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COMPARATIVE ANALYSIS OF THE EFFICIENCY OF GROUPAGE AND COMPLETE TRANSPORTATION ON A SPECIFIC ROUTE ¹²

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Abstract: This article performs a comparative analysis of the economic efficiency of groupage and full load transport on the international route Bulgaria-Italy. By applying a mathematical model for cost optimization, key indicators such as fuel consumption, revenue per litre of fuel, ton-kilometre, load factor and profit per course have been studied. The results obtained show that groupage transport offers higher profitability and better use of available capacity compared to full load transport, which confirms their strategic importance for small transport enterprises.

Keywords: Groupage transport, Full-truckload transport, Transport efficiency, Comparative analysis, Route optimization, Fuel consumption, Logistics performance.

INTRODUCTION

The role of road transport in Europe continues to be leading in the field of freight transport. According to data from the European Commission, over 70% of internal trade in the EU is carried out by road. Small and medium-sized transport enterprises have a significant contribution to this process, especially in segments with flexible service and quick response. The increase in fuel prices, the introduction of new environmental regulations and intense market competition place enterprises in a situation requiring resource optimization and improvement of operational efficiency. In the scientific literature, the topic is considered by Domagała & Kadłubek (2023), Ziółkowski et al. (2022), Martulli et al. (2021), Ruzzenenti & Basosi (2009), Valcheva (2021) and Varadinova & Angelova (2022), who emphasize the importance of energy efficiency and transportation optimization.

EXPOSITION

Methodology and mathematical model

The research uses empirical data from a transport company for the period 2024-2025, specialized in international transport on the Bulgaria-Italy route. The object of the study includes four licensed Iveco Daily 35 S 16 minibuses with a payload capacity of up to 1000 kg, an average fuel consumption of 10 l/100 km and a cargo space of 19 cubic meters. The main analysed indicators include fuel and toll costs, kilometres travelled, freight revenue, profit per course and fuel consumption per 100 km.

For the purposes of the analysis, a linear programming model for minimization of transport costs with an objective function is proposed:

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$$\min z = \sum_{i=1}^n C_i \cdot X_i \quad (1)$$

C_i – cost for course i (fuel, fees, salaries), X_i – number of completed courses of type i .

The model includes constraints for:

- load capacity $Q_i \leq 1000\text{kg}$;
- fuel: $F_i = d_i \cdot \frac{10}{100}$ (2)
- where d_i – distance travelled, km
- time per course: $T_i \leq 5$ days

The income per litre of fuel, i.e. economic efficiency shows how much revenue each litre of fuel used brings and is calculated as follows:

$$E_f = \frac{R}{F} \quad (3)$$

E_f – fuel efficiency (euro/litre), R is the total revenue from the transportation (euro), and F is the total fuel consumed for the course (litres).

The revenue per ton kilometre (transport efficiency) shows the economic result of the transport depending on the transported quantity and the distance as:

$$E_t = \frac{R}{Q \cdot d} \quad (4)$$

E_t is the efficiency per ton-kilometer (euro/tkm), Q is the average transported weight (ton), and d is the distance travelled (km).

The load factor indicates the degree of utilization of the vehicle's load capacity:

$$K_n = \frac{Q_{real}}{Q_{max}} \times 100\% \quad (5)$$

With a load capacity of 1000 kg and a real load of 950 kg, $K_n = 95\%$, where K_n – load factor, %, Q_{real} and Q_{max} are respectively the real and maximum load capacity of the vehicle, kg.

The profit per course is the easiest, but important indicator, because it shows the net financial result of a given course:

$$P = R - C \quad (6)$$

where: P is the profit, (euro), R – the revenue and C are the total costs.

The fleet efficiency on an annual basis shows how much revenue each vehicle brings per year:

$$E_a = \frac{R_{annually}}{N} \quad (7)$$

where: E_a is the fleet efficiency, (euro/per automobile), $R_{annually}$ is the total company revenue from transport, (euro) and N are the numbers of vehicles.

Geographic scope of activity and market specialization

The transport activity of the company is focused on one main international relationship: Bulgaria – Italy and vice versa. This strategic choice is determined by the language competences of the management and the long-term commercial relations established with Italian clients. The route of international transport passes entirely through the territory of the European Union, including the following countries: Bulgaria, Romania, Hungary, Slovenia and Italy.

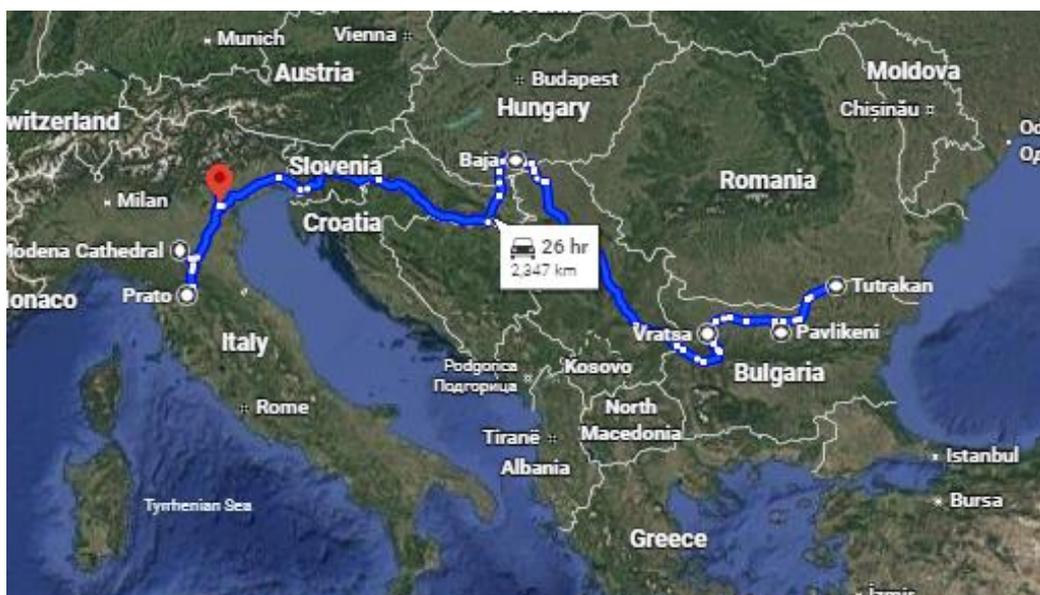


Fig. 1. Sample route Bulgaria, Serbia, Hungary, Slovakia and Italy

The route passes through border crossings without obstacles, thanks to the participation of all countries along it in the Schengen area and the single European market. In Bulgaria, cargo operations are carried out mainly in the large cities of Sofia, Plovdiv, Stara Zagora, Veliko Tarnovo and Ruse, and less often in smaller settlements. In Italy, transport is concentrated in the northern industrial regions, including Venice, Verona, Milan and others.

Geographic scope of activity and market specialization

The company operates regular weekly Bulgaria-Italy routes lasting 3-5 days, offering two main types of services: groupage transports combining cargo from different clients in one vehicle for higher profitability and optimal use of capacity, and full-load transports for the transport of a full load from one sender to one recipient, including express deliveries under 24 hours with premium freight.

The costs of implementing one international route vary in the range of 400 to 500 euro per direction depending on the specific route, the number of loading and unloading addresses and the duration of the route. The main elements of the cost structure include fuel as the largest operating cost, drivers' salaries and insurance, highway tolls and vignettes for Romania (96 euro), Hungary (203 euro), Slovenia (220 euro) and Bulgaria, as well as the Telepass system for Italy with automatic billing according to the actual distance travelled. In addition to the operating costs for each course, the enterprise has fixed annual costs for licenses, insurance (CT, Auto Casco, CMR), technical inspections, accounting services, administrative staff, taxes and office expenses.

Table 1. Cost allocation for international groupage freight

| № | Indicators | Route | | Total |
|---|---|--|-----------------------------------|-------|
| | | Tutrakan-Pavlikeni- -Vratsa-Prato- Modena-Padova | Padova-Vratsa- Sofia-Pavlikeni | |
| 1 | Kilometres travelled along the route | 2193 | 1537 | 3730 |
| 2 | Driver's remuneration, euro | 408 | - | 408 |
| 3 | Vignette fee along the entire route, euro | 11.59 | - | 11.59 |
| 4 | Average fuel consumption per 100 km | 10 | 10 | |
| 5 | Price per litre of fuel with VAT, euro | 1.32 | 1.32 | - |
| 6 | Price per litre of fuel without VAT, euro | 1.1 | 1.1 | - |
| 7 | Fuel consumed, litres | 219.3 | 153.7 | 373 |

| | | | | |
|----|-------------------------------|--------|--------|---------------|
| 8 | Amount for fuel, euro | 241.23 | 169.07 | 410.3 |
| 9 | Other costs / toll fees, euro | 34 | 21.5 | 55.5 |
| 10 | Total costs, euro | 694.82 | 190.57 | 885.39 |
| 11 | Freight excluding VAT, euro | 1711.5 | 1711.5 | - |
| 12 | Profit, euro | - | - | 826.11 |

The economic efficiency for a groupage course:

$$E_f = \frac{1711,5}{373} = 4,59 \text{ euro/litre}$$

And his profit is: $P = 1711,5 - 885,39 = 826,11$ euro

If the total revenue from groupage transportation is 39 653,28 euro and the company has 4 vehicles, so the efficiency of the car fleet per year is going to be:

$$E_a = \frac{39653,28}{4} = 9913,32 \text{ euro}$$

Table 2. Cost allocation for international full load rates

| № | Indicators | Route | | Total |
|----|---|-------------------------------|---------------------------|---------------|
| | | Pavlikeni-Sofia-Milan-Brescia | Brescia-Plovdiv-Pavlikeni | |
| 1 | Kilometres travelled along the route | 1741 | 1729 | 3470 |
| 2 | Driver's remuneration, euro | 408 | - | 408 |
| 3 | Vignette fee along the entire route, euro | 11.59 | - | 11.59 |
| 4 | Average fuel consumption per 100 km | 10 | 10 | |
| 5 | Price per litre of fuel with VAT, euro | 1.32 | 1.32 | |
| 6 | Price per litre of fuel without VAT, euro | 1.1 | 1.1 | |
| 7 | Fuel consumed, litres | 174 | 173 | 347 |
| 8 | Amount for fuel, euro | 191.4 | 190.3 | 381.7 |
| 9 | Other costs / toll fees, euro | 25 | 34 | 59 |
| 10 | Total costs, euro | 635.99 | 224.3 | 860.29 |
| 11 | Freight excluding VAT, euro | 1548.5 | 1548.5 | |
| 12 | Profit, euro | - | - | 688.21 |

The economic efficiency for one complete course:

$$E_f = \frac{1548,5}{347} = 4,46 \text{ euro/litre}$$

And its profit is: $P = 1548.5 - 860.29 = 688.21$ euro

From the calculations we can summarize that both types of courses – groupage cargo and full cargo are performed 4 times a month. One course with groupage cargo realizes a profit of 826.11 euro, that is, for the month the profit is 3304.44 euro. The course with full cargo, which is on a relatively shorter route and accordingly lower freight realizes a profit of 688.21 euro, for the month – 2752.84 euro. The total profit for the month is 6057.28 euro

The total revenue from groupage transportation for 1 year is 39653.28 euro and the company has 4 vehicles, therefore the efficiency of the fleet on an annual basis is:

$$E_a = \frac{39653.28}{4} = 9913.32 \text{ euro per automobile}$$

The total revenue from complete transportation for 1 year is 33034.08 and the company has 4 vehicles, therefore the efficiency of the fleet on an annual basis is:

$$E_a = \frac{33034.08}{4} = 8258.51 \text{ euro per automobile}$$

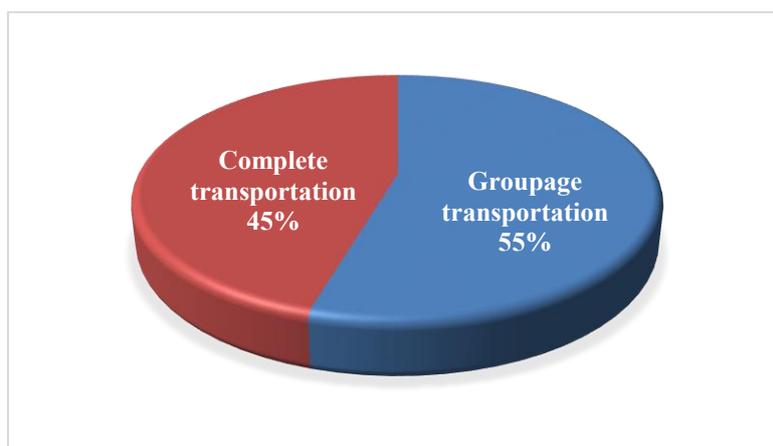


Fig. 2. Allocation of total revenue from groupage and full loads

Comparative analysis of groupage and full load transportation

The results of the study confirm the hypothesis of the higher economic efficiency of groupage transport compared to full loads on international long distances. The difference in profit of 137.9 euro per route (20% higher profitability) is mainly due to the better use of capacity and the possibility of optimizing routes with multiple loading and unloading points. The economic efficiency of groupage transport is 19.11% higher (826,11 euro compared to 668,21), which indicates a more rational use of fuel resources. The load factor for groupage transport reaches 95-100%, while for full loads it varies between 60-70%, especially on the return, when vehicles often move empty or partially loaded. This represents a significant loss of potential revenue and increases the cost per tonne-kilometre. The fuel purchasing strategy implemented by the company results in savings of 15-20% compared to refuelling in Italy and represents a good practice for optimizing operating costs.

The use of international fuel management systems (DKV) and automated billing (Telepass) demonstrates the contribution of digital technologies to improving operational efficiency and optimizing cash flow through VAT refunds.

CONCLUSION

This study demonstrates the significant advantages of groupage over full loads in terms of economic efficiency, capacity utilization and energy efficiency in international road transport. Groupage transport provides 20% higher profitability and should be prioritized as a core service for the enterprise, while full loads should be offered as a premium option with higher freight rates to compensate for lower efficiency.

It is recommended to implement telematics systems for real-time monitoring of fuel, driving style and route optimization, as well as digitalization of document flow through electronic consignment notes (e-CMR) and automated data processing.

The study of additional routes to Germany, France, the Netherlands and Belgium would expand the geographical scope and increase the possibilities for groupage combinations. The active development of return cargo to Bulgaria through partnerships with Italian forwarders and registration in transport exchanges would increase profitability by reducing empty runs. The introduction of fuel efficiency management systems through driver training in eco-driving and monitoring of driving style can reduce consumption by 5-10%.

In the long term, it is necessary to monitor the development of alternative fuels and eco-technologies, including electric vehicles, for adaptation to future EU environmental requirements. Obtaining international quality certificates (ISO 9001) and expanding the vehicle fleet by 1-2 vehicles with a sustainable growth in orders would improve the competitiveness and flexibility of the enterprise.

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