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DEVELOPMENT OF AN IMPROVED LOGISTICS MANAGEMENT MODEL FOR FUEL RETAIL ENTERPRISES

***Emīls Lubējs**, **Inguna Jurgelane-Kaldava**
Riga Technical University, Latvia
*Corresponding author's e-mail: elubejs@gmail.com

Abstract
The objective of this research was to design an economically efficient logistics management model for fuel retail enterprises to improve their competitiveness. In the current global market situation, fuel retail enterprises face various challenges, such as sharp increase in raw material price, intense market competition, high price sensitivity, low profitability, and significant logistics costs. By combining theoretical and practical insights, an improved logistics management model was designed, which provides significant competitive advantage for fuel retail enterprises. The designed model incorporates and integrates three distinct logistics arrangements, resulting in considerable advantages for fuel retail enterprises. These advantages include a reduction in logistics costs and increased independency from the fluctuating logistics service expenses. To determine the economic efficiency of the designed logistics management model, it was validated by using data obtained from a fuel retail enterprise based in Sweden. Results of the research indicated that the fuel retail enterprise can anticipate an annual reduction in logistics costs ranging from 2.91% to 3.32% from the implementation of the improved logistics management model. On top of that, the developed logistics management model is projected to be economically viable until 2027, assuming the continuation of the current market trends and conditions. The findings of the research suggest that other fuel retail enterprises may also benefit from implementation of the designed model in the current market conditions.
Key words: fuel retail, logistics management, logistics service providers.

Introduction

In the current global market situation, fuel retail industry is characterized by intense market competition. Reduction of operational costs has become a crucial activity for fuel retail enterprises to enhance their competitiveness within the market. By achieving reduction of operational costs, fuel retail enterprises can offer competitive prices to their customers, which allows them to grow their market share. The significance of operational cost reduction has been emphasized by M. Porter, who posits that by enhancing its primary activities, an enterprise can create greater value in the market, and as a result gain competitive advantage over its competitors (Porter, 1991). This theory is particularly relevant in the fuel retail industry, where enterprises sell homogenous products to their customers, which results in an intense price competition. Therefore, any cost reduction in the fuel retail industry has a significant impact on the competitiveness of an enterprise.

One of the primary activities over which fuel retail enterprises have a direct control over is logistics management. Fuel retail enterprises rely on logistics service providers (LSP) to manage their logistics operations. Selection and integration of appropriate LSPs in supply chains is a critical factor for the competitiveness of fuel retail enterprises. For example, an enterprise that relies on outsourcing of logistics services may expose itself to the risks associated with fluctuations in logistics service charges. On the other hand, an enterprise that manages its logistics operations solely with in-house logistics is likely to incur significantly greater logistics costs compared to utilizing outsourced logistics services. Therefore, to make an informed decision regarding the selection and integration of appropriate LSPs, an in-depth analysis of different types of LSPs is required.

The objective of this research was to design an economically efficient logistics management model for fuel retail enterprises in order to improve their competitiveness. To develop an improved logistics management model for fuel retail enterprises, various theoretical and practical aspects regarding LSPs have been integrated into the model, such as specifics of different types of LSPs and the current situation of the fuel retail industry.

Materials and Methods

To reach the objective of the research, various qualitative and quantitative research methods were used. A literature review on various types of LSPs was conducted. The study also employed a range of quantitative research methods to analyze the data, such as correlation analysis, linear regression analysis, time series analysis and ABC analysis. The designed model was validated by using data obtained from a fuel retail enterprise based in Sweden. The enterprise generates annual fuel sales of approximately 1.77 billion liters and incurs annual logistics costs of approximately 19.9 million EUR.

Results and Discussion

Most widely adopted LSPs by fuel retail enterprises are first party logistics (1PL), second party logistics (2PL) and third-party logistics (3PL). 1PL, also referred to as in-house logistics, is a logistics arrangement where the fuel retailer manages its logistics operations with the use of its own vehicles and resources. Implementation of 1PL is often associated with 'make-or-buy' decision making process, in which an enterprise evaluates the economic efficiency of producing logistics services in-house versus outsourcing them (Fadile, Oumami, & Beidouri, 2018). Primary drivers that motivate an enterprise's decision to implement 1PL logistics are cost reduction associated with economies of scale, the ability for an enterprise to allocate its resources towards its core business operations and improved customer service (Zhu *et al*., 2017). Therefore, it can be concluded that although implementation of 1PL results in higher logistics costs for a fuel retail enterprise, it provides a significant competitive advantage in the market. Moreover, 1PL arrangement provides the highest level of control over logistics operations as all operations are managed in-house by the enterprise itself.

2PL is a logistics arrangement where fuel retail enterprise outsources transportation function to a LSP. The primary benefits from integrating 2PL providers in supply chains include the ability for enterprise to retain control over other aspects of logistics operations and allows retailer to benefit from the expertise of the 2PL service provider (Płaczek, 2010). Therefore, it can be concluded, that 2PL logistics arrangement is beneficial for a fuel retail enterprise that wants to maintain control over its logistics operations but lacks resources or expertise to transition to in-house logistics.

3PL is a logistics arrangement where fuel retail enterprise outsources all of its logistics operations to a LSP. Compared to 2PL arrangement, a 3PL provider fulfills a wide range of logistics functions, such as procurement, transportation, planning, inventory management, order fulfillment and others. 3PL arrangement is associated with having lower average logistics costs, due to LSP's ability to leverage its expertise, resources and economies of scale (Skjoett-Larsen, 2000). By implementing a 3PL solution in their supply chains, an enterprise can expect a lower control level over logistics operations, since LSP has a complete control over logistics management (Zacharia, Sanders, & Nix, 2011). Therefore, it can be concluded that by integrating a 3PL service provider within its supply chain, fuel retail enterprise exposes itself to the risk of substantial increase of logistics costs, connected to the fluctuation of logistics service charges. This risk is particularly pronounced in markets characterized by limited competition among LSPs.

While implementation of different types of LSPs has distinct advantages and disadvantages for fuel retail enterprises, the benefits of combining multiple logistics arrangements simultaneously has not been researched in the scientific literature. To assess the potential benefits that fuel retail enterprise may accrue from concurrent implementation of multiple types of LSPs, a theoretical model incorporating 1PL, 2PL and 3PL was designed (Table 1). The designed model segments the sales points of the fuel retail enterprise into three distinct market segments of varying strategic significance and applies different logistics arrangements to each of the identified segments. By tailoring logistics arrangements to the unique requirements of each market segment, fuel retail enterprise can expect more effective resource allocation.

The model combines three different logistics arrangements, thus necessitating the implementation of a segmentation method, which would divide the sales points of a fuel retail enterprise into three segments with varying strategic significance. The most appropriate method for this task is ABC analysis, as it enables the categorization of items based on their strategic significance. Factor which most appropriately characterizes the strategic significance of a sales point is fuel sales volume. It is logical to suggest that higher volume of fuel sales would result in a greater revenue for the fuel retail enterprise, making it a suitable factor to use in the ABC analysis. In the context of the designed model, a distribution proportion of 70% was selected for segment 'A', 25% for segment 'B', and 5% for segment 'C' (Figure 1). It is worth noting that the proportions defined for this analysis are not fixed and alternative distribution proportions can be used in the context of the designed model.

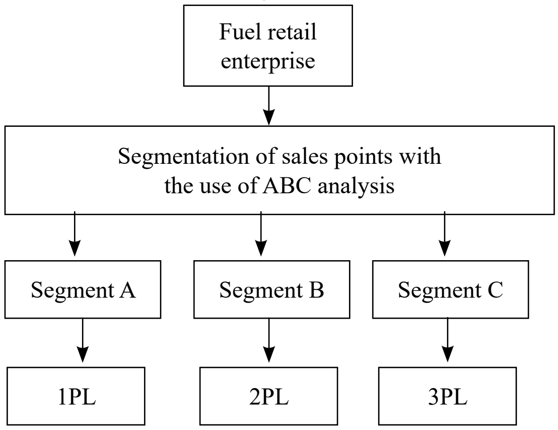

Figure 1. Visualization of the designed logistics management model for fuel retail enterprises.

To evaluate the economic efficiency of the designed logistics management model, it was validated using data obtained from a fuel retail enterprise based in Sweden. The enterprise operates 460 sales points and generates annual fuel sales of approximately 1.77 billion liters, while incurring annual logistics costs of approximately 19.9 million EUR. The reasoning for validating the designed model on the specific enterprise is because it operates all three different logistics arrangements simultaneously, allowing for a more practical calculation and evaluation of the model's economic efficiency. Based on the available dataset, the enterprise serves 69% of its sales points with 1PL, making it the primary logistics arrangement within the supply chain. 2PL is used for 30%, while 3PL is only used for 1% of its sales points. The enterprise currently does not use any sort of segmentation method for its sales points.

Table 1

Optimal logistics arrangement selection for market segments of varying strategic significance

Strategic importance of market segment	Optimal logistics arrangement	Justification for the appropriateness of logistics arrangement selection
High	1PL	• The fuel retail enterprise can reap the advantages of economies of scale due to the substantial fuel sales volume. • 1PL provides the highest level of control over logistics management; therefore, better visibility of logistics operations can be expected.
Medium	2PL	• The fuel retail enterprise retains control over logistics management, because 2PL provider fulfills only transportation function. • 2PL arrangement does not require investments for fuel retail enterprise.
Low	3PL	• Segment generates low income; therefore, high level of control over logistics management is not practical. • Compared to other logistics arrangements, 3PL provides the lowest logistics costs.

The initial stage of evaluating the economic efficiency of the designed model was to determine the existing trends of logistics costs in the fuel retail industry. To test the assumption that logistics costs are directly correlated with diesel fuel retail prices, data was collected from the fuel retail enterprise covering fuel sales from January 2020 to July 2022. In addition, data on the average diesel retail prices was collected from the European Commission database (European Commission, 2023). The collected data was compiled and analyzed using Microsoft Excel.

By conducting a visual analysis of the data, a positive correlation was observed between the two variables (Figure 2). Based on the calculations

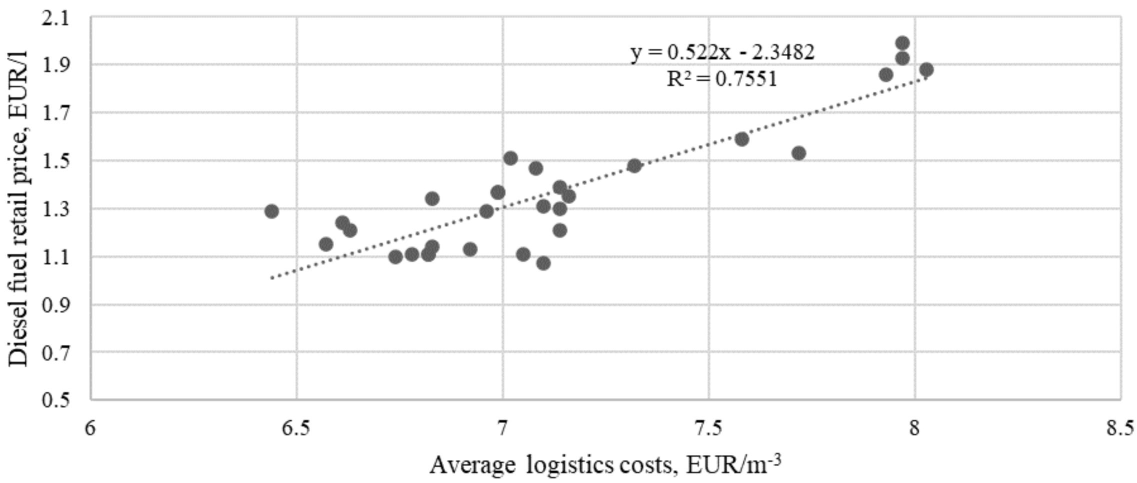

Figure 2. Scatter chart depicting the relationship between diesel fuel retail prices and average logistics costs.

performed by Microsoft Excel's Data Analysis tool, a correlation coefficient of 0.87 was determined between the two variables. The findings indicate that fluctuations in diesel retail prices are a statistically significant factor that affects the logistics costs of fuel retail enterprises.

As fuel retail prices tend to increase annually, it can be deduced that fuel retail enterprises should anticipate a corresponding growth in logistics costs. To quantify this effect, the available data from the fuel retail enterprise used in the analysis was used to calculate the annual growth rate of logistics costs for each of the three logistics arrangements. Time series analysis was conducted using data from July 2021 to July 2022 to derive the most accurate and recent logistics cost growth rate.

By performing visual analysis of the data, it is evident that 1PL incurs the highest logistics costs compared to other two logistics arrangements (Figure 3). The collected data indicates that outsourced logistics services result in lower logistics costs, which may be attributed to the high maintenance costs associated with in-house logistics arrangement.

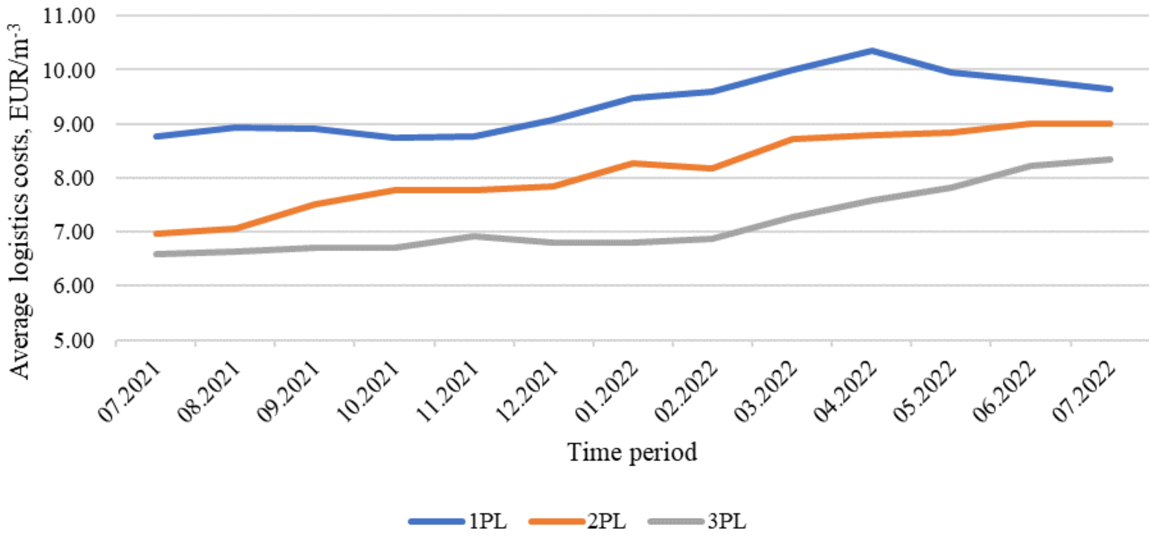

Figure 3. Average logistics costs of the fuel retail enterprise by logistics arrangement (2021–2022).

The calculation of logistics cost growth rates indicates that 1PL arrangement, despite incurring the highest logistics costs, has the lowest growth rate among the three logistics arrangements (Table 2). The analysis of the data indicates that the logistics costs for the 1PL arrangement increase at an annual rate of approximately 0.8%, whereas the logistics cost growth rates for outsourced services are 2.2% and 2.0% for the 2PL and 3PL arrangements, respectively. From the performed calculations it can be concluded, that a fuel retail enterprise capable of achieving economies of scale in the long term may gain a competitive advantage in the market by implementing 1PL arrangement, as it provides independency from the fluctuations of logistics services charges, and yields the lowest logistics cost growth rate, which can be attributed to the higher level of control over logistics management.

The subsequent stage in assessing the economic efficiency of the designed model involved conducting ABC analysis on the data available of the fuel retail enterprise. The purpose of this analysis was to segment the sales points of the fuel retail enterprise into three categories based on varying levels of strategic importance. As previously mentioned, the fuel retail enterprise operates 460 sales points. Specifically, 69% of the sales points are being serviced via 1PL arrangement, while 30% and 1% of the remaining sales points are served by 2PL and 3PL arrangements, respectively. The sales points were classified into three segments based on their fuel sales volume, in line with the distribution proportions of the proposed logistics management model. Upon performing the ABC analysis on the data obtained from the fuel retail enterprise, the results indicated a revised distribution of logistics arrangements. The analysis suggests that the fuel retail enterprise would be serving 46.1% of its sales points with 1PL arrangement, 35.4% of its sales points with 2PL arrangement, and 18.5% of its sales points with 3PL arrangement (Figure 4). Based on the analysis, it can be inferred that the implementation of the improved logistics management model would facilitate a higher level of integration of outsourced logistics services for the fuel retail enterprise.

Table 2

Calculation of average logistics cost growth rate for all three logistics arrangements

Time period	Logistics cost growth rate compared to previous period, %		
	1PL	2PL	3PL
07.2021	-	-	-
08.2021	2.1	1.5	0.9
09.2021	-0.4	6.3	0.9
10.2021	-1.9	3.5	0.1
11.2021	0.3	0.1	3.2
12.2021	3.5	0.8	-1.5
01.2022	4.4	5.3	-0.2
02.2022	1.4	-1.0	1.0
03.2022	4.1	6.7	5.9
04.2022	3.4	0.7	4.3
05.2022	-3.7	0.6	2.9
06.2022	-1.5	1.8	5.1
07.2022	-1.7	-0.1	1.5
Average	0.8	2.2	2.0

To determine the economic benefit of the improved logistics management model, the subsequent step involved calculation of the average logistics costs associated with each of the three logistics arrangements. For the calculation of the average logistics costs the following formula was used:

$$AC = \frac{TC}{Q} \quad (1)$$

where: AC – average logistics costs of a logistics arrangement per one cubic meter of fuel sold, EUR; TC – total annual logistics costs of a logistics arrangement, EUR; Q – total volume of fuel sold per year, m^3.

To calculate the average logistics costs, the available data of the fuel retail enterprise for the year 2021 was utilized. The data used for the calculation of the average logistics costs of the fuel retail enterprise consisted of the fuel volume sold and the logistics costs for each of the three logistics arrangements. The calculations of the average logistics costs for each of the three logistics arrangements were summarized in a table (Table 3). Based on the calculations, in 2021 the fuel retail enterprise incurred logistics costs of approximately 19.88 million EUR.

To calculate the projected logistics costs for the fuel retail enterprise after applying the improved logistics management model, it was necessary to determine the fuel sales volume for each of the three segments identified through the ABC analysis. Upon obtaining this data, the projected logistics costs for each of the three segments could be computed by using the formula:

$$C = AC * Q \quad (2)$$

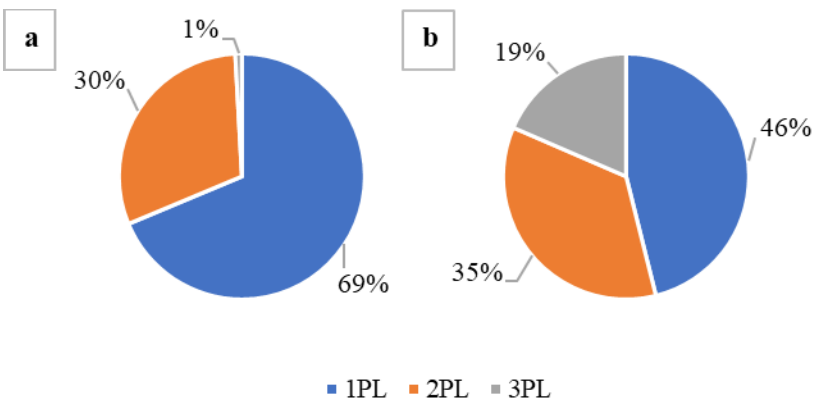

Figure 4. Distribution of LSPs in the fuel retail enterprise: in the current situation (a), and after applying the designed logistics management model (b).

where: C – annual logistics costs of a segment, EUR; AC – average logistics costs of a logistics arrangement per one cubic meter of fuel sold, Q – total volume of fuel sold, m^3.

The results of the projected logistics costs calculation for the fuel retail enterprise were summarized in a table (Table 4). Based on the calculations, it was determined that the implementation of the improved logistics management model for the fuel retail enterprise would result in a total annual logistics cost of approximately 19.23 million EUR. The results of the analysis indicate that implementation of the improved logistics management model would result in a reduction of logistics costs of approximately 650 thousand EUR, equivalent to a 3.3% decrease in logistics costs for the fuel retail enterprise.

An important factor for determining long-term economic efficiency of the designed logistics management model is the growth rate of logistics costs associated with the three different logistics arrangements. As previously analyzed, the logistics cost annual growth rate for the 1PL arrangement is approximately 0.8%, while that of the 2PL and 3PL rangements are 2.2% and 2.0%, respectively. By considering the aforementioned growth rates, a calculation was conducted to project the logistics costs for the fuel retail enterprise until the year 2027 (Table 5). Calculation was performed until the year 2027, as the fuel retail industry is subject to many unpredictable factors that can significantly affect logistics costs. By projecting logistics costs for a five-year period, the analysis becomes more realistic and provides insights for potential long-term economic efficiency of the logistics management model.

The results of the calculation until 2027 suggest that the implementation of the improved logistics management model can lead to a reduction in logistics costs for the fuel retail enterprise ranging from 2.91% to 3.32%. (Table 6). This suggests that the model has the potential to yield sustained economic benefits in the long term.

Although the calculations of potential economic benefits from implementing the improved logistics management model were based on data from a single fuel retail enterprise, they provide an indicative illustration of the potential benefits that may be realized by fuel retail enterprises that adopt the proposed logistics management model. The utilization of multiple logistics arrangements in combination allows for efficient allocation of resources, while the use of a 1PL arrangement provides independence from the rapidly growing logistics service charges and affords the highest level of control over logistics management.

Table 3

Calculation of the average logistics costs in 2021

Logistics arrangement	Total annual logistics costs, EUR	Fuel volume transported by each of logistics arrangement, m^{-3}	Average logistics costs, EUR/m^{-3}
1PL	16,752.397	1,380.246	12.14
2PL	3,019.390	371.370	8.13
3PL	109.642	15.229	7.19
Total	19,881.429	1,766.845	11.25

Table 4

Calculation of projected logistics costs in 2021 after applying the improved logistics management model

Segment category	Logistics arrangement used for segment	Average logistics costs, EUR m^{-3}	Fuel volume transported within segment, m^{-3}	Projected logistics costs, EUR
A	1PL	12.14	1,234.064	14,981.537
B	2PL	8.13	444.380	3,612.809
C	3PL	7.19	88.401	635.603
Total	-	-	-	19,229.950

Table 5

Projection of logistics costs for the period 2022–2027

Year	Period	Projected annual logistics costs, thousand EUR			Projected annual logistics costs after applying improved logistics management model, thousand EUR		
		1PL	2PL	3PL	1PL	2PL	3PL
2022	0	16,886	3,085	111	15,077	3,692	647
2023	1	17,021	3,153	113	15,197	3,774	660
2024	2	17,157	3,223	116	15,319	3,857	673
2025	3	17,295	3,294	118	15,441	3,942	686
2026	4	17,433	3,366	120	15,565	4,028	700
2027	5	17,572	3,440	123	15,689	4,117	714

Table 6

Calculation of projected logistics cost reductions through the implementation of the designed model

Year	Period	Projected annual logistics costs, thousand EUR	Projected annual logistics costs after applying improved logistics management model, thousand EUR	Logistics cost reduction	
				Thousand EUR	%
2022	0	20,083	19,416	667	3.32
2023	1	20,288	19,631	657	3.24
2024	2	20,496	19,848	647	3.16
2025	3	20,706	20,069	637	3.08
2026	4	20,919	20,293	626	2.99
2027	5	21,135	20,520	615	2.91

Additionally, the 1PL arrangement demonstrates the lowest logistics growth rate, making it a preferred solution for fuel retail enterprises that seek to leverage economies of scale.

Conclusions

Based on the research, the following conclusions can be made:

1. Implementation of 1PL arrangement for fuel retail enterprises can provide significant competitive advantage for fuel retail enterprises that are able to leverage economies of scale, as 1PL has a lower logistics cost growth rate compared to outsourced logistics services.
2. The disproportionate growth of outsourced logistics service charges compared to the in-house logistics costs can be attributed to the inadequate competition between logistics service providers in the fuel retail industry.
3. The proposed logistics management model, which utilizes ABC analysis, can enable fuel retail enterprises to enhance their resource allocation and optimize their logistics operations, leading to greater efficiency and potential logistics cost reduction.
4. Development of sustainable logistics management model for fuel retail enterprises requires long-term projections of logistics cost growth rates.
5. Further research is needed to explore the potential benefits and limitations of implementing the designed logistics management model for different fuel retail enterprises in various locations and under different circumstances.

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