bituminous masses (Rogalski et al., 2018). The fleet of vehicles used meets the Euro5 standard. The vehicles are of the Mercedes-Benz make and carry the classification code ADR: FL. The fleet of vehicles meets certain design features for vehicles carrying flammable liquids and gases. The company has single-compartment insulated vehicles with code L4BH, designed for the transportation of hazardous materials (Generowicz et al., 2023). The tankers it owns are made of high-grade stainless steel with capacities ranging from 30,000 [dm<sup>3</sup>] to 31,000 [dm<sup>3</sup>]. The company handles the transportation of the hazardous substance T60 for a company that uses the medium substance T60 as a binding agent in the production process of carbon electrodes (<http://mptransport.pl/index.php/flota>, download date: 15.01.2024).

The vehicle fleet complies with the technical standards and legal requirements that allow the vehicles to operate in Poland and within the European Union (Meżyk, 2016). Figure 1 shows the classification of legal requirements for the selection of vehicles transporting hazardous substances (Pusty, 2009).



Figure 1. General classifications of legal requirements for the selection of vehicles transporting dangerous substances

(source: own compilation based on Pusty, 2009)

The tankers used have skeletonless cylinder-shaped tanks with a wall thickness of 3 [mm] and a stainless steel density of 8,000 [kg · m<sup>-3</sup>] (Janczak, 2014). The tankers used by the company, when moving in traffic, must have:

- pneumatic connections for the brake system;
- a control panel for the braking system;
- safety devices for lateral entry of the vehicle into another traffic lane;
- a safety valve to be used against overpressure support;
- a loading hatch;
- a main rear unloading valve and a hermetically sealed upper valve;
- a closing flap;
- a clamping ring with a safety handle;
- a pump used for unloading and loading the substance;
- a wedge;
- spare wheel holders;
- a fire extinguisher and a first aid kit;
- a toolbox (Nowacki et al., 2017).

The above-mentioned components of the tank car's structure must have continuous technical inspections so that the vehicle meets safety requirements and does not present a danger on the road (<https://www.tdt.gov.pl/dzialalnosc>, download date: 27.01.2024). Figure 2 shows the tanker of the company described.



Figure 2. Tanker used for the transport of hazardous substances  
(source: <http://mptransport.pl/index.php/flota>)

The essence of the distribution of the T60 medium is not the primary purpose of the manufacturer's business, but is a business development phase acting to achieve success in the sale of a product (substance). The substance transported is a component of another product. Distribution decisions are not only limited to the transport organisation, but to:

- the management of the mutual relationships of the actors involved;
- controlling the flow of information;
- obtaining financial resources;
- taking care of market development;
- compliance with certain requirements and standards (Nowakowska-Grunt, Starostki-Patyk, 2017).

The composition of the hazardous substance medium T60 is set out in detail in the safety data sheet, drawn up in accordance with European Parliament and Council Regulation 2006 No. 1907/2006/EC. The drawing up of a certified study confirming the identification of the substance sold and transported is required mainly for reasons of operational safety and recognition of possible risks (Urban et al., 2014). This document is mandatory and is checked by the Road Transport Inspectorate (Kowalski et al., 2022). According to the law, every manufacturer, supplier as well as user should be able to read the safety data sheet. The description of the substance shall include the following information:

- the identification of the mixture;
- hazard identification;
- first aid measures;
- fire-fighting measures;
- environmental release measures;
- handling in storage;
- control of personal protective equipment;

- physico-chemical properties;
- toxicological information;
- ecological information;
- transport information;
- waste treatment;
- regulatory information (<https://www.laboratoria>, download date: 27.01.2024).

Medium T60 is a binding agent in electrode manufacture, identified in the safety data sheet as the binder pitch SP 84 in article P11 (Jancza, 2014). The mixture contains heterocyclic hydrocarbons and aromatic hydrocarbons, which may cause, among other things:

- allergic skin reaction,
- severe burns,
- mucous membrane irritation,
- genetic defects,
- tumours,
- infertility,
- harmful effects on the health of the child in pregnant women,
- harmful effects on aquatic organisms (Szaniawska et al., 2015).

This substance is for specialist use only. In order to transport this substance, the carrier must have the appropriate authorisation. The characteristics of the substance, which are described in the table, are of particular relevance to transport and storage 1 (Grzegorzczuk, Buchcar, 2021).

Table 1  
Chemical composition of medium T60

Identification of the substance CAS number	EINECS	Name of the substance	Hazard class	Substance content [%]
65995-93-2	266-028-2	Coal tar, high temperature pitch	Rakotw. Kat. 2; T; R45	>50
50-32-8	200-028-5	Benzopyrene	Rakotw. Kat. 2, Muta. 1B	<2,5

(source: own compilation based on: RUTGERS, Charecteristics sheet)

Storage of the T60 medium substance requires a suitably adapted warehouse, workstation and specific storage conditions, i.e. sealed, dry and durable high-temperature silos (Ciula et al., 2023). When changing the location of the hazardous substance in the unloading room, adequate ventilation should be provided. An important requirement according to the RUTGERS safety data sheet for persons working in substance relocation is to have certified protective clothing (overalls), gloves (CE marking, cat III), oxygen mask (with P3 filter) and sealed goggles and appropriate footwear (Mężyk, 2015).

Efficient fleet management requires constant attention to quality, maintaining high standards of vehicle durability and efficiency, reducing operating costs and meeting production targets (Banach, 2015). Efficient and safe management refers to a long-term process of planning, taking decisive action and anticipating the consequences of actions taken. To this end, a transport company employs a fleet management employee to:

- ensure that tyres are changed on time (responsible for purchasing the right tyres, scheduling visits to the vulcaniser);
- monitor the quality of the cars and control the quality of the technical condition of the vehicle (monitors the service activities) and send the vehicle for periodic check-ups and technical inspections;
- create analyses and reports and describe the conclusions of the obtained results;
- control the costs of vehicle operation (e.g. payment of insurance, finding the most cost- and time-efficient repair shop, monitoring of vehicle combustion, fuel prices and available budget);
- monitor fuel prices when paying with fuel cards valid in the European Union (<https://e100.eu/pl/blog/business>, download date: 01.02.2024).

The components of an effective truck fleet management system include the introduction of, among other things, appropriate processes and systems for monitoring the location and condition of vehicles. This allows decision-makers to properly manage the fleet in order to reduce risks, improve safety and check the current location of equipment and vehicles (Jurecki, 2014). The introduction of GPS systems also makes it possible to monitor fuel consumption, manage required maintenance and communicate freely in remote areas where mobile network signals are unavailable. The overarching goal of these activities is to increase productivity and efficiency and equivalently improve the safety of employees driving trucks and carrying out transport orders (<https://www.ve-rizonconnect.com>, download date: 01.02.2024).

## 2. Objective and research methodology

The aim of the study is to find an element of HGV fleet management that can be improved and managed more effectively. The methodology used in the thesis is mainly focused on the results of my own research – a survey and analysis of the elements of HGV fleet management. The subject of the study in the thesis, consists of many elements, such as:

- employees of a company transporting T60 medium;
- employees managing the truck fleet;
- data available from the transport company: number of employees, scope of activities of the position, fleet management logic, main elements of fleet management, description of the company, description of the T60 medium.

The subjects of this study are the employees in charge and fleet management of a company transporting hazardous material. The research carried out is intended to highlight which of the main elements of truck fleet management are the least effective.

The main research problem posed in this thesis is as follows: “Can the efficiency of vehicle fleet management be increased using the example of a company transporting a T60 medium?”. The specific research problems, on the other hand, took the form of the following questions:

1. Can knowledge of and compliance with legislation related to the transport of hazardous materials increase the efficiency of truck fleet management?
2. Do in-house drivers contribute to the efficiency of fleet management?
3. How can managers contribute to increasing the efficiency of fleet management?
4. How can the company's fleet management process be improved?

Given the above research questions, the research hypothesis in this thesis is as follows: "There are areas for increasing the efficiency of vehicle fleet management using the example of a company transporting a T60 medium".

The techniques used in the study are subordinate to the research method – analysis. The research techniques used in the study are:

- Survey;
- observation;
- document analysis;
- content analysis;
- statistical techniques.

In this study, research tools such as a survey questionnaire and an EXCEL spreadsheet were used.

### **3. Description of own research**

#### **3.1. Analysis of own research – questionnaire**

For the research part of the study, a questionnaire was prepared on drivers involved in the transport of hazardous materials. The group surveyed was 50 people. The survey was conducted in the months of January to May 2023. The first part of the questionnaire contained a metric, the next part referred to questions directed towards the drivers working in the described company.

Knowledge of legislation, standards and compliance with all regulations by drivers transporting hazardous materials is a very important aspect in the effective management of a fleet of vehicles. Transporting, loading and unloading hazardous materials in compliance with standards and legislation is designed to protect the company from the potential risks of cargo unsealing. Unsealing a load during improper loading, unloading or transport can lead to numerous financial penalties, environmental hazards and road accidents. On this basis, six questions were selected to be answered by drivers transporting hazardous materials. Then, on the basis of an analysis of the answers obtained, the company can select training courses for drivers transporting hazardous materials accordingly.

100% of the people surveyed in the study were male. Seventeen respondents were between the ages of 26 and 35. Thirteen respondents indicated that they were aged between 36 and 45. Twelve people indicated that they were over 45 years old. Eight respondents indicated that their age was between 18 and 25. Additionally, the survey asked about the length of service of the respondents. Most respondents (22 persons) have seniority between 4 and 6 years and 18 respondents have seniority between 7 and 10 years. Respectively, 5 respondents each indicated that their seniority is within 1 to 3 years and above 10 years. Another aspect examined in the survey was the education of the respondents. Vocational education is held by 24 respondents, secondary education is held by 14 respondents, primary education is held by 10 respondents and tertiary education is held by two respondents. In addition, all survey respondents are involved in the transport of hazardous materials.

The first question posed was as follows: "How often do you come into contact with the transport of hazardous materials?". The first question related to the frequency of contact of the respondents with the transport of hazardous materials. Thirty-seven respondents have frequent contact with the transport of hazardous materials. Eight have

infrequent contact with hazardous materials and five have daily contact with hazardous materials. All employed drivers in the company are licensed to transport hazardous materials. However, some of the drivers also transport food materials in the form of fruit. Based on the question posed, it can be concluded that some of the drivers have very little contact with the transport of hazardous materials.

Another question posed in the survey was as follows: "Have you been made well acquainted with the law concerning the transport of hazardous materials in Poland?". Forty-five respondents answered that they were well acquainted with the law concerning the transport of hazardous materials. In contrast, only 5 respondents indicated that they were not well acquainted with the law related to the transport of hazardous materials in the country. Analysing the above responses, it can be concluded that adequate training should be provided to make the employees more familiar with the current laws on the transport of hazardous materials.

The third question posed is as follows: "Do you comply with the legislation on the transport of hazardous materials?". Figure 3 shows the individual responses to the question posed.

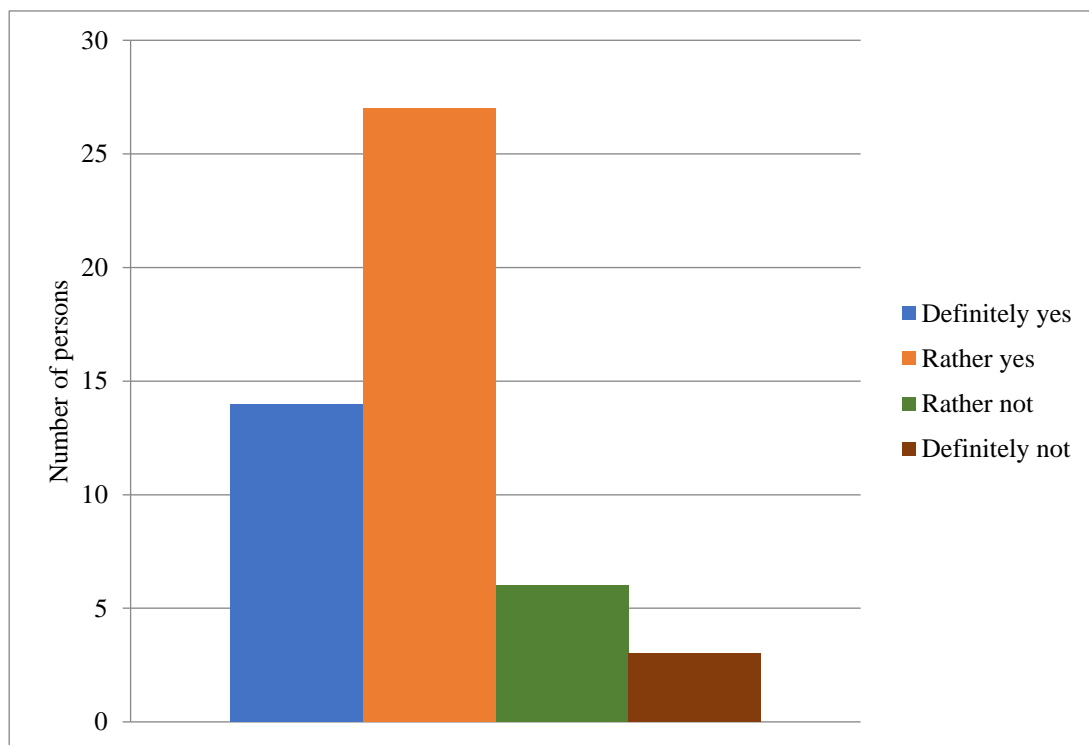


Figure 3. Compliance with the law relating to the transport of hazardous materials (source: own elaboration)

In the third question, respondents were asked to indicate whether they comply with the law on the transport of hazardous materials. Twenty-seven indicated that they rather comply with the regulations. Fourteen respondents indicated that they definitely comply with the regulations related to the topic described. Six people indicated that they tended not to comply with them and 3 people indicated that they definitely did not comply with these regulations. Comparing question 2 with question 3, it can be concluded that some drivers, despite knowing the law on the transport of hazardous materials, do not comply with it at work.

The fourth question posed in the survey was as follows: "Are you aware of the danger caused by the transport of hazardous materials?". The majority of those surveyed, as many as 90%, are aware of the danger caused by the transport of hazardous materials. On the other hand, 10% of the respondents have no such awareness related to this risk. Analysing the above answers to the question asked, it can be concluded that the company should organise training. This training should be aimed at making employees aware of the dangers of not complying with legislation on the transport of hazardous materials.

The fifth question concerned the proper parking of a tanker truck with hazardous substances. The question was as follows: "When transporting hazardous materials, is parking done in designated areas?". Respondents 54% indicated that parking does not take place in designated areas. In contrast, the remaining 46% of respondents indicated that parking takes place in designated places. The parking of a combination of vehicles transporting hazardous substances is a very important aspect. Leaving a vehicle in an inappropriate place is punishable by a fine of 30 000 [PLN]. Vehicles transporting hazardous goods may park in a car park which is suitably prepared for this purpose in accordance with the regulation of the Minister of Internal Affairs and Administration on the technical conditions of car parks. Parking spaces for vehicles transporting dangerous goods must be at least 3.5 [m] wide and at least 20 [m] long. According to the new regulations, these sites must be suitably located, i.e. no closer than 300 metres from residential buildings and water intakes. In the event that such a parking space is separated by a wall with adequate fire resistance, which is at least four metres high, the minimum distance from houses and water intakes will be halved. Parking stalls for vehicles carrying hazardous loads must be at least 30 metres from the stalls of other cars. Where there is a forest of at least 3 [ha] nearby, such a site must be set back 40 metres from the tree line. The same distance must be maintained if there are railway tracks or gas pipelines in the vicinity.

The last question was about vehicle monitoring and read as follows: "Is the vehicle equipped with monitoring?". Respondents at 58% indicated that their vehicle is not equipped with monitoring. In contrast, 42% of respondents indicated that their cars have monitoring on board. In this case, vehicle monitoring is based on better fuel management. Fleet fuel management for trucks in companies should be based on an efficient and intelligent monitoring system that supports the recording and control of the vehicle refuelling process (Wieteska et al., 2016). The GPS tool should facilitate the management of fuel management, the staff team and the vehicle fleet. GPS Online provides transport companies with a comprehensive service, control and equipment system containing information on:

- fuel management system based on GPS technology;
- fuel distributors;
- ON fuel tanks;
- terminals for access to tanks;
- access to the distribution system;
- parts and accessories;
- modules for automatic drive and time accounting;
- notifications of urgent and worrying events;
- automatic report on control of consumption and exceeding of fuel standards, as shown in Figure 4 (<http://www.gpsonline.com.pl>, download date: 02.02.2024).



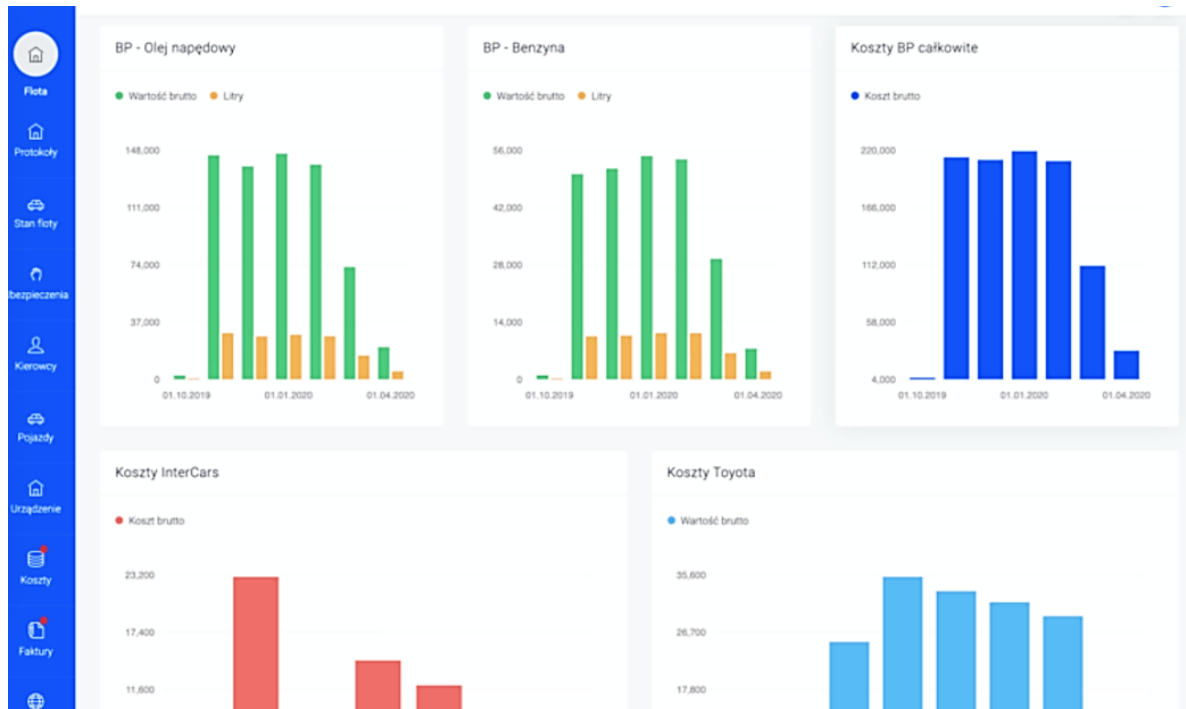


Figure 4. Mobile fuel fleet management

(source: own elaboration)

Truck assemblies have been continuously improved over the years. They are currently characterised by low fuel consumption due to the vehicle configuration together with its bodywork, driving style and maintenance (Redmer et al., 2014). These factors have a decisive impact on lower fuel consumption, which is influenced by vehicle features such as:

- traditional adaptive cruise control and the Eco option;
- adaptive cruise control function that guarantees constant vehicle speed (minimum fuel consumption) and anticipates changes in road conditions, in particular curves, gradients and intersections;
- function of switching off the running engine when the vehicle is idling, thus saving approximately 1.5 [l] less fuel when the truck is stationary;
- fitting of alloy wheels reduces weight, increases payload and reduces fuel consumption;
- a system that informs when a drop in tyre pressure is detected helps maintain the correct tyre pressure and saves fuel;
- the driver assistance function, DPA, allows you to correct and maintain an efficient driving style (<https://www.dafrucks.pl>, download date: 02.02.2024).

### 3.2. Efficiency of fleet management based on a described transport company

The area of truck fleet management is undergoing dynamic development, from a company perspective. For this reason, a comprehensive truck fleet management is an essential aspect. In order to effectively manage a truck fleet, elements such as:

- monitoring;
- regular servicing and maintenance;
- route optimisation;

- cost control;
- safety;
- data analysis (Nivette, 2022).

Figure 5 shows the developed plan for the effective management of the truck fleet.

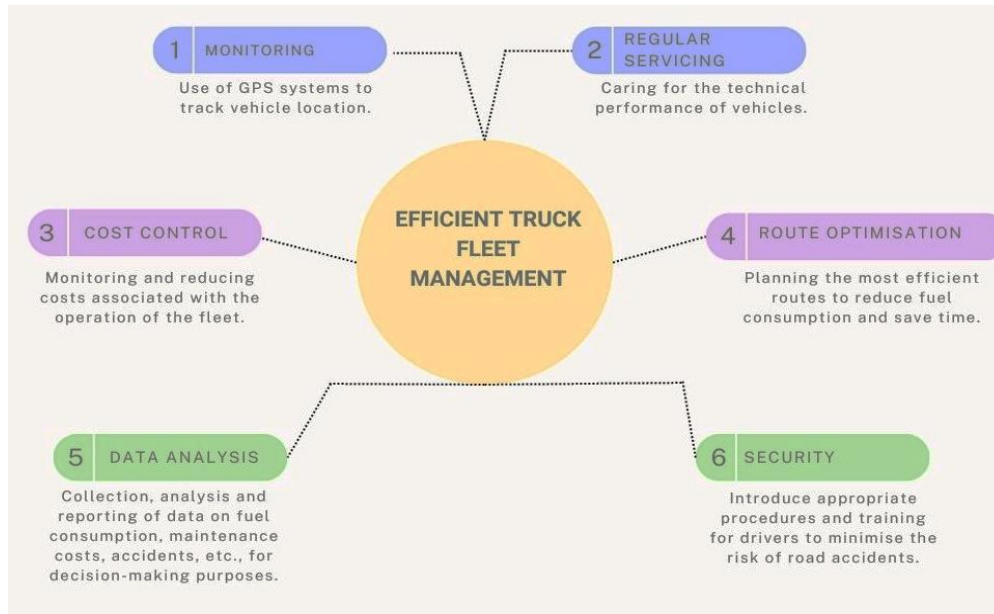


Figure 5. Plan for the effective management of the truck fleet (source: own elaboration)

All the elements listed in the figure above have already been implemented by the company in its truck fleet management system for several years. Table 2 shows the most important criteria and functions.

Table 2  
Key criteria and functions for truck fleet management

Criteria Functions	SCALE	GPS system	Service repair	Cost monitoring	Route planning	Data reading	Driver training
		8	7	9	7	5	4
Monitoring	5	40	35	45	35	25	20
Regular servicing	3	24	21	27	21	15	12
Cost control	4	32	28	36	28	20	16
Route optimisation	4	32	28	36	28	20	16
Data analysis	3	24	21	27	21	15	12
Security	2	16	14	18	14	10	8

(source: own elaboration)

In the table above, employees in the transport company have adopted criteria and functions that are classified as follows:

- A) functions:
- monitoring,
  - regular maintenance
  - cost control,

- route optimisation,
  - data analysis,
  - security.
- B) Criteria:
- GPS system,
  - service repair,
  - cost monitoring,
  - route planning,
  - data reading,
  - driver training.

A scale of 1 to 5 was adopted for each function, while a scale of 1 to 10 was adopted for each criterion. Company staff jointly assigned a scale for each function and criterion. Each function was then multiplied by the criteria. The resulting scores were added together and the sum of the individual functions was obtained (Table 3).

Table 3

The sum of the most important functions for the management of heavy goods vehicle fleets

Functions \ Criteria	$\Sigma$
Monitoring	200
Regular servicing	120
Cost control	160
Route optimisation	160
Data analysis	120
Security	80

(source: own elaboration)

#### 4. Conclusions

Based on the result, it can be concluded that the most important function for the company is vehicle monitoring. The second most important function for the company is cost control and route optimisation. The next most important functions are regular maintenance, data analysis and safety, which is the least important function according to the employees. The results presented above coincide with a survey of employees who transport hazardous materials. The company should take decisive steps in training employees on the law and on hazardous materials standards. Failure to comply with legislation can lead to a wide variety of accidents and increase the resulting damage. Underestimating the problems that can occur as a result of non-compliance and disregarding basic safety rules not only puts health or life at risk, but also causes irreversible environmental pollution.

Following the survey, it can be seen that there is no systematic training in the transport of dangerous goods for drivers. Any change in the regulations should lead to the organisation of training for all persons involved in the process of transporting dangerous goods in the company. Companies also do not use precise and clear instructions for their employees on the problem described. As a result, when a problem arises, drivers do not always know how to react, which often leads to losses for the

company. Appropriate training could help in this regard. The hypothesis put forward in the paper that there are areas for increasing the efficiency of vehicle fleet management using the example of a company transporting a T60 medium is a correct hypothesis, as the above conclusions show.

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