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Cost Analysis in the Field of Road Freight Transport: A Specific Approach

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Abstract. *Due to the high importance and reliability of road freight transport as a key link in the supply chain, the price of this service highly affects the price of all the products available to customers. In addition, due to increased competitiveness and decreased differentiation opportunities, organizations must focus on analyzing and reducing their costs to maintain their market share and offer reliable services for a fair price. Costs associated with the road freight transport have been discussed in numerous pieces of academic literature. However, most studies present only a theoretical approach, which is not necessarily easy to apply in real conditions due to high complexity and an organization's inability to continuously monitor external factors. This paper aims to provide a clear, real view of costs associated with providing the service of road freight transport, focusing on direct and indirect costs. Thus, a medium organization operating in the selected field will be analyzed to identify costs and their associated values, which will be used to calculate the cost per kilometer. These findings are not only relevant to the organization, but also to other practitioners and academicians seeking to understand the real costs that occur in this type of organization and paves the way for further research in cost reduction strategies.*

Keywords: cost analysis, road freight transport, direct costs, indirect costs, fuel consumption, SMEs.

Introduction

The road freight transport market is highly competitive, and service differentiation is only achieved through price or intangible aspects such as the quality perceived by the service beneficiary, thus, identifying and analyzing the costs generated by the provision of the transport service is an essential activity within the road freight transport organization (Poliak et al., 2021). Given that the rate of increase in costs is much higher than the rate of increase in prices, organizations must identify practical methods of reducing costs in order to remain in the market and maximize their profit.

Road freight transport is a crucial part of the supply chain, as it facilitates the movement of goods or products in between its other components. Therefore, more than one such transport operation is needed before the product reaches the final customer. Thus, the price of this service clearly affects the final price of the product. It is necessary to understand the costs of providing road freight transport services, as to identify methods of lowering the price. Figure 1 graphically presents the importance of transport operations in the supply chain.

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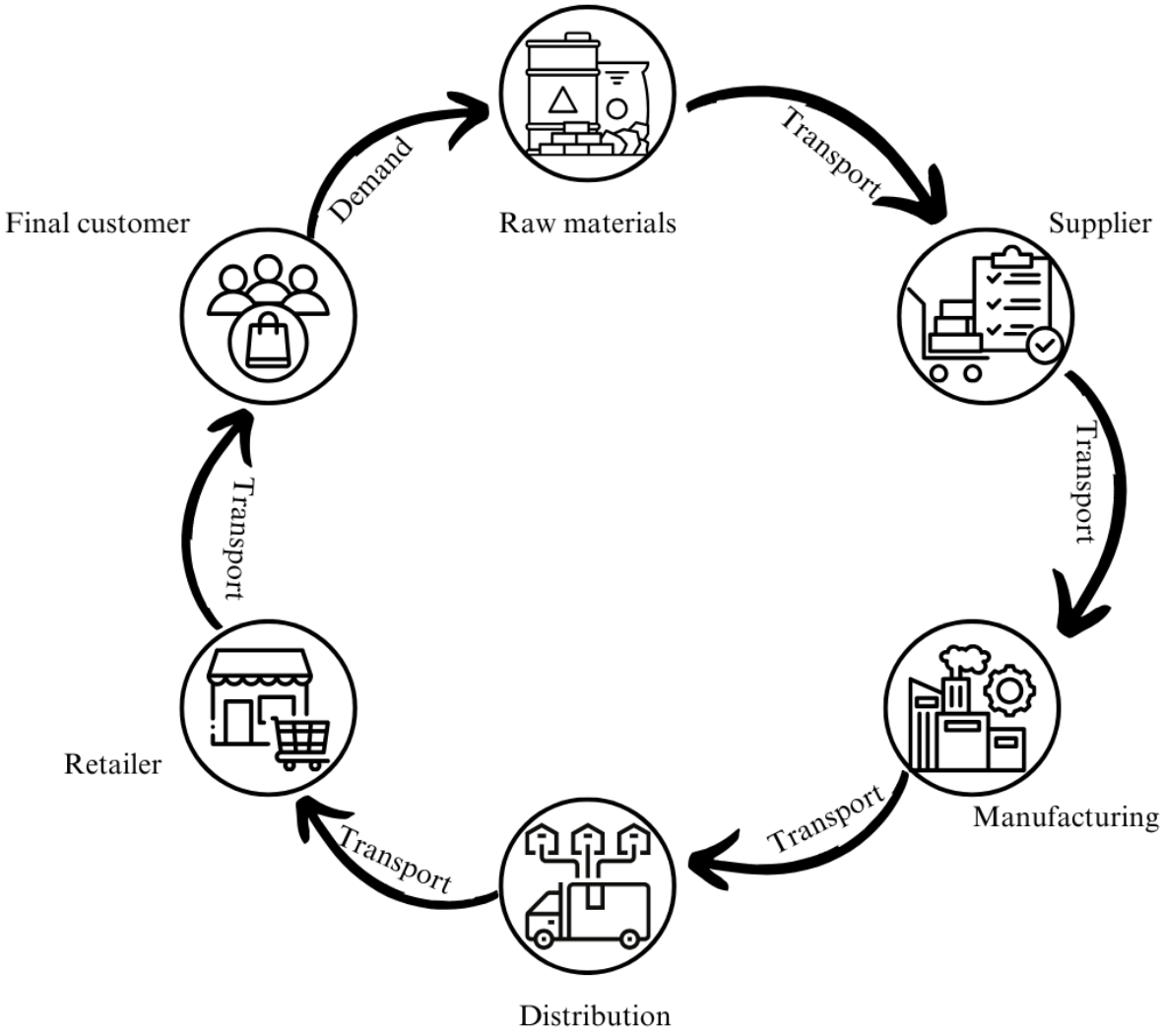

Figure 1. The prevalence of transport services in the supply chain

Source: Authors' own research.

Direct costs are those expenses that can be directly attributed to a cost object, such as a product (Horngren et al., 2012). In the case of a road freight transport organization, direct costs are those that arise from the actual provision of the service. These costs are divided into three categories: costs associated with the vehicle, such as fuel, inspections, spare parts, costs associated with the route to be followed, such as vignettes, bridge and road tolls, and costs associated with the driver, which are summarized in salary, per diem and bonuses.

Indirect costs are those expenses that, although they arise from carrying out the road freight transport activity, are necessary for the operation of the organization (Narayanaswamy, 2022). This category can include costs such as, but not limited to: salaries of technical, economic and socio-administrative personnel, rent, utilities and depreciation.

Determining the cost per kilometer in road freight transport is essential as it allows organizations to accurately assess costs and integrate them into the price charged for providing road freight transport services. This approach helps organizations to budget effectively, set competitive prices, and make informed decisions regarding route planning, vehicle maintenance,

and fuel usage. By understanding these costs in detail, businesses can improve efficiency and reduce overall expenses. Accurate cost models and drivers are crucial for setting transport rates (Izadi et al., 2020).

The aim of this paper is to provide a clear view of the real costs associated with providing road freight transport services. In doing so, a medium organization that operates within this field has been chosen as the object of the study, highlighting its real costs. This approach facilitates not only a better understanding of the value of these expenses, but also the identification of cost elements that can be improved.

Literature review

To analyze the costs of a road freight transport organization, it is necessary to understand their types and how they relate to the main activity. This section aims to provide a proper theoretical background that can facilitate a deeper understanding of costs and their relevance, as well as highlight the importance of calculating the cost per kilometer.

Cost analysis of road freight transport providers

The cost associated with road freight transport has been recognized as an extremely important economic indicator of the efficiency of the entire logistics supply chain (Zeng and Rosetti, 2003). Given that numerous transport operations are required along the logistics supply chain, it is obvious that the price of the transport services directly affects the final price of the product, which is paid by the final consumer. It has been observed that the distance traveled is directly proportional to the volume of the costs required (Sternad, 2019). Thus, the greater the distance, the higher the costs.

From an organizational perspective, the costs associated with road freight transport fall into two categories: internal costs and external costs. Internal costs, also known as direct costs, include expenses that are directly borne by the organization, such as operational costs, opportunity costs of travel time and road tolls (Márquez and Cantillo, 2013). External costs, also known as social or indirect costs, are expenses that are borne collectively by society as a whole: costs associated with accidents, pollution, congestion and infrastructure.

The total costs of the road freight transport service are composed of the sum of internal and external costs (Márquez and Cantillo, 2013). Given that the transport price must reflect the costs generated by providing the service, the lower the costs, the lower the price of the transport service will be. In other words, the costs are directly proportional to the final price of the road freight transport service.

*Direct cost*s

Internal costs refer to the direct costs of the transport organization, which are necessary to be able to carry out the activity of road freight transport. In turn, these costs are divided into operational costs and investments (Piecyk and McLinnon, 2007). Operational costs are represented by the expenses associated with fuel, tires, lubricants, road taxes, salaries, insurance, and any other specific taxes necessary for carrying out road freight transport, as well as the depreciation of fixed assets. Investments can be represented by the purchase of new vehicles for carrying out road freight transport or other cars or equipment necessary to carry out operations adjacent to road freight transport.

Vehicle fuel consumption can be influenced by factors such as pavement characteristics, weather conditions, and vehicle properties (Zhang and Li, 2020). In practice, vehicle fuel

consumption is calculated by dividing the amount of fuel used to the number of kilometers traveled by a vehicle. Consumption, as is well known, is expressed in percentage form.

There are several methods to determine the fuel consumption of a vehicle. First, there is the consumption specified by the manufacturer, but this value is often obtained only under ideal road conditions. Also, some software applications use an erroneous formula for calculating fuel consumption, which implies a consumption of 24% for an unladen truck, and for each ton loaded 0.5% is added. In the case of grain transport, where the mass of the load is approximately 24 tons, the consumption of a truck is 36%, plus or minus 0.5%. In practice, these methods have proven not to reflect reality. There are also numerous theoretical models proposed for calculating fuel consumption, but all have limitations in terms of applicability (Wang and Rakha, 2017).

The cost associated with tires is one of the largest costs of a road freight organization. The quality of tires is crucial, as tires represent the only point of contact of the assembly with the ground. Secondly, using quality tires favors a lower fuel consumption rate (Schoettle et al., 2016).

Taxes and insurance represent another high cost of road freight transport activity. In Romania, taxes associated with road freight transport are taxes associated with the licenses required to provide road freight transport services, which include, but are not limited to: the transport license, a certified copy of the road freight transport license required for each vehicle, the license for related activities (in the case of forwarding agents) and the sanitary and veterinary records of vehicles used for the transport of food, animal feed and live animals.

Salaries represent another high-weighted expense. Given the global skills shortage, organizations need to offer competitive salaries to retain their employees. For professional drivers, the average salary is 3 euros per hour in Eastern European countries but can be two or three times higher in the West (Norbert and Šimurková, 2018; Busu, 2018).

Another direct is the depreciation of fixed assets. Depreciation is not used as a means of determining value, but rather as a cost allocation technique. Fixed assets are not depreciated based on the decrease in value, but rather on the systematic allocation of their initial cost over several fiscal years (Constantin Cucură and Margău Zăgrean, 2016). Depreciation only affects fixed assets, such as motor vehicles, vehicles, or real estate. Ideally, the depreciation of goods should be included in the cost of transport. In this regard, it would be necessary to calculate the depreciation value per kilometer traveled.

Indirect costs

Indirect costs represent costs that cannot be directly attributed to the road freight transport service, yet they still arise as organizational needs (Wouters et al., 2012). These types of costs include administrative salaries, rent, bills for utilities and depreciation. While depreciation has been previously presented as a direct cost, it is worth nothing that this is only acceptable for assets that proactively take part in the road freight transport process, such as trucks and trailers. The depreciation of any other assets owned by the organization represents an indirect cost.

This type of costs can be associated to all the other processes that are needed within the organization to ensure smooth and efficient operations. These costs must be assimilated in the price of the transport services. Thus, it is of utmost importance to include them in the calculation of the cost per kilometer. Indirect costs may also be represented by marketing and public relations costs, licensing, insurance, vehicle tax and cleaning and hygenization.

Methodology

To analyze and calculate direct and indirect costs in road freight transport, all relevant costs will be detailed and expressed in monetary form for a period of 1 year. Three vehicle assemblies, composed of truck and trailer, used for road freight transport have been chosen to conduct a cost analysis on. Analyzing all 65 vehicles owned and used by the organization in providing road freight transport services would be a far too detailed and time-consuming approach. The vehicles were chosen based on their performance for the previous year, namely 2024. The selected vehicles were noted with X_1 – maximum performance, X_2 – average performance, X_3 – minimum performance. All vehicles have operated throughout the year, without extended periods of standstill. Individual costs and average costs are calculated. Table 1 illustrates the particularities of the three vehicle assemblies that serve as the object of study, illustrating their performance.

Table 1. Performance of the analyzed vehicles

Item	Kilometers traveled	Km_u	N_{to}	Q_c (tons)
X_1	103,135	21,633	310	5,776.79
X_2	77,925	15,914	247	4,450.42
X_3	50,459	9,405	183	3,983.79

Source: Authors' own research.

Note: Km_u = kilometers traveled unloaded;
N_{to} = number of transport orders performed;
Q_c = quantity of cargo transported.

This approach facilitates the real calculation of the cost per kilometer in road freight transport, encapsulating all the cost elements that must be taken into account both for the provision of the road freight transport service and for the operation of the organization. Since all trucks carry out road transport of bulk goods, which can only be carried out in full loaded trucks, the amount of goods transported is not necessarily a criterion of performance, as the weight of the goods varies. To avoid any confusion, it is noted that all costs will be expressed in the national currency, RON.

Results and discussions

Following an analysis of the costs incurred by the organization compared to the field of work, the following four categories of direct costs were identified: costs associated with fuel consumption, costs associated with tires, costs associated with maintenance and other direct costs. All of these categories contain a series of elements of cost. The information presented in this section is provided after analyzing data provided by the organization's financial and accounting department, as well as through analyzing various processes and their implementation.

Costs associated with fuel consumption

Within this cost category we find the following subcategories: fuel, AdBlue and fuel filters. The costs associated with fuel filters can also be integrated into this category, as their replacement is conditional on the number of kilometers driven. The organization performs these replacements on its own, so there are no other labor costs.

In practice, fuel consumption is calculated as a percentage, depending on the number of kilometers traveled between two full diesel fills. The same procedure is used to calculate AdBlue consumption. In equation (1) this formula is presented:

$$C = \frac{Q}{N_{km} * 100} \quad (1)$$

Where: C = fuel consumption associated with a distance of 100 kilometers;
Q = quantity of diesel fuel consumed:
N_{km} = number of kilometers traveled.

Table 2 shows the costs associated with fuel consumption for the three analyzed assemblies.

Table 2. Annual fuel and AdBlue consumption

Item	Q_{fT} (l)	C_f	M_C	Q_{AT} (l)	C_A
X_1	38,927.55	37.74%	37.84%	2,372.15	2.3%
X_2	30,824.14	39.55%	39.77%	1,324.73	1.7%
X_3	18,290.46	36.24%	35.62%	958.72	1.9%

Source: Authors' own research.

Note: Q_{fT} = total amount of fuel used;
C_f = fuel consumption per 100 kilometers;
M_c = average monthly consumption;
Q_{AT} = total amount of AdBlue used;
C_A = AdBlue consumption per 100 kilometers.

After comparing the average monthly consumption value with the annual consumption value, there is a slight difference between the two values. However, it is recommended to calculate the monthly consumption to have the most accurate results. In addition, by constantly calculating the consumption, fluctuations can be observed more quickly, which may be caused by technical problems.

Table 3 shows the values associated with these costs. Please note that these values are real values, obtained from the accounting department. These values exclude value added tax.

Table 3. Total costs associated with fuel consumption

Item	Fuel cost	AdBlue cost	Fuel filter cost	Total costs
X_1	238,048.8	3,202.40	130	241,381.20
X_2	240,810.2	1,788.38	135	242,733.58
X_3	112,457.9	1,294.27	75	113,827.17

Source: Authors' own research.

Thus, it is highlighted that the costs associated with fuel consumption are high, which is expected as they represent a primary resource in road freight transport. It is imperative that these costs are included in the calculation of the cost per kilometer.

Costs associated with tires

The following cost elements are identified: tires, tire mounting cost, tire replacement cost, and costs associated with unforeseen situations, such as repairing a tire crack. The organization that has been studied only uses all-season tires, so they do not need to be changed depending on the season. Taking into account the fact that there is no conclusive data on the average lifespan of a tire, it is necessary to analyze the time of purchase of the last complete set of tires, its lifespan (measured in kilometers traveled) and the association of this cost according to the number of kilometers traveled in the analyzed financial year. The costs of mounting and dismounting tires, in the case of a new tire, will be integrated into the cost of the tire, to facilitate a better cost allocation.

Given the specifics of the organization, namely the road transport of bulk goods and the fact that over 80% of the kilometers traveled are carried out with cargo on board, but also the fact

that, for loading and unloading goods, more maneuvers are required than in the case of general goods, tires wear out faster. Thus, according to the information offered by the organization, an average tire lifecycle of 150,000 km will be used. Following the analysis of the purchase price of all tires purchased in 2024, an average price of 2,174.59 RON per tire was calculated. In addition, labor costs associated are included with an unitary cost of 33.61. Thus, the cost associated with a tire is 2,208.2 RON and the cost per kilometer is 0.01472 RON.

It is worth noting that a tractor and semi-trailer assembly uses a total of 12 tires. Table 4 illustrates the costs associated with tires, illustrating their value within a financial year. Incidental costs refer to the costs of repairs in the event of a breakdown. The category "Other costs" includes costs generated by adjusting the wheel geometry and other parts required when changing a tire, which are dependent on frequency, not on number of units.

Table 4. Total costs associated with tires

Item	Tire cost	Other costs	Incidental costs	Total costs
X_1	18,217.77	0	324.44	18,542.20
X_2	13,764.67	350	0	14,114.67
X_3	8,913.07	633.52	160	9,706.59

Source: Authors' own research.

Costs associated with maintenance

The costs associated with the replacement of parts that wear out over time or with the number of kilometers traveled, such as oil, oil filters, fuel, particles or pollen, as well as consumable parts in the breaking system are considered in this category. It is noted that brake pads are replaced after approximately 250,000 kilometers, and brake discs after 500,000 kilometers.

Given that truck inspections are performed after 150,000 kilometers, all parts required for inspections are presented, along with their associated costs. The cost is then divided by the number of kilometers traveled between two inspections, thus obtaining the cost per kilometer. To obtain the cost associated with each vehicle, the cost per kilometer traveled will be multiplied by the number of kilometers traveled by each assembly. Table 5 presents these cost elements, their unit value and cost per kilometer.

Table 5. Cost elements associated with maintenance

Cost element	Unit value	Cost per kilometer
Cabin air filter	54.00	0.00036
Filter dryer	68.97	0.00046
Fuel filter	113.95	0.00075
Purifier filter	312.74	0.00208
Oil filter	112.85	0.00075
Hydraulic filter	266.00	0.00177
Water filter	63.00	0.00042
Pollen filter	29.83	0.00019
Decanter filter	68.00	0.00045
Brake pads	4,728.00	0.01891
Brake discs	5,904.00	0.01181
Total costs	11,721.34	0.03795

Source: Authors' own research.

In addition, this section also includes costs associated with repairs of technical breakdowns and other car parts, such as replacing wipers and certain worn-out components in the cabin.

Furthermore, costs associated with other maintenance activities, such as the periodic technical inspection, are presented in Table 6. Furthermore, the cost per kilometer is calculated.

Table 6. Total costs associated with maintenance

Item	Periodic inspection	Maintenance	Repairs	Total costs	Cost per kilometer
X_1	210.08	745.66	18,928.64	19,884.38	0.19279
X_2	210.08	563.39	9,185.34	9,958.81	0.12779
X_3	210.08	364.81	12,880.71	13,455.6	0.2666

Source: Authors' own research.

Other direct costs

There are two cost elements: the salary of the professional driver and the depreciation of vehicles used in road freight transport. Given that road freight transport is carried out with assemblies consisting of a tractor and a trailer, the cost for depreciation will include both the depreciation of the towing vehicle and the depreciation of the trailer. In calculating these values, the period of 1 calendar year set as the duration of the study will be taken into account.

However, a third cost element will be added: the vignette. Given that, in Romania, the road tax is still paid only depending on the category of the vehicle and the period for which its release is requested, this can be considered a direct cost, as it does not depend on either the number of kilometers traveled or the route. In addition, most of the organization's activity is carried out on national territory.

In addition, this category also includes the GPS fee paid for each vehicle used in road freight transport. Table 7 highlights the values associated with these direct costs, according to the accounting archives of the organization studied.

Table 7. Value of other direct costs

Item	Professional driver salary	Assembly depreciation	Vignette	GPS fee	Total other direct costs
X_1	166,726.50	30,937.50	4,856.49	406.8	202,927.29
X_2	143,209.00	36,547.49	4,856.49	406.8	185,019.79
X_3	93,436.50	-	4,856.49	406.8	98,699.79

Source: Authors' own research.

Given that these amounts are annual, but also the impossibility of allocating them according to the number of kilometers, in order to identify the average cost per kilometer, two methods can be used: dividing the total cost for each vehicle by the number of kilometers traveled and calculating the arithmetic mean of the three results, or using an average annual mileage of 70,000 kilometers for each vehicle, and dividing the amounts obtained by this number. The results of both methods will be presented below in Table 8.

Table 7. Average cost per kilometer associated with other direct costs

Item	Method 1	Method 2
X_1	1.96	2.89
X_2	2.37	2.25
X_3	1.95	1.40
Average	2.09	2.18

Source: Authors' own research.

It is noted that there is no major difference between the two average values obtained. In the following section, the average of the two results will be used, to ensure that these costs are represented as completely as possible in the calculation of the cost per kilometer. Thus, the value that will be used is 2.135 RON per kilometer.

Indirect costs

To be able to carry out its activity optimally, the organization carries out a series of processes adjacent to the road transport of goods. The costs resulting from the performance of these processes are indirect costs, which must be assimilated by the road transport of goods, therefore implicitly integrated into the cost per kilometer.

Table 8 presents the values of indirect costs associated with each assembly. Given that these costs do not depend on and do not incubate the road transport of goods. Thus, they will be allocated as fixed expenses. To identify the cost associated with each vehicle, the total value of each cost element was calculated and divided by the number of vehicles owned by the organization.

Table 8. Average cost per kilometer associated with other direct costs

Cost elements	Value
Administrative staff salaries	1,500.00
Licenses	316.27
Insurance	8,976.03
Depreciation of real estate	2,675.30
Car tax	602.04
Marketing and advertising costs	1,142.30
Sanitation costs	553.85
Utilities	1,476.92
Total costs	17,242.71

Source: Authors' own research.

To identify the associated cost per kilometer, the methods described previously in are used. Table 9 presents the results of these calculations.

Table 9. Average cost per kilometer associated with other direct costs

Item	Method 1	Method 2
X_1	0.167	0.246
X_2	0.221	
X_3	0.342	
Average	0.243	0.246

Source: Authors' own research.

Using the same method as previously, the average value of the two results is to be used in following calculations. Thus, the value of indirect costs per kilometer is 0.244 RON.

Total cost per vehicle

To provide a better understanding of the cost structure and how it varies for each vehicle analyzed, it is necessary to view the total costs for each item. Figures 2,3 and 4 graphically present how costs are allocated to each vehicle studied.

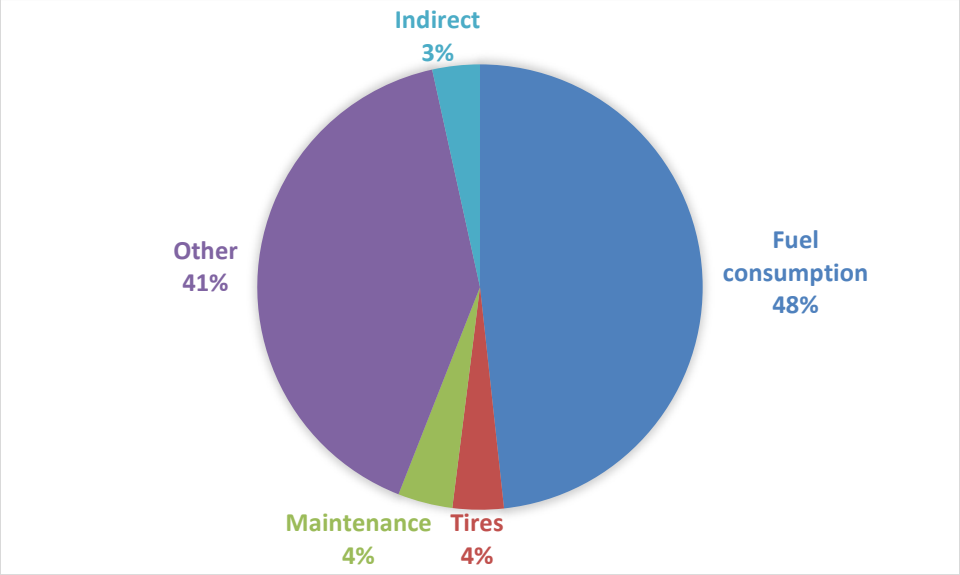

Figure 2. Total costs structured for X_1

Source: Authors' own research.

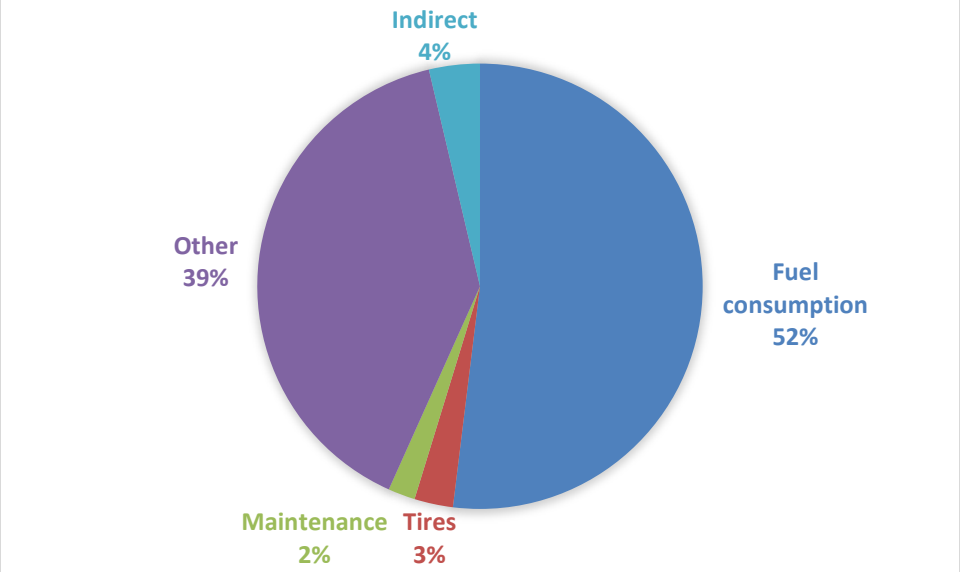

Figure 3. Total costs structured for X_2

Source: Authors' own research.

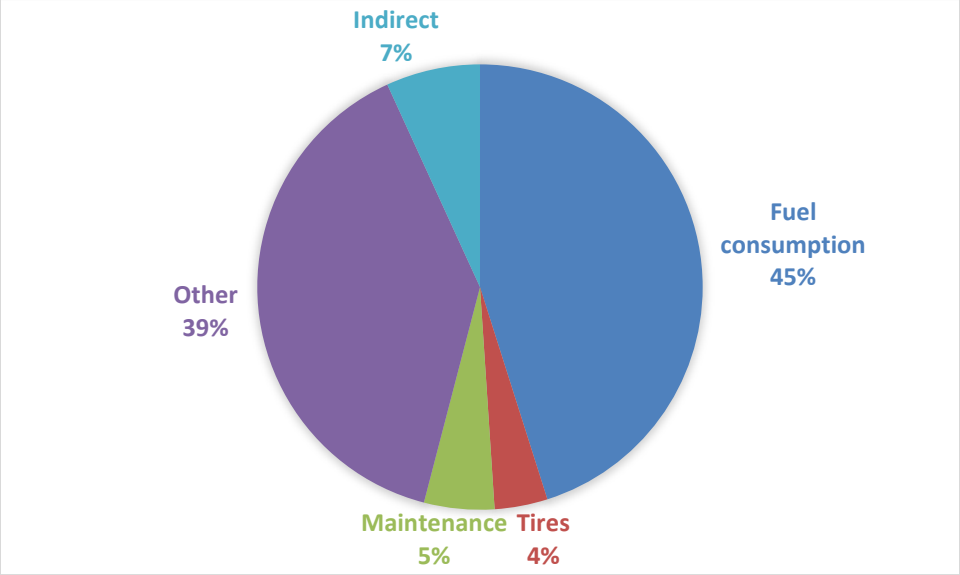

Figure 4. Total costs structured for X_3

Source: Authors' own research.

It is clear that the cost structure varies according to the specific costs of each vehicle. From the analysis that has been conducted in this study, costs associated with fuel consumption account for between 45%-52% of the total costs, tires, for 3%-4%, maintenance, for 2%-5%, other direct costs, for 39%-41%, and indirect costs, for 3%-7%. These variations are considerable and inconsistent, thus more research on this topic is needed.

Cost per kilometer in accordance with direct and indirect costs

It is necessary to identify the cost per kilometer for each cost category identified and analyzed in this research report. Table 10 presents the price per kilometer associated with fuel consumption and maintenance. To calculate this cost, the cost associated with the total amount of fuel and AdBlue will be divided by the number of kilometers traveled by each vehicle. In order to calculate an unitary cost per kilometer, the average of these values is also calculated.

Table 10. Average cost per kilometer associated with fuel consumption and maintenance

Item	Costs associated with fuel consumptions	Costs associated with maintenance
X_1	2.34043	0.19279
X_2	3.11496	0.12779
X_3	2.25583	0.26666
Average	2.57040	0.19574

Source: Authors' own research.

After analyzing all the costs identified in the previous subsection and relating them to a kilometer traveled, this research report will present the cost per kilometer for the organization studied. The results obtained previously are the ones that will be considered. Table 11 presents the total direct and indirect costs associated with road freight transport for the 3 vehicles analyzed. It also reiterates the number of kilometers travelled by them, to facilitate the calculation of the cost per kilometer.

Table 10. Average cost per kilometer associated with direct costs

Cost category	Cost per kilometer
Cost associated with fuel consumption	2.57040
Cost associated with tires	0.01472
Cost associated with revisions	0.19574
Other direct costs	2,135
Indirect costs	0.244
Total cost per kilometer	5.15986

Source: Authors' own research.

Following the calculations, the cost per kilometer is, on average, 5.15986 RON. This result is in accordance with previous research, stating that the average transport cost per kilometer is between 1 euro and 1.15 euro (Sternad, 2019). In establishing the transport price, road taxes for the route traveled, VAT, and the profit percentage that the organization wants to achieve are added. In addition, the organization must also consider ensuring risk budgets, which ensure the ability to pay for unforeseen expenses and those related to resolving risk situations that were not foreseen.

Conclusion

It has been noted that there are a variety of costs that need to be taken into account by a road freight transport organization when calculating the cost per kilometer through the lens of direct and indirect costs. Through a detailed cost analysis carried out by following the proposed methodology, these types of costs, their elements and their values have been presented.

Since the cost per kilometer is an essential parameter within any organization, especially in the field of road freight transport due to the specific characteristics of this industry, it was imperative to determine the cost per kilometer based on direct and indirect costs. Following the calculations performed, it was stated that, in the case studied, the cost per kilometer related to organizational costs is worth 5.15986 RON.

The present research paper has certain limitations. First of all, in order to generalize the value of the cost per kilometer, it is necessary to conduct the study on a larger sample. In addition, the findings of this study can only be linked to similar organizations that operate within the same market: national road freight transport of bulk goods. Thus, it is necessary to analyze if the findings can apply to organizations that provide different types of transport services.

All in all, this piece of work proves to be an important starting point for future applied research in terms of costs and cost management. By providing an overall financial perspective of the studied organization, this study provides real information regarding the costs of a road freight transport organization.

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