

ANALYSIS OF FUEL COSTS INCURRED DURING TRANSPORTATION

VANESSZA ELIZABET KOROPCSÁK¹ - JÁNOS JUHÁSZ²

Abstract: The unexpected war situation in Europe caused extraordinary supply disruptions on the market of domestic and international raw materials. As a result, the companies found themselves in several unfavourable situations, which endangered their daily operations. The aim of the research work is how the fuel costs of companies performing transport tasks can be reduced, and to what extent they represent a financial burden - typically in the provision of daily activities. When purchasing a significant amount of fuel, the price difference provides an opportunity for development, which can be used to achieve significant annual cost savings. It can be beneficial for a business, as the cost saved can be booked or shown as profit. In this way, the development of processes within the company can come to the fore, as it can strengthen the weak points of the company.

Keywords: *raw materials, shipping, transportation, supply chain*

1. INTRODUCTION

This research work focuses on the investigation of the fuel costs of vehicles, during which it aims to identify the waste inherent in the shipping and transportation processes, and we would like to draw attention to the consistent use of raw materials. We have limited the analyses for the following main areas: international, road and freight transportation.

The factors that influences the earnings within the company may be the activities aimed at reducing the regular costs of the company in some way, either in the short or long term. One of the most difficult things for a company (or even an individual) is to reduce existing mandatory expenses. If you can reduce these expenses without affecting the quality of the products and services offered by the company, it can be a large positive impact in your profits. To refuelling the transport vehicles is a regular monthly cost for the transport company, and the reduction is the main aim of this research topic [2]. Logistics deals with the movement and flow of materials, information, and people. Within this, it also includes the methodological planning, organization, management, and control of the routes. If we interpret logistics in terms of economics, then it can be said that the goals of logistics processes are as follows:

- the moved material, finished or semi-finished product reaches the specified place at the specified time,
- in quantity, and
- in quality, so that
- the cost of delivery does not exceed the planned cost.

The planned cost means the fixed amount for carrying out the given logistics process [3]. The complexity of transportation systems connected to hyperconnected global supply chain, and these systems requires more and more up to date methods in the operation of the freight transportation processes.

¹BsC. student, University of Miskolc, Institute of Logistics, Hungary
koropcsakvanessza@gmail.com

²PhD. student., University of Miskolc, Institute of Logistics, Hungary
janos.juhasz1@uni-miskolc.hu

This paper is organized as follows. Section 1 presented an introduction, which summarizes the research aims in freight transportation systems. Section 2 describes the logistics challenge of the shipping, which focuses on operation cost. Section 3 and 4 demonstrates the numerical analysis of the reduction of the company's fuel costs. Conclusions are discussed in Section 5.

2. LOGISTICS CHALLENGES OF SHIPPING

One of the main goals of logistics is to use financial resources as efficiently as possible. Drawing a parallel between this and the transportation process, the focus of the research is concentrated on reducing fuel costs. In the case of a transport company with a fleet of 40 trucks, more favourable fuelling expenses can be achieved with calculations, planning and continuous monitoring.

Shipping is considered one of the main branches of logistics. Its purpose is none other than that the transport of goods is organized in such a way that it is optimal regarding the given time, specified costs and the safety of the transport. Many companies operate as a freight forwarder and carrier at the same time, so it may seem like the two concepts are one and the same. The biggest difference between the two activities is the movement of goods. Because the company or the company that deals with transportation does not physically move goods [4, 5].

Shipping is also mentioned as mental work. The freight forwarder organizes the transport with his language, logistics, freight law, geographical and organizational skills and represents the interests of the customer. It does all this to make the given transport as efficient as possible in terms of time and costs. The carrier, on the other hand, deals with the physical movement of the goods. This is the process during which the product moves from "A" to "B", that is, from the customer to the recipient, until it is delivered to the desired disposal location. The principal or the consignee can perform the task of carrier, however, due to the significant cost, risk and logistical challenges of this, this task is most often outsourced [6, 7].

3. POSSIBILITIES OF REDUCING COMPANIES' FUEL COSTS

The aim of the operation of enterprises is to achieve the greatest possible profit. A company realizes a profit if its returns (revenues) exceed its expenditures (expenditures) in the given period. Otherwise, if the value of the expenses is greater than the value of the returns, then its operation is unprofitable in the given period. For a company dealing with shipping and transportation, the income can increase if its customer base expands. This increases the amount of transport tasks, which can lead to an increase in yield. This requires the ability to adapt and change direction.

In order to succeed and achieve results, sometimes you have to completely change direction or strategy. Of course, every change and every development require time, but this is the only way to maintain or increase the income of the given business. Increasing profit can be approached from two sides. One approach is if, for example, we increase the number of our customers, this can be called an influencing factor outside the company, which of course depends on the influences transmitted by the company to the participants in the market. On the other hand, factors influencing earnings within a company can be activities aimed at reducing the company's regular expenses in some way, either in the short or long

term. In the case of the former, the fact that it is reliable, i.e. the shipment always arrives on time and undamaged at the dump site, can serve as a solution for a company dealing with shipping and transportation to win the favour of the customer. With a better offer, the given company can win a large part of the customer base, but it is of no use if you do all this in such a way that the business declines economically.

There are already many such possibilities in the 21st century, with which we can increase our income, such as by using different strategies, modern technology tools, and applying different well-founded calculations. An example of this calculation is flight planning, which is carried out using different, already known methods, such as the Dacey - Vogel method. It is a heuristic procedure used to solve optimization problems related to transportation and related costs.

One of the most difficult things for a company (or even an individual) is to reduce existing mandatory expenses. If you can reduce these expenses without affecting the quality of the products and services offered by the company, it can have a large positive impact on profits. There are many mandatory expenses for a business, such as the services of an accountant, the payment of employee salaries and contributions, or marketing costs. For a transport company, in addition to the general and mandatory expenses listed above, a regular monthly expense is the refuelling of the transport vehicles. More precisely, in the next chapter of the research, the reduction of this mandatory expenditure is presented using a fictitious company example.

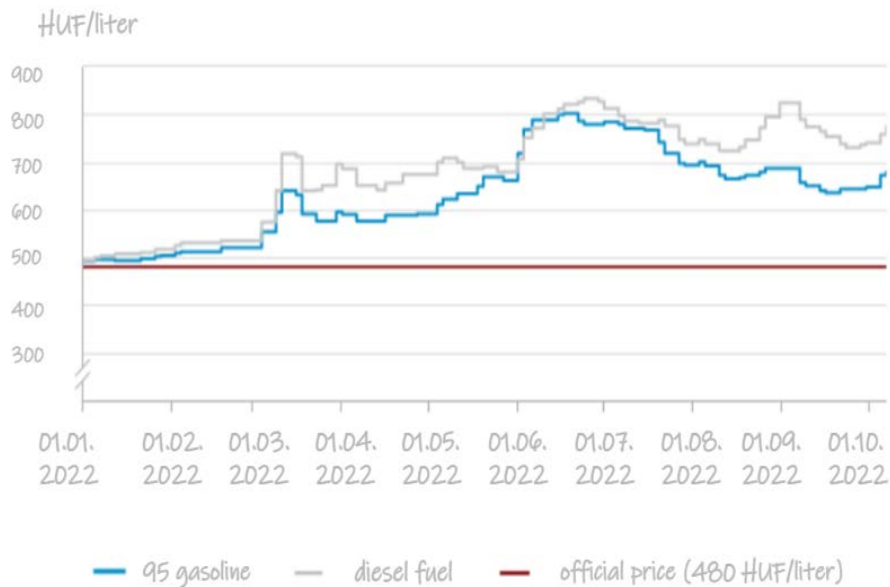


Figure 1: Evolution of the average domestic market- and official prices of fuels (the first 10 days in 2022)

By analysing Fig. 1, we can conclude that compared to the beginning of 2022, fuel prices have increased by up to 60%, which significantly increased their expenses for those who cannot pay official prices. This conclusion is enough to say that it needs to be addressed.

Table I. summarizes the initial data that form the basis of our calculations. We have summarized the gas stations in Nyíregyháza, which is located within five kilometres from the starting point.

Table I.

Detailed data table of fuel filling stations (Nyíregyháza)

Fuel filling station	Price (HUF/liter)	Address	km
MOL	778.9	Nagykállói str.	0
MOL	778.9	László str.	2.32
MOL	778.9	Pazonyi str.	2.49
MOL	778.9	Vasgyár str.	2.78
MOL	778.9	Széna space	3.12
MOL	778.9	Tokaj str.	5.44
Shell	782.9	Orosi str.	1.04
Shell	782.9	Pazonyi str.	2.94
Shell	782.9	Korányi F. str.	2,95
Shell	782.9	Mező str.	3.02
OMV	779.9	Kert str.	1
OMV	779.9	Debreceni str.	1.71
OMV	779.9	Tiszavasvári str.	4.2
Oplusz	768	Lujza str.	0.87
Lukoil	77.9	outlying area	5.03

The Table II. represents the various of the fuelling stations. The first column contains the fuel filling stations, the second column the unit prices of the fuel, the third column the location, and the last column the distance from the starting point in kilometres. The lines marked in red indicate the best possibilities for each fuel filling station. The selection was made according to the number of kilometres.

We have calculated the prices of the quantities to be refuelled using the different prices at the designated filling stations, which is illustrated in the following table.

Table II.

Fuel prices for 1390 litres of fuel at the various fuelling stations

Fuel filling station	Net price (HUF)	VAT (HUF)	Gross price (HUF)	VAT rate
MOL	852,496.85	230,174.15	1,082,671.00	0.27
Shell	857,067.14	231,408.13	1,088,475.26	
OMV	853,775.57	230,519.40	1,084,294.97	
Oplusz	840,724.76	226,995.69	1,067,720.45	
Lukoil	847,943.95	228,944.87	1,076,888.82	

The obtained values clearly show that the cheapest value is provided by Oplusz fuel providers for 1390 litres of fuel. However, on this basis, it cannot be stated that this option is the most economical even considering other aspects. Additional analyses can be found in the full version of the research.

4. REDUCING THE FUEL BUDGET

When buying a small amount of fuel, the amount that can be saved is negligible. We can say that for an individual who refuels twice or three times a month, it is not worth worrying about which filling station to refuel according to the mentioned aspect. When buying a significant amount of fuel, the price difference provides businesses with an opportunity that they can use to save a large amount of money annually. Why is this a great potential for a business?

It has a favourable effect, as the amount of money saved can be booked as profit or can be reassigned to the development of processes within the company, which are the "weakest links" of the company.

In this way, the given business can become stronger, and then it can profit again from successful developments.

The numerical analyses with two cases as follows:

- I. In the first case, a short route was defined: Nyíregyháza-Hajdúnánás-Nyíregyháza. As a next step, we map the fuel stations located within 5 kilometres of the vehicle's location. We selected them according to filling stations, and then selected the closest one from each. From the data obtained in this way, we calculated the distance in km that can be covered with fuel before filling the propellant, the distance that can be covered from one litre, the amount that can be refuelled, the net and gross sums to be paid for the amount of fuel that can be filled, as well as the VAT.

The calculations are described as follows:

$$G_{ijk} = Q \times g_{ijk}, \quad (1)$$

where

- Q: the quantity of all vehicles in a fleet expressed in numbers; 40 pieces,
- g_{ijk} : savings, where i =month, i.e. 1, 2, ..., 12 (1=January, 2=February, ..., 12=December), j =year, i.e. 2019, ... 2022, and k =qualification rate, i.e. 1, 2, ... 5 (1=best, 2= 2nd best, ..., 5=worst); HUF 20,754.81 (best),
- G_{ijk} : monthly savings in the given period, where i =month, i.e. 1, 2, ..., 12 (1=January, 2=February, ..., 12=December), j =year, i.e. 2019, ... 2022, and k = with the rating scale, i.e. 1, 2, ... 5 (1=best, 2= 2nd best, ..., 5=worst).

$$G_{9;2022,1} = Q \times 9;2022.1 \text{ HUF}$$

$$G_{9;2022,1} = 40 \times 20,754.81 \text{ HUF}$$

$$G_{9;2022,1} = 830,192.4 \text{ HUF}$$

That is, the best savings in October 2022 for a fleet of 40 vehicles is 830,192.8 HUF.

Annual savings (October):

$$G_{jik} = q_j \times G_{ijk}, \quad (2)$$

where

- q_j : number of months of the year, 12 months,
- G_{ijk} : monthly savings in the given period, where i =month, i.e. 1, 2, ..., 12 (1=January, 2=February, ..., 12=December), j =year, i.e. 2019, ... 2022, and k = by rating scale, i.e. 1, 2, ..., 5 (1=best, 2= 2nd best, ..., 5=worst); HUF 830.192,4,
- G_{jik} : annual savings according to month i , where i =month, i.e. 1, 2, ..., 12 (1=January, 2=February, ..., 12=December), j =year, i.e. 2019, ... 2022, respectively with the degree of k =rating, i.e. 1, 2, ..., 5 (1=best, 2= 2nd best, ..., 5=worst).

$$G_{2022,9,1} = q_{2022} \times G_{9;2022,1}$$

$$G_{2022,9,1} = 12 \times 830,192.8 \text{ HUF}$$

$$G_{2022,9,1} = 9,962,308.8 \text{ HUF}$$

Interpreting the results, it can be stated that a company with a fleet of 40 vehicles saves HUF 830,192.4 in the given period, when drivers refuel once a month in the amount of 1,390 liters. This amount may increase if multiple fuel fillings are required per vehicle in a given month, or may decrease if, for example, it is not necessary to fill up the vehicle completely, or the remaining amount of fuel will be used in the following month. On an annual basis, the amount that can be saved is HUF 9,962,308.8. Even from this example, it is very clear that with a minimal investment of time and energy, a transport company can save several million HUF every year.

- II. In the second case, these calculations were examined in the case of an operating transport company. Finally, conclusions were drawn from the data of the two cases.

$$\frac{\text{average gross amount for June when refueling 1,390 liters of fuel}}{\text{average gross amount in October when refueling 1,390 liters of fuel}} = \quad (3)$$

$$\frac{k_{ij}}{\text{average October savings}}$$

- k_{ij} : average June savings, where i =month, i.e. 1, 2, ..., 12 (1=January, 2=February, ..., 12=December) and j =year, i.e. 2019, ... 2022, in this case $k_{6,2022}$.

$$\frac{\text{HUF } 967.024,05}{\text{HUF } 1.080.303,66} = \frac{\text{HUF } k_{6,2022}}{\text{HUF } 8465.16}$$

$$k_{6,2022} = \text{HUF } 7.577,511$$

I.e. the value of the average savings in June is HUF 7,577,511 for the company dealing with transportation in the case of a vehicle that refuels once a month.

The monthly and annual average cost savings can be defined as follows:

$$K_{ij} = Q \times k_{ij}, \quad (4)$$

where

- K_{ij} : monthly average savings in the given period, where i =month, i.e. 1, 2, ..., 12 (1=January, 2=February, ..., 12=December) and j =year, i.e. 2019, ... 2022, in this case $K_{6,2022}$,
- Q : the quantity of all vehicles in a fleet expressed in numbers,
- k_{ij} : average savings in a given period, where i =month, i.e. 1, 2, ..., 12 (1=January, 2=February, ..., 12=December) and j =year, i.e. 2019, ... 2022, in this case $k_{6,2022}$.

$$K_{6;2022}=Q \times k_{6;2022}$$

$$K_{6;2022} = 40 \times \text{HUF } 7,577.511$$

$$K_{6;2022} = \text{HUF } 303,100.4$$

$$K_{ji} = q_j \times K_{ij}, \text{ where} \quad (5)$$

- K_{ji} : the annual average savings according to month i , where i =month, i.e. 1, 2, ..., 12 (1=January, 2=February, ..., 12=December), and j =year, i.e. 2019, ... 2022, in this case $K_{2022,6}$,
- q_j : the number of months of the year,
- K_{ij} : monthly average savings in the given period, where i =months, i.e. 1, 2, ..., 12 (1=January, 2=February, ..., 12=December), in this case $K_{6,2022}$.

$$K_{2022;6}=q_{2022} \times K_{6;2022}$$

$$K_{2022;6} = 12 \times \text{HUF } 12,303,100.4$$

$$K_{2022;6} = \text{HUF } 3,637.205$$

It can be concluded that the average monthly savings in June 2022 - for 40 vehicles: HUF 303,100.4, which is approx. 3,637,205 HUF per year.

The case study clearly illustrates that the company could have saved 3,6 million HUF per year by applying the described method.

5. SUMMARY

The research concerns one of the biggest raw material supply problems of our time, which is present in the everyday life of many ordinary people in addition to companies. In this study, we investigated the possibilities of reducing fuel costs - in the spirit of energy sustainability.

By spending enough time and work, more favourable fuel expenses can be achieved for the company or even for an average person. All of this is supported by specific route plans, and the necessary data and calculations are verified with data corresponding to reality. Although the vehicle routes are considered to dedicated distances in this paper, the service task of vehicles and the timeframe are not taken into consideration. In further studies, the calculations can be extended to a more complex model including additional transportation constraints.

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