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PROPOSAL OF A METHODOLOGY OF CRITERIAL ASSESSMENT OF TECHNICAL INDICATORS FOR THE PURPOSE OF SELECTING AN OPTIMAL SEMI-TRAILER TRACTOR FOR THE NEEDS OF A TRANSPORT COMPANY

Summary. The goal of this work is to describe the current state of road freight transport from the point of view of the entrepreneur and the owner of semi-trailer tractors within the Slovak Republic. The article contains a brief description of freight transport works and points out the individual aspects of doing business in this sphere in Slovakia. In the next one, an original criterion evaluation program is created in the MS Excel application for semi-trailer tractors. In this program, an owner, a future owner, or a driver of a tractor can compare any number of tractors. Subsequently, based on the point evaluation, the program determines, which tractor in the comparison has more points and, therefore, it is more suitable for business activity. A sample comparison will be made on two tractors (Swedish and German brands) operated by a commercial transport company. The parameters of the tractors given, checked and calculated by the manufacturer are implemented in the criterion evaluation program. In the criterion evaluation, a tractor of one brand

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scored more points and therefore won. All knowledge, results, and conclusions found in the work are discussed with the management of a commercial transport company and its drivers. Based on the findings and results achieved, it can be concluded that the criterion evaluation program is extremely suitable for the application of any tractor, any brand, and thus the condition of the repeatability of the experiments is guaranteed. Based on these aspects, all the objectives of the work were fulfilled, and thus the result of the research is suitable as a decision-making aid for the purchase of a tractor for the future owner.

Keywords: tractor trailer, criterion evaluation, transport company, calculation

1. INTRODUCTION

Transport is a sector of the national economy that facilitates the movement of goods and individuals, thereby enhancing the quality of life and promoting the growth of the enterprise. Transport can be characterized as a deliberate movement activity carried out by means of transport, which consists in moving people or things in time and in the space. After the Second World War, a new field of science, namely logistics, began to deal with this area. The content of logistics is complex planning, management, and control of activities that make up logistics chains. Transport is the main component of these logistic chains. The main task of transport is to ensure the movement of material within the transfer processes using transport means and transport routes. In transport, the relocation process is made up of mutually technological joints, work operations, and processes, with the help of which the relocation of people or things is carried out. The relocation process can subsequently be referred to as the operation of transport [1-3].

Transport differs from other branches of the national economy. In principle, inland, road, and rail transport are possible to transport large amounts of goods. Therefore, means of road and, rail transport are still developed, tested and evaluated. While the rail transport needs new designs of many types of wagons [4,5], truck and semitrailer tractor designs are under investigation and modernized [6,7]. Ride comfort for drivers (often also for a passenger – a second driver) one of the most important factors when a semi-trailer tractor is selected. Other factors are the buying costs, operational costs, needs for maintenance, and others. Although rail transport offers some advantages, such as low running resistance, drag, rolling resistance [8,9], road transport provides goods delivering just-in-time, door to door and others. Road transport tries to adapt for operation some similar technologies, such as electric powertrains [10-12] and others; diesel combustion engines are still widely used as a source of energy for semi-trailer tractors. These differences need to be considered when making decisions in the transport business. If some of these differences are exaggerated or, on the contrary, simplified, this can have a negative impact on repair services, or on the economic results of the given company or entity focusing on road transport. Road transport, as well as road vehicle transport, can be defined according to three basic areas of technical foundations: transport means, transport routes, and transport equipment, while these three areas are directly involved in the transport process, and transport means are a specific factor of this type of transport process. It is because they ensure passenger and freight transport itself. The basic characteristic of these transport means is their ability to move. This characteristic distinguishes them from other elements of the technical foundations of road transport, which e.g., enable or simplify the relocation process. These are conditioning functions or operations in the design of buildings or individual devices.

For example, these are buildings in which operations related to transport or equipment enabling cargo handling are provided.

In its early days, road freight transport was at a disadvantage compared to railway transport. With the increasing density of land roads, this ratio mutually developed in favor of road freight transport. In the past, freight transport was mainly characterized by the transport of non-expensive and rare items. Mainly construction material (soil for construction) was transported. However, road freight transport is currently involved in the transport of food, pharmaceutical, and agricultural products, the supply of shops, and the transport of semifinished products. Trucks are the most powerful machines on the road carrying various types of cargo, from small packages to fuel. The term "utility vehicles" covers a large group of machines that can be met on and off the roads.

Of course, there are many ways to start a transport company, and each company may have a different procedure. Operating companies must have valid necessary licenses, permits and various requirements of a legislative nature [13-16]. Hence, the operation of a transport company requires many permits and licenses. The carrier must respect both national legal regulations and European Union regulations, which are superior to national law [17-20]. According to the law, it is necessary that the vehicle is approved for the specified type of transport. The vehicle must meet various conditions, mainly related to its technical capability, and the technical condition has been verified at technical control and emission control stations. All vehicles must be registered in the country for the purposes of obtaining a traffic license. Nowadays, an entrepreneur has to ensure and comply with many factors in order to be able to officially operate a transport company, such as:

- Professional competence: this requirement must be met by the transport manager, who can be the entrepreneur himself or a person "connected" with this company. Thus, he must prove a relationship with the holder of the certificate of professional competence;
- Technical base: it is a place or space where parking and possible maintenance of vehicles can be carried out. Of course, space requirements depend on the number of vehicles and the amount of company equipment. The approximate area determined for one vehicle is of 60 m^2;
- Transport regulations: it is a document and at the same time a directive that defines and guides the rules on freight transport;
- Ownership of vehicles: if an entrepreneur wants to carry out an activity, he must prove that he is the owner of vehicles. This is demonstrated through purchase, rental or leasing contracts [21-23].

All the above knowledge indicates that it is necessary to make the right decision for the purchase of a vehicle, which will suit the given company the most due to its characteristics. It is for this purpose that the criteria selection methodology was developed, which arose from the cooperation of the academic environment with the commercial transport company Kastrans, Ltd.

2. EXAMINED TRACTORS

Two real tractors were selected for a creation of the methodology for the criteria assessment. There were tractors of Swedish and German producers. The transport company as well as its employees have already experience with these tractors in the form of active contact, and drivers really drive them. Figure 1 shows an illustration of the compared tractors.

Fig. 1. An illustration of evaluated tractors of the Swedish (left) and German (right) producers

2.1. A description of the Swedish tractor

It is a two-axle tractor from the Swedish commercial vehicle producer, which belongs to the German automotive concern. These tractors are among the more premium lorries on the market compared to the competition. They excel in the quality of processing, driving characteristics, fuel consumption and operational reliability. These will be the most important factors in the evaluation criterion in comparison with the competition. In our case, it is a tractor model manufactured in 2021, and it had 70,000 kilometers at the time of evaluation. It is equipped with the largest and most spacious two-bed flat-floor cabin, which is intended mainly for long-distance transport and which should provide the driver with sufficient comfort while driving as well as while resting. The engine has a power of 335 kW (450 HP). It is a 13-liter (13,000 cm^3) low-speed turbocharged diesel internal combustion engine. The internal combustion engine meets the emission standard EURO 6 NEW [24].

The chassis is made as a steel frame. It is two-axle, where the rear axle is driven by four wheels. The front axle is sprung with steel leaf springs. The rear axle is equipped with an air suspension system that provides suspension and height control of the rear axle. The wheelbase of the tractor is 3,750 mm. The chassis also includes fuel tanks with two fuel tanks with the total volume over 1,000 liters of diesel.

The tractor engine is developed according to the characteristic philosophy of the producer as a low-speed one. It is suitable for burning 100% HVO fuel, and it meets the Euro 6 emission standard. Emissions control is ensured only by means of the SCR system, while the leading Twin-SCR system is available. It ensures double dosing of AdBlue, and it has a number of advantages, whether the impact on the environment or engine performance. The unit uses a double camshaft system to improve gas exchange. This solution contributes to the improvement of lubrication, cooling, and performance of the turbocharger. The gearbox is an automatic 12-speed. The differential (a rear axle) is equipped with a lock. The constant transmission ratio of a distribution box is 2.59. The advantage of transmission system is, that the operating fluid (oil) is filtered by an oil cleaner (filter). This ensures more thorough maintenance and thus a potentially longer service lifecycle [24].

The service brakes are classical disc brakes on both axles. The brake system is equipped with the Auto-hold function, which represents a support system for starting uphill. In the system, it is possible to set ESP and ABS for a semi-trailer with this function. The parking brake system is electropneumatic, and it is applied only on the rear axle. The tractor also includes two additional brakes, a retarder and an engine brake. Their operation can be controlled automatically or manually by a control switch under the steering wheel. The main additional brake in the tested tractor is the retarder, which is 5-position. It is able to provide a braking torque of 4,100 Nm at a speed of the Cardan shaft as low as 600 rpm.

The flat floor cabin is among the largest, most comfortable and, in terms of interior quality, also the best finished. This type of cabin is suitable for traveling long distances and for a long stay of the driver away from home. Also, thanks to its interior spaciousness, it is also suitable for comfortable travel with two drivers. Depending on the equipment, the cabin can reach different levels of equipment. The specific model has superior interior and exterior equipment. The interior of the model has wide beds, advanced infotainment, comfortable air-suspended seats that are heated, and the driver's seat is also ventilated. There is also independent air conditioning.

The exterior is also equipped above the standard compared to the basic models. The air suspension of the cabin, consisting of four bellows, has a very good effect on driving comfort. The biggest advantage is the LED lighting, which consists of main headlights, fog lights, daytime running lights, and four powerful auxiliary lights.

For the purpose of this research, this Swedish tractor is marked as “SW” tractor.

2.2. A description of the German tractor

It is a very popular and well-selling model from the German car manufacturer, which is owned by a competing German concern to the concern mentioned above. The tested model has been produced from 1998 to the present. The newest model generation is available for the presented research, where this vehicle will be compared with the Swedish tractor described above. This German tractor has many fans, mainly due to its spaciousness and good ergonomic layout of the cabin components. Mainly because of this, many drivers prefer it. The producer stands out for its extensive service network, thanks to which it can promptly respond to possible vehicle breakdowns practically anywhere, and this is one of the main reasons why entrepreneurs choose lorries of this brand.

The compared tractor is from 2019, and to this day, it is still the current and latest model in the offer of this brand. At the time of the criterion evaluation, the mileage was 180,000 kilometers. It is a fifth generation of the tractor with a power of 352 kW (480 HP) and supercharged by a turbocharger. The transmission of power and torque to the wheels is handled by a 12-speed automatic transmission. The engine meets the strictest Euro 6 emission standard [25].

The tractor does not differ in any particular way compared to the Swedish tractor described above. It also consists of a steel frame and two axles. The rear with four wheels is driven from it. The wheelbase is 3,700 mm. The suspension concept is also very similar, i.e., the front axle is sprung by leaf springs and the rear by a pair of air bellows. The total volume of two tanks is 1,300 liters. Due to these oversized tanks, the side covers of the tanks (aerodynamical accessories) cannot be installed, which would improve the aerodynamics and thus also the vehicle's consumption slightly.

The Mercedes-Benz tractor engine is designed as an inline engine. It has a noticeably smaller volume in comparison with the Swedish tractor and the same number of cylinders, i.e., 6 (-). The engine of the German tractor includes an EGR valve. In winter operation, it is an advantage that it has automatic active screens (lamellas) of the radiator, which close and open according to the engine temperature, thus ensuring a quick warm-up to operating temperature. However, this system is also not perfect, and the slats tend to get stuck in bad weather, especially when it snows. This malfunction is then reported to the driver quite often on the on-board computer.

The gearbox is an automatic 12-speed one. It includes a single disc clutch. It is possible to drive on the pre-programmed Economy/Normal/Power driving programs. The differential (rear axle) is also equipped with a lock. The differential is provided with active lubrication and its constant transmission ratio is of 2.412. The German tractor is equipped just by one additional brake, and it is an engine brake. This is a big disadvantage of this particular model because the engine brake cannot provide as much power as the retarder. For its effectiveness, it needs to have increased revolutions, and this means that the automatic transmission must unnecessarily downshift by several gears at once when braking. This variant is much less gentle on the engine itself, as it works on the principle of closing the exhaust valves, which leads to greater requirements for lubrication of individual components. It also has a negative impact on driving comfort, either through sound effects or uneven or choppy driving. The engine brake has a power of 410 kW and is therefore classified as a high-performance engine brake. Service brakes are classic disc brakes, controlled by air on both axles [25].

The cabin of the tested model is a flat floor cabin. It is not among the largest in terms of vertical dimensions. The interior of the compared tractor cabin looks very modern and, in this respect, it is very difficult to find competition. Classic exterior mirrors have been replaced by a camera system, which consists of external side cameras and an internal pair of large displays on which the image from the cameras is projected. Moreover, the classic instrument panel was replaced by a pair of tablets that have premium graphics, excellent readability and easy handling. Further, the steering wheel contains capacitive surfaces and touch control surfaces, on the basis of which communication between the driver and the system is very fast, intuitive and simple.

As for the interior architecture itself, the German tractor is in the opinion of the company's drivers more practical and more suitable for resting while standing due to a break or overall stay away from home. The dashboard is simple, so the crew feels more spacious. The exterior is equipped with basic lighting technology, consisting of main xenon headlights and halogen fog lamps. The suspension of the cabin includes four air bellows.

For this research, this German tractor is marked as “GR” tractor.

3. EVALUATION OF TESTED TRACTORS FROM THE DRIVERS’ POINT OF VIEW

Semi-trailers tractors, mainly when they are used for long-haul transportation, should meet strict requirements. These requirements relate to more factors. From a driver and a passenger (a second driver point of view), comfort is one of the most important [26-28]. Comfort in a cabin of a tractor is influenced mainly by vibration and oscillation caused by driving on road irregularities [29,30] and by thermal conditions in it [31].

The SW tractors of the Kastrans, Ltd. Company are rated by its drivers as superior and premium tractor with high equipment. From the exterior side, drivers like the design of the car itself, its exterior lighting technology and, of course, details such as the side tank covers, tank

holders and all fenders painted in the color of the tractor. Such accessories are missing from most tractors, and that is why this particular tractor looks very premium and unusual on the road, and drivers like that.

According to the drivers, the interior itself has a luxurious impression. Comfortable leather seats, which are equipped with heating and ventilation, have a very good effect on driving comfort, which is only increased by the very size type cabin. It is the drivers who had the opportunity to try both SW and GR tractors that see the biggest difference in driving comfort. The SW tractor is incomparably quieter and more refined. Just the fact that the SW tractor is equipped with a retarder additional brake compared to the GR tractor makes every deceleration quieter, gentler and, as quoted, "less kicked and jerky".

Drivers who drive the GR tractor like the equipment elements that they would not find in other tractor units. However, they have certain reservations about it. From the outside, the car looks modern and aerodynamic. The absence of physical rearview mirrors only confirms the modern design. However, in terms of design, the drivers lack the side covers of the tanks, which would complete the overall design. Of course, they would welcome additional light meters in addition to the main and fog lights. But their absence is not something that is necessary for them to drive. According to the drivers, the interior of this tractor is the biggest advantage. It is well organized and practical. However, long-time truck drivers are having trouble getting used to the new electronic rearview mirror system. They would rather go back to classic physical rearview mirrors. They consider the displays to be poorly readable, unnatural, and the image is distorted according to them, especially reversing and tight handling are distorted in the displays.

Driving the GR tractor is pleasant, drivers like the high seating position and the ease of use of the on-board computer. When driving on an imperfect road, the Mercedes gives a "dug and jumpy impression", especially when the load is unevenly distributed in a semi-trailer. They consider driving in the SW tractor to be more comfortable and quieter.

4. PROPOSAL OF THE METHODOLOGY

The proposed methodology will be suitable for large companies, local private entrepreneurs, or drivers themselves, who need a system to compare competing tractors and choose the one that will be more suitable for the buyer according to the given parameters.

This system or the method will also be suitable for various publications, where it will be necessary to compare semi-trailer tractors with each other and draw different conclusions regarding the properties of the given tractors. Subsequently, it will be possible to compare them between all existing mass-produced models. The first step for creating a criterion evaluation system will be the most fundamental selection of parameters that we will examine and compare. Therefore, it was decided to divide the given parameters into several categories as follows:

1. Features of operational characteristics.
2. Features of a utility and comfort characteristics.

Among the operational characteristics of the tractors, the following will be taken into account:

- Engine power in kW,
- Engine torque in Nm,
- Fuel consumption in $l \cdot 100\ km^{-1}$,
- Distances to service for the given tractor,
- Service price.

The utility characteristics of the tractor will include:

- Chassis, cabin and seat suspension,
- Lighting technology,
- Cabin size,
- Cabin equipment,
- Design and driving comfort.

The second step of creating a comparison methodology is to assign the given parameters their importance and express it numerically. This means, more important parameters will be assigned more weight. Numerical evaluation of operational characteristics:

- Power of the combustion engine in kW → 100 points (with the chosen optimal value of 700 kW).
- Torque of the combustion engine in Nm → 100 points (optimal value 4000 Nm).
- Fuel consumption in l.100 km-1 → 200 points (optimal value of 15 l·100 km^{-1}).
- Distance to service for the given vehicle → 50 points (optimal value up to 5 km).
- Price of the service → 50 points (optimal value up to €2400·year^{-1}).
- Numerical evaluation of utility and comfort characteristics.
- Suspension of the chassis, cabin and seats → 100 points.
- Lighting technique → 100 points.
- Cabin size → 150 points.
- Cabin equipment → 100 points.
- Design and driving comfort → 50 points.

If we consider the sum of the first category, which is equal to 500 points, and the sum of the second category, which is also 500 points, then the sum of the maximum achievable points per tractor can be 1,000. This means that a semi-trailer tractor, which would theoretically be rated 1,000 points is the optimal choice for its purchase without the negatives present. The description of the justification for the selection of individual parameters is as follows:

- The power of the combustion unit - just like the torque of the drive unit, has a fundamental influence on the driving dynamics of the vehicle.
- The torque of the combustion engine - with this parameter, dynamic properties are primarily influenced, such as the acceleration of the vehicle and its speed, especially at the maximum load of the tractor with a fully loaded semi-trailer. This parameter can be evaluated in such a way that the higher the torque, the better the dynamics of the tractor.
- Fuel consumption - it is one of the most important parameters that should be considered when buying any vehicle, not only a semi-trailer tractor. The main thing is that today's trend is the constant increase in the price of fuel, fuel consumption most significantly affects the cost of operation.
- Distance to the service for the given vehicle – this factor, as well as other factors, affects the purchase of a tractor. The driving force is how companies carry out their business activities, and thereby generate turnover and subsequent profit. Usually, there is little time to service the cars because the tractors are almost always on the road with their drivers. Thus, the proximity of the service greatly facilitates the logistics, the time required, and the costs of the company.
- Service price – each producer of tractors has a different set length and range of service intervals, and this directly affects the service price. The criterion evaluation considers the price of the service for one year of use, or 150,000 km. In this particular case, there is a paid

service contract on the vehicles, which includes all service operations associated with the vehicle, and thus the price of the service contract for 12 months will be taken into account.
- Suspension of the chassis, cabin, and seats - a very important factor regarding the crew's driving comfort and directly affects it.
- Lighting technology – external lighting is considered, which the driver uses especially at night and thus directly influences driving safety from several points of view, such as e.g., exhaustion, predictability, and also driving comfort.
- Cabin size, cabin equipment, design and driving comfort - the bigger the cabin, the bigger the equipment and the more "premium" the tractor owner chooses, the less problem he will have to secure the crew, i.e., the driver to the vehicle. Nowadays, there is a problem with the shortage of truck drivers. That is why this aspect can be a decisive parameter in how to get a driver.

5. AN APPLICATION OF THE PROPOSED METHODOLOGY

The values of individual determined parameters are implemented in two different tables. Subsequently, evaluation points are assigned to both evaluated tractors for each parameter separately. A tractor that achieves better results in an individual parameter receives a greater number of evaluation points. The evaluation results are implemented in comparison tables. After the subsequent summing up of all the evaluation points of the individual categories, a more suitable tractor is determined.

Tab. 1

Quantification of operational parameters of evaluated tractors

Features of operational characteristics	Engine power [kW]	Engine torque [Nm]	Fuel consumption [l·100 km^{-1}]	Service distance [km]	Service price [€ per year]
SW tractor	335.6	2550	22.4	37	3480
GR tractor	350	2500	21.6	9.8	3948

Each parameter is compared with the parameter that was chosen as optimal (rated with the full number of points, or 100% of the possible rating). Individual tractors, which will be evaluated with points in the criterion evaluation, will be more or less close to the ideal evaluation based on the created formulas for individual parameters. These will be shown as examples in the following points. They also serve as a guide in the case of implementing other tractors that someone would be interested in comparing according to this system. Sample calculations will be shown on the parameters of the compared SW tractor. The power value was determined by the tractor manufacturer, and then a calculation was made (1):

$$\frac{X}{100} = \frac{335.6}{700} \rightarrow \frac{33650}{700} \rightarrow X = 47.94 \text{ points} \tag{1}$$

where X = specified number of points; 700 = ideal parameter value with which the value of a specific tractor is compared; 100 = the maximum possible number of points that can be achieved.

The torque value was determined by the tractor producer and then the calculation (2) was made:

$$\frac{X}{100} = \frac{2550}{4000} \rightarrow \frac{255000}{4000} \rightarrow X = 63.75 \text{ points} \tag{2}$$

where X = specified number of points; 4000 = ideal parameter value with which the value of a specific tractor is compared; 100 = the maximum possible number of points that can be achieved.

The consumption values of the compared tractors were actually measured on the same route starting at Address: Tehelná 2, 03601 Martin, Slovakia and ending at Remusweg 8, 33729 Bielefeld, Germany (Figure 2), with the same semi-trailer and with a load of the same weight of 9,000 kg. This route combines urban, non-urban and highway traffic in approximately the same weather conditions. Therefore, the result of this consumption test is real, which is carried out in real conditions with one driver and the same driving style, and thus relatively accurate. When someone wants to compare other tractors and does not have the opportunity to experimentally determine the fuel consumption, it is recommended to apply the data from the tractor producer. To assign points depending on consumption, a calculation (3) was made as follows:

$$\frac{X}{200} = \frac{15}{22.4} \rightarrow \frac{3000}{22.4} \rightarrow X = 133.9 \text{ points} \tag{3}$$

where X = specified number of points; 15 = ideal parameter value with which the value of a specific tractor is compared; 200 = the maximum possible number of points that can be achieved.

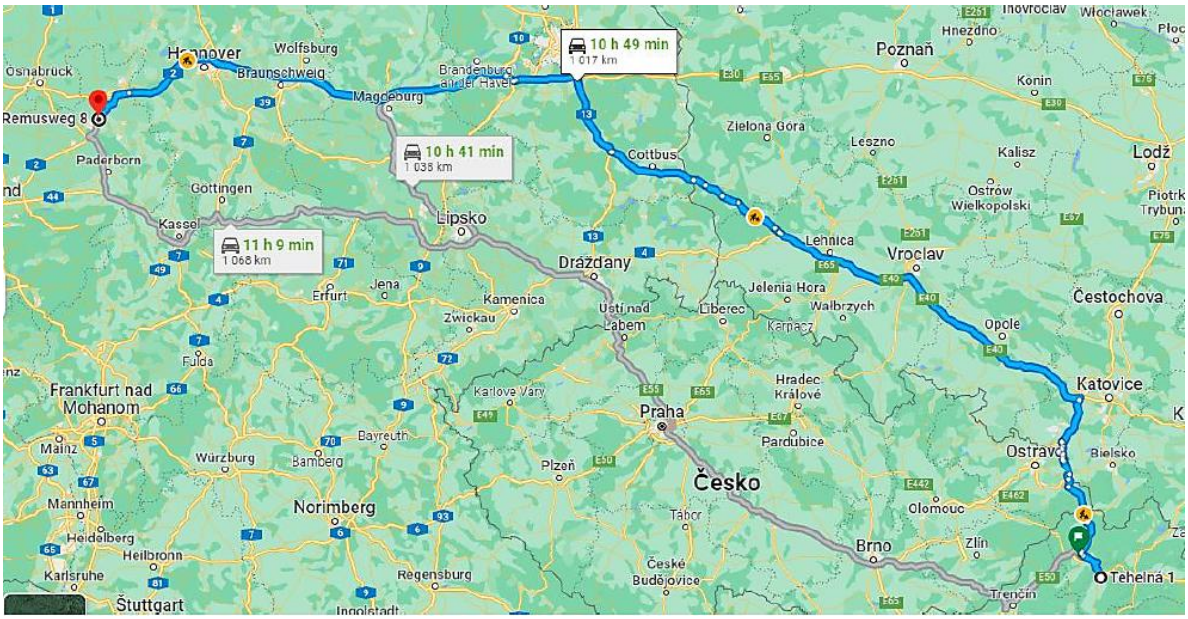

Fig. 2. The route of measuring fuel consumption of tractors

The Kastrans, Ltd. Company headquarters is in the Slovak village of Žabokreky. The nearest authorized service from this address is 9.8 km away for the GR tractor. The nearest authorized service for the SW tractor is 37 km far from the transport company headquarters. For the possible implementation of other tractors, it is recommended to use Map Explorer to find out the exact distances of the authorized services of individual brands. To assign points depending on the distance to the service, a calculation (4) was made as following:

$$\frac{X}{50} = \frac{5}{37} \rightarrow \frac{250}{37} \rightarrow X = 6.76 \text{ points} \tag{4}$$

where X = specified number of points; 5 = ideal parameter value with which the value of a specific tractor is compared; 50 = the maximum possible number of points that can be achieved. The Kastrans, Ltd. Company has full-service contracts paid for the vehicles, which they pay with a monthly fee. As a result, we can determine with maximum accuracy how much financial resources have been invested in an individual tractor. A monthly fee of 290 euros is paid for the service contract for the SW tractor, which is 3,480 euros per year. If the company does not have a paid service contract for the tractor, we recommend summarizing the service tasks according to the manufacturer's service plan for one year or according to the number of selected kilometers and having a price offer made for them in an authorized service.

Tab. 2

Summary of obtained points of the group of operating parameters and evaluation of the suspension

Suspension (max. points)	Front axle (20)	Rear axle (20)	Cabin (20)	Driver's seat (20)	Passenger's seat (20)	Total (100)
SW tractor	0	10	20	20	20	70
GR tractor	0	10	20	20	0	50
Features of operational characteristics (max. points)				Total evaluation (500)		
SW tractor				286.86		
GR tractor				307.29		

To assign points depending on the price of the service, a calculation (5) was made:

$$\frac{X}{50} = \frac{2400}{3480} \rightarrow \frac{120000}{373480} \rightarrow X = 34.48 \text{ points} \tag{5}$$

where X = specified number of points; 2400 = ideal parameter value with which the value of a specific tractor is compared; 50 = the maximum possible number of points that can be achieved. The evaluation of utility and comfort characteristics consists in the fact that, unlike the evaluation of operational features, individual categories will have their own items and points will be assigned to them based on their conditions, or the number of points will be determined using a mathematical formula, where the values of the SW tractor will serve as a sample.

The suspension scoring system consists of the following divisions:

- Front axle: if the front axle is sprung with air bellows = 20 points, otherwise = 0 points.
- Rear axle: if the rear axle is equipped with 4 air bellows = 20 points, 2 air bellows = 10 points, other types of suspension = 0 points.
- Cabin: if the cabin is equipped with air suspension = 20 points, other types of suspension = 0 points.
- Driver's seat: air suspension = 20 points, hydraulic suspension = 10 points, other types of suspension = 0 points.
- Passenger seat: air suspension = 20 points, hydraulic suspension = 10 points, other types of suspension = 0 points.

The lighting technology scoring system consists of the following divisions:

- Interior ambient night lighting if it contains = 10 points, if it does not contain = 0 points.
- Fog lights if included = 20 points, if not included = 0 points.
- Main headlights: LED technology = 50 points, xenon technology = 40 points, halogen technology = 20 points.
- Additional lights: each pair (row) of additional lights is evaluated with 5 points.

Tab. 3

Evaluation of lighting technology

Lightning technology (max. points)	Interior ambient lightning (10)	Fog light (20)	Headlight (50)	Additional lights (20)	Total (100)
SW tractor	10	20	50	5 + 5	90
GR tractor	10	20	40	0	70

Tab. 4

Meaured cabin geometry and cabin size evaluation

Cabin size	Hight [mm]	Width [mm]	Length [mm]	Cabin size (max. points)	Hight (50)	Width (50)	Length (50)	Total (150)
SW tractor	2300	2100	2060	SW tractor	23	21	20.6	64.6
GR tractor	2040	2350	2040	GR tractor	20.4	23.5	20.4	64.3

$$230 \cdot \frac{1}{10} = 23 \text{ points} \tag{6}$$

$$210 \cdot \frac{1}{10} = 21 \text{ points} \tag{7}$$

$$206 \cdot \frac{1}{10} = 20.6 \text{ points} \tag{8}$$

Tab. 5

Evaluation of cabin equipment, design, comfort and overall evaluation of utility characteristics

Cabin accessories	Max. points	SW tractor	GR tractor	Design	Max. points	SW tractor	GR tractor
Independent heating	20	20	20	Colored front bumper	5	5	5
Independent air conditioner	20	20	0	Panels between axles	Colored = 5 Uncolored = 3	0	5
Navigation	20	20	20	Colored rear mudguards	5	5	5
Adaptive cruise control	10	10	10	Opinion of two independent drivers	2.5 + 2.5	2 + 2 = 4	2.5 + 2 = 4.5
Seat heating (driver + passenger)	5 + 5	5 + 5 = 10	0 + 0 = 0				
Seat ventilation (driver + passenger)	5 + 5	5 + 5 = 10	0 + 0 = 0				
Refrigerator	10	10	10				
Total	100	95	60	Total	20	14	19.5
Comfort	Max. points	SW tractor	GR tractor	Features of a utility characteristics		Total	
Driver 1	15	15	10	SW tractor		364.10	
Driver 2	15	13	11	GR tractor		263.30	
Total	30	28	21				

Another evaluated criterion is the size of the cabin. The height from the center of the floor (between the seats) to the center of the cabin ceiling is measured. The width from the center of the side window on the driver's side to the center of the passenger side window is measured. Further, the length from the center of the front window to the center of the back wall of the cabin is measured. The relevant calculations are written by equations (6) for height, (7) for width and (8) for length. Points for individual parameters are determined according to tab. 5. Likewise, Table 5 explains the design evaluation. The evaluation also includes a subjective evaluation of tractors by two independent drivers, which is also shown in Table 5, which also gives an overall evaluation of the utility properties. The results of the evaluation are shown in Table 6.

Tab. 6

The result of the criterion evaluation

Total evaluation	Features of operational characteristics (500)	Features of utility characteristics (500)	Total (1000)
SW tractor	286.86	367.10	653.96
GR tractor	307.29	279.30	586.59

6. CONCLUSIONS

The result of the analysis determined a more suitable tractor for the owner, the future owner, or the driver. Based on the points obtained in the individual categories and their subsequent addition, it is determined which of the two compared tractors is better according to the criterion evaluation. Based on the data of the research, the SW tractor is more suitable. After consulting with the drivers of the evaluated tractors and the company's management about the evaluation results, we concluded that the results are sufficient and that the criterion evaluation system is professional. This is because the criterion evaluation was created based on the experience of drivers, owners, and other responsible individuals in a real transportation company.

Criterion assessment is created in the Microsoft Excel program. This is a set of individual tables into which the data are input. Based on these data, integrated mathematical formulas (equations (1) to (8)) will generate an individual number of points for a given category and a given tractor. The resulting values from the tables of the individual features of the tractors that are evaluated and scored, are calculated based on the integrated links in the program and generate the final evaluation of the tractors in points. Thus, it can be said, that the criterion evaluation created in the Microsoft Excel program is actually a calculation program that, based on the input data, calculates the required values, either temporary or total. The program is very easy to use for an ordinary user and the control is intuitive.

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